INSTRUCTION MANUAL and PARTS CATALOG

FOR

Gasoline Driven ELECTRIC GENERATING SET

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MODEL JWC 4·10S-3

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D. W. ONAN & SONS INC. • MINNEAPOLIS 14, MINN.

918-54A

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CAUTION

This power unit must be properly installed and properly operated to insure the best performance.

Improper installation, lack of proper routine attention, or the use of improper oil or fuel may result in failure of the equipment when urgently needed.

STUDY THIS INSTRUCTION MANUAL THOROUGHLY

SAFETY NOTICE

1. DO NOT ATTEMPT ADJUSTMENTS OR CHANGES ON WIRING WHILE THE POWER UNIT 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.

3. EXHAUST GASES PRODUCED ARE POISONOUS, AND EXCESSIVE INHALATIONS MAY RESULT IN SEVERE SICKNESS OR DEATH. PIPE ALL EXHAUST GASES OUT OF DOORS.

4. 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.

5. OPERATOR SHOULD OBSERVE EVERY STANDARD SAFETY REGULATION WHILE OPERATING THIS POWER UNIT.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

DESCRIPTION

1. General—

a. Description.—Power Unit JWC4-10S-3, 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 JWC4-10S-3 supplies 127/220-volt, 4-wire, 3-phase, 60-cycle, alternating current. The rated capacity is 10 K.W. at unity power factor.

c. Purpose.—Power Unit JWC4-10S-3 is used to furnish electricity to operate radios, signal systems, lights, motors, heating units, other appliances, and for testing purposes, 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	Article	Width	Length	Height	Weight in Lbs.
1	Power Unit JWC4-10S-3	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. Fuel Consumption.—Fuel consumption at full load is approximately 1.9 gal. per hr.; at half load, 1.4 gal. per hr.; at no load, 1.1 gal. per hr.

g. 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.

h. 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

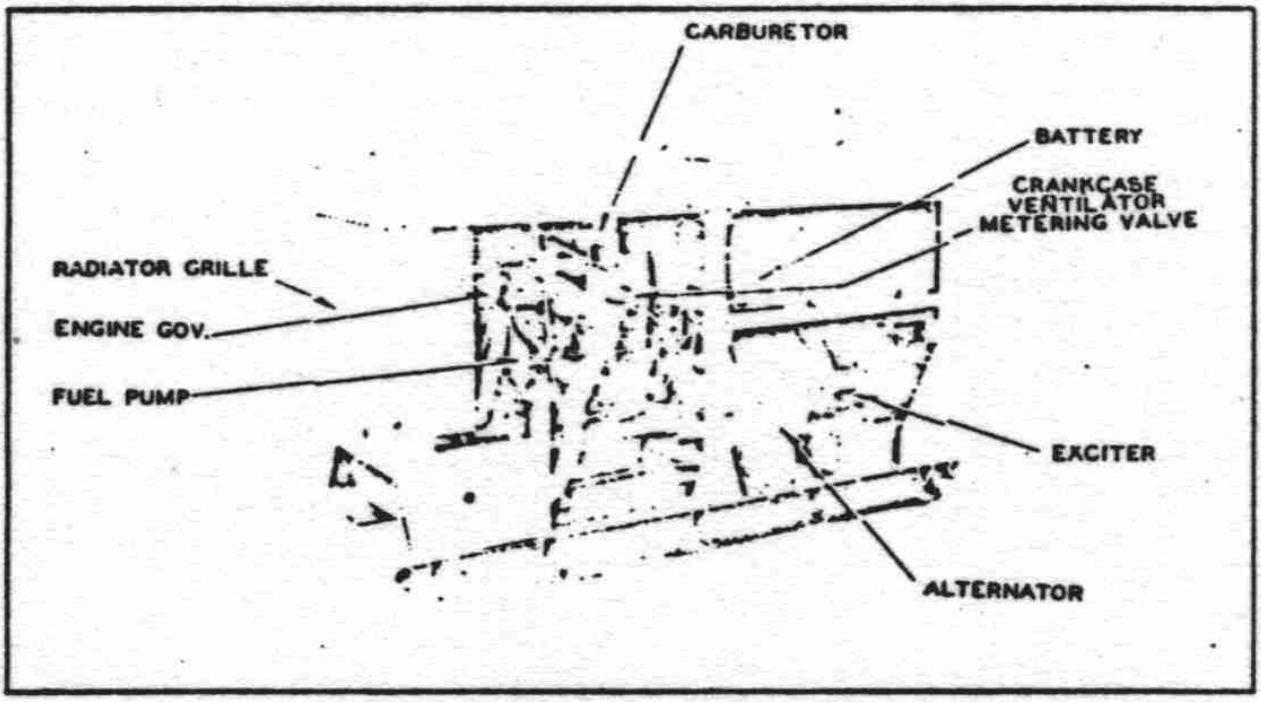

FIG. 1 POWER UNIT JWC4-10S-3 (RIGHT SIDE)

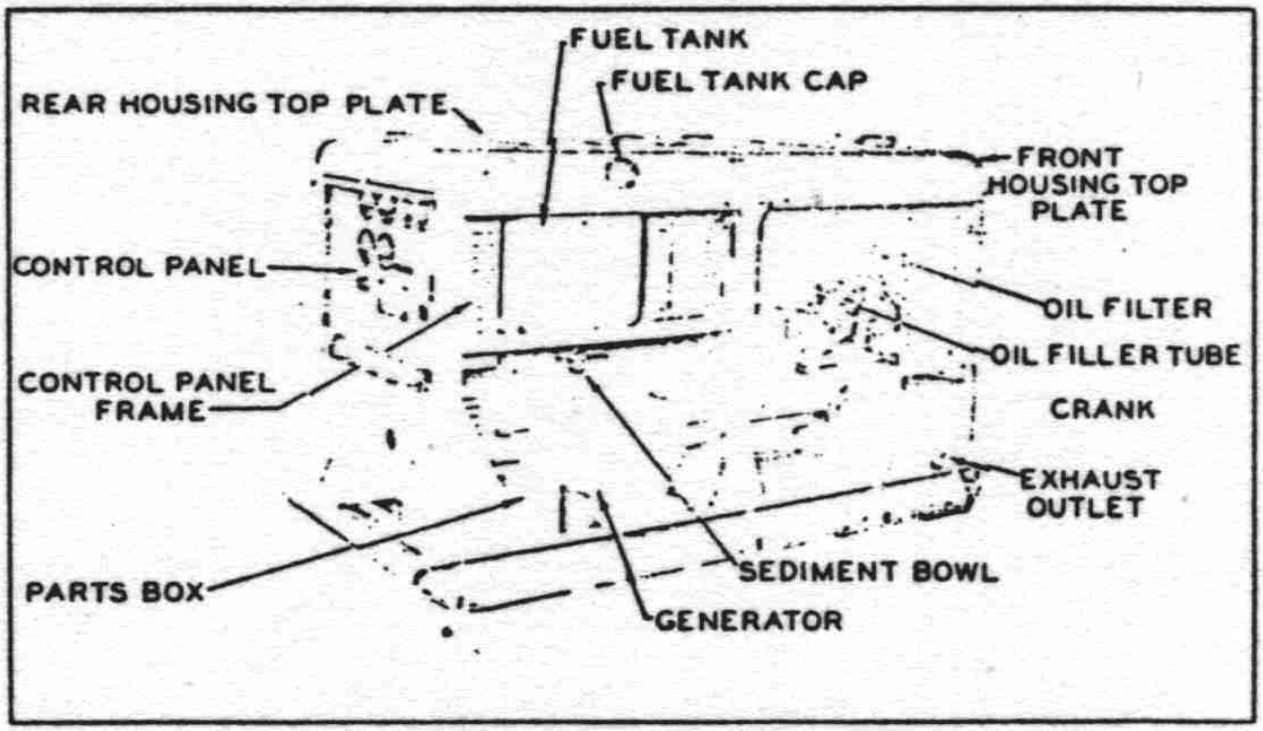

FIG. 2 POWER UNIT JWC4-10S-3 (LEFT SIDE)

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 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 127/220-volt, 4-wire, 3-phase, 60-cycle, alternating current. It is designed to operate with a full load temperature rise not to exceed 40° C.

f. Regulation.—

(1) *Voltage Regulation.*—The output voltage regulation of the generator after reaching normal operating temperature is within the limits of approximately 235 volts at no load to 215 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. Selector switch permits connecting with any one of the three load phases.

(2) *A.C. Ammeters.*—0-50 ampere scales, indicate the load amperes for each of the A.C. OUTPUT terminals A, B, and C.

(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) *Voltmeter Selector Switches.*—Serve to switch the A.C. VOLTMETER to any one of the three phases.

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

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

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

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

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

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 to approximately 6 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 too high.

(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.

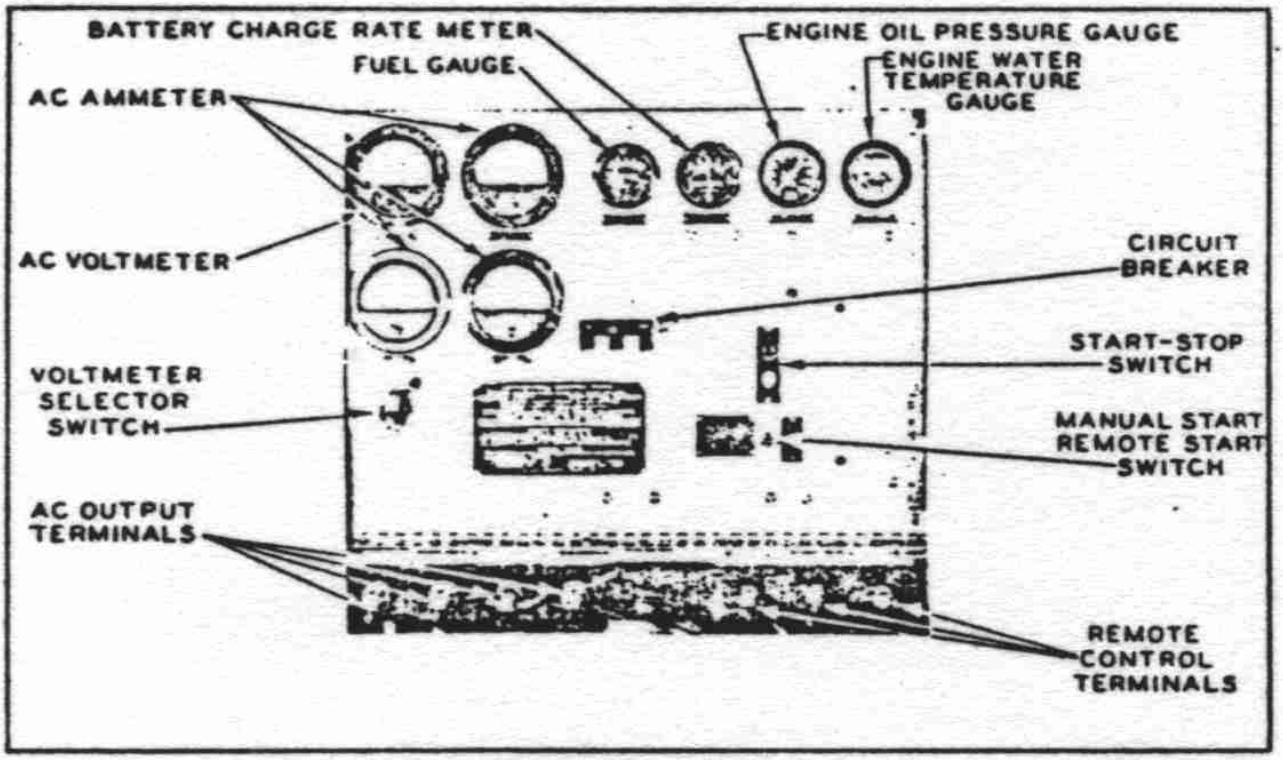

FIG. 3 CONTROL PANEL

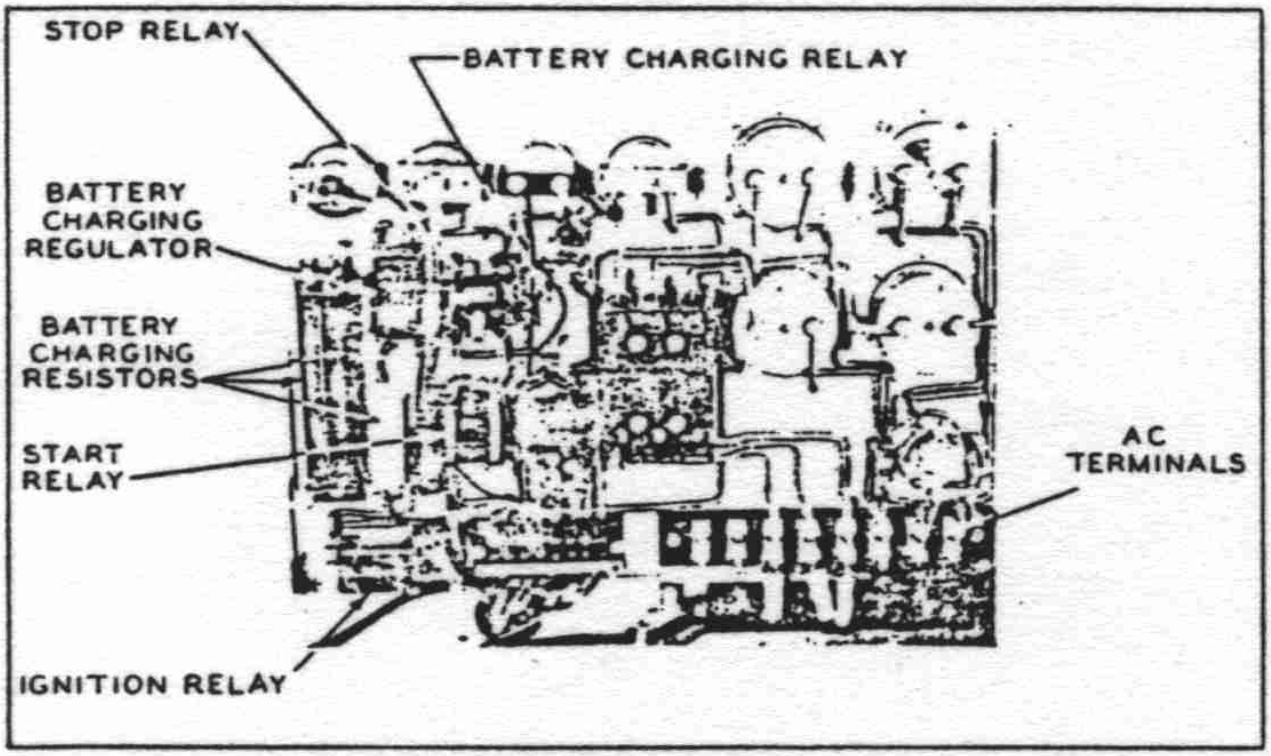

FIG. 4 CONTROL PANEL (REVERSE SIDE)

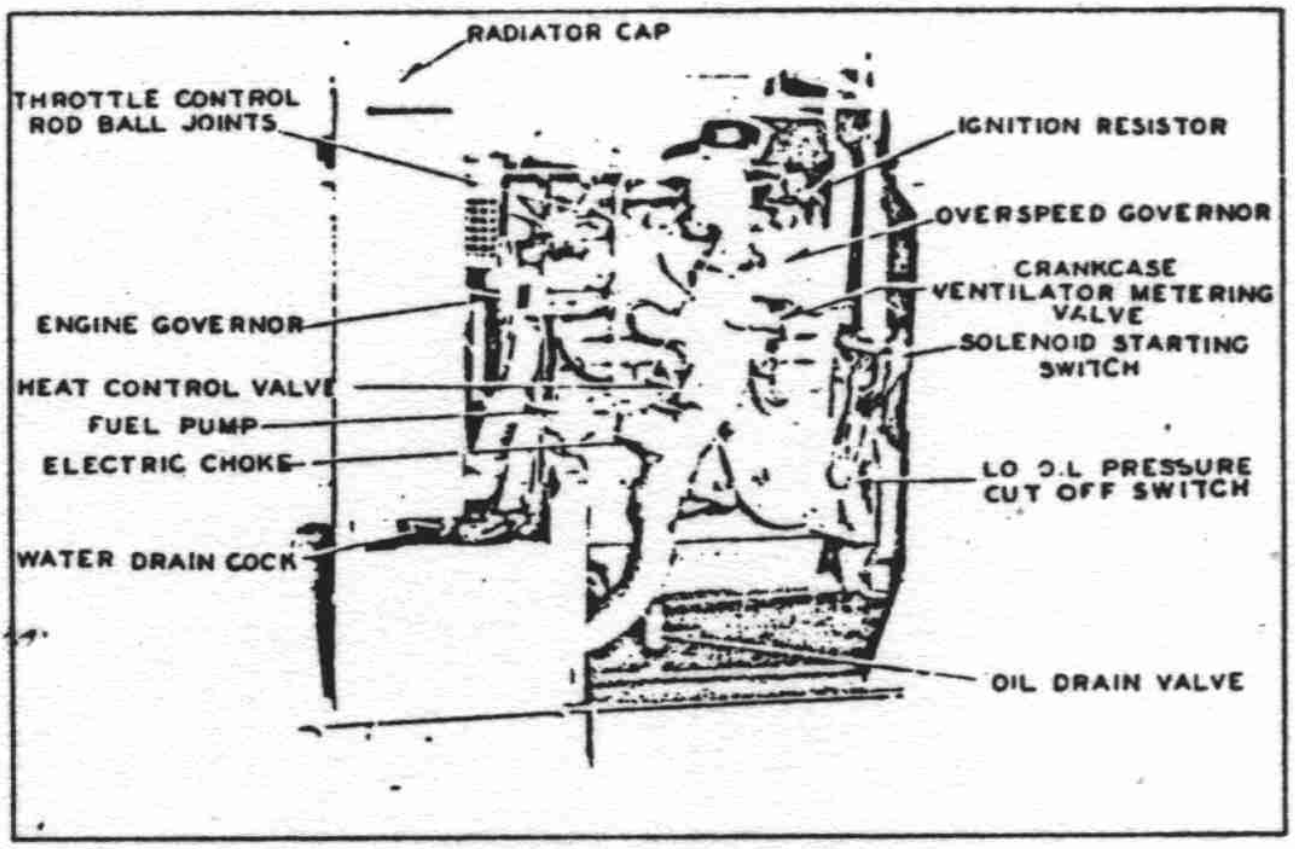

FIG. 5 RIGHT SIDE OF ENGINE

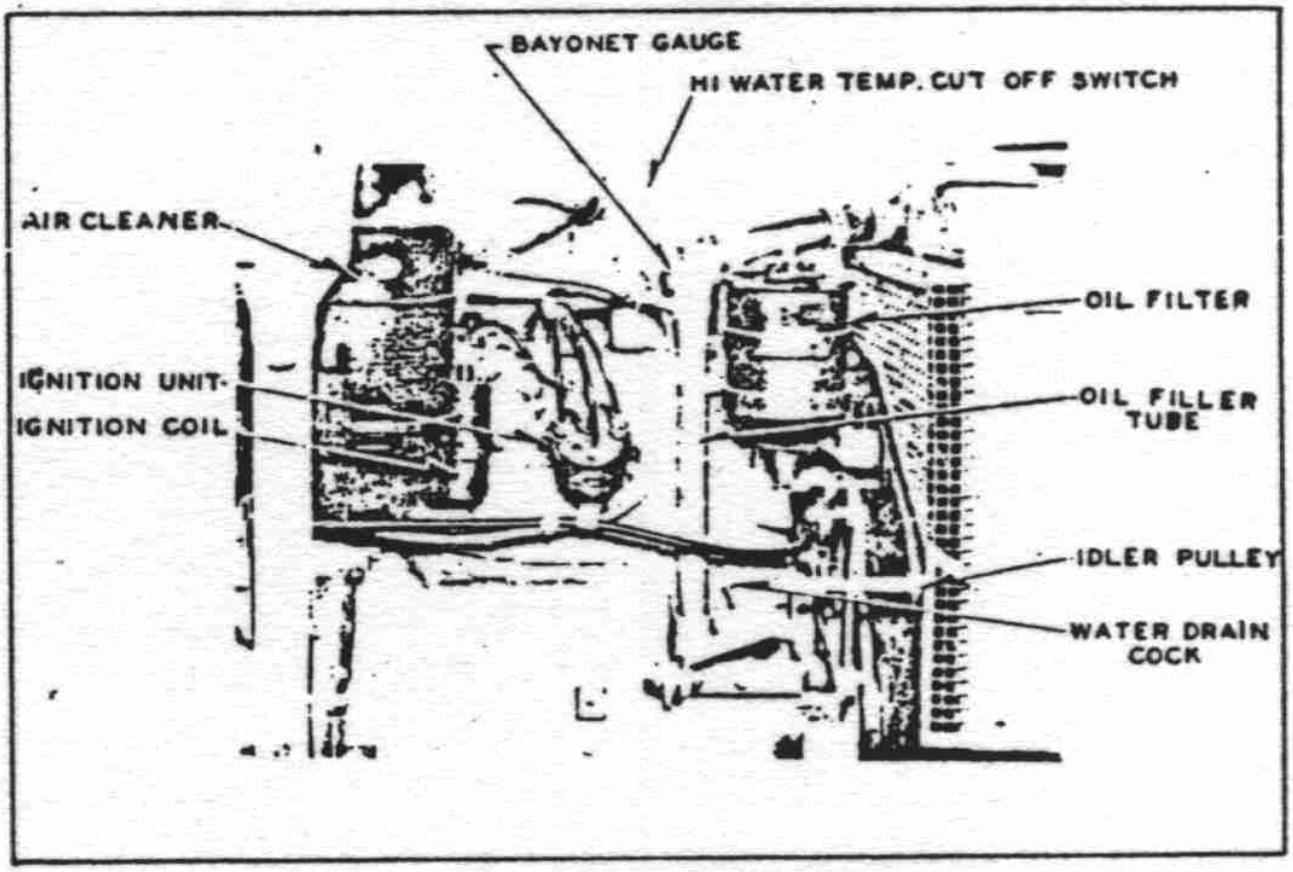

FIG. 6 LEFT SIDE OF ENGINE

(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.

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.

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 the power unit 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) *Electrical Connections.* — Connect the load wires to the A.C. OUTPUT terminal posts below the control panel. See the wiring diagram. One of the phase wires should be connected to each of the terminals A, B, and C. The neutral wire, if used, should be connected to the NEUTRAL terminal post. Use wire that is of proper size for the load. If the correct wire size is not known, the wiring tables in Section V may be used as a guide.

(3) *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 R. Connect the insulated terminal of the stopping switch to the REMOTE CONTROL terminal B. Connect the REMOTE CONTROL terminal W 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.

(4) The power unit should set approximately level when in operation even though mounted in a trailer.

(5) *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 the power unit 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, it would be desirable to install the power unit inside a building or inside a mobile vehicle. Observe all safety precautions mentioned in this section having reference to the dangers of exhaust gases, fire hazards, etc.

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. Install the fuel tank out-of-doors, if possible, but not farther from the power unit than a 20 ft. 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. Do not use wire that is too small. See Table of Maximum Safe Carrying Capacities for Inside Wiring in Section V. Make sure that all connections are mechanically and electrically secure.

c. 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.

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 which covers the vent holes. Fill each cell with the correct electrolyte to a level $\frac{3}{8}$ inch above the tops of the separators. Replace the vent caps and tighten securely. Be sure the Scotch tape has 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. (Approximately 4 quarts required.) Use good, clean, engine oil, crankcase grade, 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 (*d*). Refer to (Fig. 43) 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) *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.

(17) *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.

(a) Highly leaded fuel is not required and should be avoided if possible. Due to the action of the lead in the combustion chambers, on the valve seats, and on the spark plugs, such fuels cause engine performance to deteriorate more rapidly than normal.

(18) *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.

(19) *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.

(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 a-c output voltage. With a constant, unity power factor load, and after the power unit has reached normal operating temperature, the voltage should be between the limits of approximately 215 volts at full load and 235 volts at no load. The voltmeter selector switch permits reading the voltage across any one of the three load phases. Setting the switch to position 1 connects the voltmeter across load phase B-C (see wiring diagram); position 2, phase A-C; position 3, phase A-B.

(6) A.C. AMMETERS indicate the a-c output in amperes. Each of the three ammeters indicates the amperes for the A.C. OUTLET terminal to which it is connected. The upper ammeter serves for terminal B (see wiring diagram); the lower right ammeter for terminal A; the lower left ammeter for terminal C. Full load for any one terminal is 26.5 amperes. Three-phase load will register approximately equally on all three ammeters. A single-phase, 230-volt load will register on only the two ammeters corresponding with the output terminals to which the single phase load is connected. A single-phase, 127-volt load will register on only the one ammeter connected in the phase to which the single-phase load is connected. As far as practicable, single-phase load should be distributed approximately equally on the three phases to maintain a balanced condition. In any case, an individual ammeter reading should not exceed 32.5 amperes, which is an overload of 25% for the load phase to which it is connected.

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.

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 engine oil, crankcase grade, S.A.E. 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.

(d) Clean the generator slip rings, commutator and brushes often. See that the brushes ride easily in their holders.

(4) *Engine Water Temperature.*—The normal Engine Water Temperature gauge reading after the power unit reaches operating temperature is about 175° F. Under very cold operating conditions, cover a lower portion of the radiator surface with cardboard, if necessary, in order to raise the engine water temperature to at least 160° F.

(5) *Emergency Operation.*—In case of failure of the start relay or the ignition relay to close the ignition circuit, the engine cannot be operated with the MANUAL START-REMOTE START switch in the REMOTE START position. Under this condition the power unit may be operated with the MANUAL START-REMOTE START switch in the MANUAL START position. It will be necessary to switch to the REMOTE START position before the engine can be stopped by pressing the STOP button. When operating with the switch in the MANUAL START position, the High Water Temperature Cut-Off switch and the Low Oil Pressure Cut-Off switch do not operate. Extra attention should be given to avoid overheating and low oil pressure.

10. Trouble and Remedy Chart.—

Symptom	Possible Cause	Check	Remedy
Exciter will not crank engine. May use hand crank until trouble corrected.	Discharged battery.	Hydrometer test.	Recharge or replace battery.
	Corroded terminals.	Battery terminals.	Clean and tighten terminals.
	Loose connections.	Cable connections.	Tighten connections.
	Defective solenoid switch.	Short across large terminals of switch.	Replace switch.
	Engine stuck.	Try with hand crank.	Return unit to depot for repairing.
	Defective start relay.	Start relay operation.	Clean contacts. Return unit to depot for replacement if necessary.
	Exciter will not operate as a motor.	Short across large terminals of solenoid switch.	Return unit to depot for repairing.
Engine cranks too slowly. May use hand crank until trouble corrected.	Too heavy oil in crankcase.	Inspect oil.	Drain, refill with lighter oil.
	Weak battery.	Hydrometer test.	Recharge or replace battery.
	Corroded terminal.	Battery terminals.	Clean and tighten terminals.
	Defective cable.	Battery cables.	Install new cable.
Engine runs but AC voltage does not build up.	Poor commutation.	Exciter brushes and commutator.	See that brushes seat well on commutator, are free in holders, are not worn shorter than $\frac{3}{4}$" and have good spring tension. If commutator is rough or badly grooved, return unit to depot for repair.
	Open circuit, short circuit or ground in generator.	No simple test, see paragraph 50h.	Return unit to depot for repairs.
	Poor seating of brushes on slip rings.	Slip rings and brushes.	Give slip ring brushes same attention as commutator brushes.

Symptom	Possible Cause	Check	Remedy
Engine is cranked electrically but will not start.	Battery too weak to supply ignition while cranking.	Hydrometer test.	Recharge or replace battery. Start by hand crank meanwhile.
	Faulty ignition.	Spark plugs.	Clean, adjust or replace plugs.
		Breaker contacts.	Resurface or replace contacts and adjust gap.
		Coils, cables, condenser.	Replace defective parts.
	Corroded start relay contacts.	Try with Manual Start-Remote Start switch in Manual Start position.	Clean the relay contacts. Return unit to depot for replacements if necessary.
	Lack of fuel or faulty carburetion.	Fuel tank empty.	Refill.
		Clogged fuel line.	Clean.
		Shut-off cock closed.	Open shut-off cock.
		Fuel screens.	Clean.
		Fuel pump.	Clean, repair or replace.
		Electric choke.	Replace, if defective.
		Cylinders flooded.	Crank few times with spark plugs removed.
		Poor fuel.	Drain, refill with good fuel.
		Dirt in carburetor.	Clean.
	Poor compression, usually because of leaking valves.	Hand crank with ignition off, noting whether compression uniformly good on all cylinders.	Tighten or replace head gasket. Tighten spark plugs. Adjust tappets. If still not corrected, return unit to depot for repairing.
	Wrong timing.	Spark timing.	Retime.
Voltage unsteady but engine not missing.	Poor commutation or poor brush contact at slip rings.	Exciter commutator and brushes.	See that brushes seat well on commutator, are free in holders are not worn shorter than $\frac{3}{4}$" and have good spring tension. If commutator is rough or badly grooved, return unit to depot for repairs. Tighten connections.
	Loose connections, especially in exciter circuits.	Check for loose connections.	
	Fluctuating load.	Check load. Some fluctuating loads, such as a motor driving a single action reciprocating pump, are normal conditions.	Correct any abnormal load condition causing trouble.
Generator overheating.	Overloaded.	Ammeter.	Reduce load.
Voltage drops under heavy load.	Engine lacks power.	See symptom of engine missing under heavy load.	See remedies for engine missing under heavy load.
		Crank with ignition off, noting whether compression uniformly good on all cylinders.	Tighten or replace head gasket. Tighten spark plugs. Adjust tappets. If still not corrected, return unit to depot for repairing.
		Carburetor.	Clean carburetor.
		Carburetor air cleaner.	Clean air cleaner.
		Choke.	See that it opens wide.
		Carbon in cylinders.	Remove carbon.
		Restricted exhaust line.	Clean or increase the size.
Engine misses at light load.	Carburetor idle adjustment set wrong or clogged.	Carburetor.	Adjust, clean if needed.
	Spark plug gaps too narrow.	Spark plugs.	Set at .030".
	Intake air leak.	Intake manifold.	Tighten or replace gaskets.
	Faulty ignition.	Breaker and coil.	Adjust or replace.
	Uneven compression.	Crank with ignition off noting whether compression uniformly good on all cylinders.	Tighten head gasket and spark plugs. Adjust tappets. If still not corrected return unit to depot for repairing.
Engine misses at heavy load.	Spark plugs defective.	Spark plugs.	Replace.
	Faulty ignition.	Breaker, coil and condenser.	Adjust or replace.
	Clogged carburetor jets.	Carburetor.	Clean.
	Clogged fuel screens.	All fuel screens.	Clean.
	Tappets adjusted too close.	Tappets.	Adjust.
	Defective high tension cables.	High tension cables.	Replace.

Symptom	Possible Cause	Check	Remedy
Engine misses at all speeds.	Fouled spark plug.	Spark plugs.	Clean and adjust.
	Defective or wrong spark plug.	Spark plugs.	Replace.
	Sticking valves.	Valves.	Return unit to depot for repairing.
	Broken valve spring.	Valve springs.	Replace.
	Defective ignition wires.	Ignition wiring.	Replace.
	Pitted or improperly adjusted breaker contacts.	Breaker contacts.	Adjust or replace.
	Defective ignition condenser.	See if breaker contacts sooty and spark weak and yellow.	If so, replace condenser.
	Tappets need adjusting.	Tappets.	Adjust.
Low oil pressure.	Oil too light.	Inspect oil.	Drain, refill with proper oil.
	Oil badly diluted.	Inspect oil.	Drain, refill with proper oil.
	Oil too low.	Oil level.	Add oil.
	Oil relief valve not seating.	Oil relief valve.	Remove and clean.
	Badly worn engine bearings.	Smoky exhaust, excessive oil consumption which cannot otherwise be accounted for.	Return unit to depot for repairing.
	Sludge on oil screen.	Must remove pan to check.	Return unit to depot for checking.
	Badly worn oil pump.	No simple check.	Return unit to depot for checking.
	Defective oil gauge.	No simple check.	Return unit to depot for checking.
High oil pressure.	Oil too heavy.	Inspect oil.	Drain, refill with proper oil.
	Clogged oil passage.	No simple test.	Return unit to depot for repairing.
	Oil relief valve stuck.	Oil relief valve.	Remove and clean.
	Defective oil pressure gauge.	Should read zero when unit not operating.	If not, install new oil pressure gauge.
Engine stops unexpectedly.	Fuel tank empty.	Fuel gauge.	Refill, or set fuel shut-off valve for other tank.
	Water temperature high.	Water in radiator.	Add water.
		Cardboard over radiator.	Remove cardboard.
		Unit overloaded.	Reduce load.
		Ventilation.	Increase ventilation.
		Fan belt.	Tighten, or install new one.
		Water not circulating freely due to sludge or defective hose.	Drain, flush and refill radiator, replace defective hose.
	High water temperature cut-off switch set too low temperature.	High water temperature cut-off switch.	Set dial to correct temperature.
	Low oil pressure, usually due to lack of oil.	Bayonet gauge.	Add oil to crankcase.
Engine backfires at carburetor.	Lean fuel mixture.	Carburetor.	Clean carburetor.
		Fuel screens.	Clean screens.
		Air leaks at intake manifold.	Replace gaskets, tighten.
	Poor fuel.	Fuel.	Drain, fill with good fuel.
	Spark too late.	Flywheel marks.	Retime ignition.
	Distributor wires crossed.	Distributor wires.	Install wires correctly.
	Intake valves leaking.	Hiss through carburetor when hand cranked with ignition off.	Adjust tappets. If this does not correct, return unit to depot for servicing.
Black, smoky exhaust, excessive fuel consumption, fouling of spark plugs with black soot, possible lack of power under heavy load.	Fuel mixture too rich.	Carburetor float for leak and high level, needle valve for leak, jets and metering rod for wear or damage, gasket washers for leaks.	Install needed carburetor parts, adjust float level. Be sure all jet gaskets are in place and tight and needle valve gasket is in place and tight.
	Choke not open.	Choke.	See that choke opens properly.
	Dirty carburetor air cleaner.	Air cleaner.	Clean, refill to proper oil level.
Circuit breaker trips and disconnects load.	Load too great.	Ammeters.	Reduce load.
	Load line short circuited.	Ammeters.	Remove short circuit.

Symptom	Possible Cause	Check	Remedy
Excessive oil consumption, light blue smoky exhaust.	Poor compression, usually due to leaking valves.	Hand crank with ignition off, noting whether compression uniformly good on all cylinders.	Tighten or replace head gasket. Tighten spark plugs. Adjust tappets. If still not corrected, return unit to depot for servicing.
	Oil leaks from oil pan or connections. This does not cause smoky exhaust.	Inspect visually for leaks.	Replace gaskets and leaking tubing. Tighten screws and connections.
	Oil too light or diluted.	Inspect oil.	Drain, refill with correct oil.
	Bearing clearance too great.	Oil pressure gauge registers low and this cannot otherwise be accounted for.	Return unit to depot for repairing.
	Oil pressure too high.	Oil pressure gauge.	Refer to symptom of high oil pressure for remedies.
	Engine misses firing.	Voltmeter reading unsteady and exhaust irregular.	Refer to symptoms of engine misses.
	Faulty ignition.	Spark plugs.	Clean, adjust or replace.
		Breaker contacts.	Resurface or replace contacts and adjust gap.
		Coils, cables, condenser.	Replace defective parts.
	Unit operated a great deal at light or no load.	Operating conditions.	No remedy needed.
	Too much oil.	Bayonet gauge.	Drain excess oil.
Lights dim at far end of line but bright near unit.	Too small line wire for load and distance.	Wire size, against load and distance.	Install larger or extra wires or reduce load.
Motors run too slowly and overheat at far end of line but OK near unit.	Too small line wire for load and distance.	Wire size, against load and distance.	Install larger or extra wires or reduce load.
Light pounding knock.	Loose connecting rod bearing.	Short out one spark plug at a time to locate.	Return unit to depot for repairing.
	Low oil supply.	Bayonet gauge.	Add oil.
	Low oil pressure.	Oil pressure gauge.	Refer to symptom of low oil pressure for remedies.
	Oil badly diluted.	Inspect oil.	Change oil.
Dull metallic thud, if not real bad may disappear after few minutes operation. If bad, increases with load.	Loose crankshaft bearing.	Accelerate under load.	Return unit to depot for repairing unless one of the next 3 remedies permanently corrects the trouble.
Sharp metallic thud, especially when cold plant first started.	Low oil supply.	Bayonet gauge.	Add oil.
	Low oil pressure.	Oil pressure gauge.	Refer to symptom of low pressure for remedies.
	Oil badly diluted.	Inspect oil.	Change oil.
Pinging sound when engine is rapidly accelerated or heavily loaded.	Carbon in cylinders.	Inspect through spark plug hole.	Remove carbon.
	Spark too early.	Flywheel marks.	Retime ignition.
	Wrong spark plugs.	Spark plugs.	Install Champion J-9 plugs.
	Spark plugs burned or carboned.	Spark plugs.	Install new plugs.
	Valves hot.	Tappet clearance.	Adjust tappets.
	Fuel stale or low octane.	Fuel.	Use good, fresh fuel.
	Lean fuel mixture.	Carburetor.	Clean.
Clicking sound.	Tappet clearance too great.	Tappet clearance.	Adjust tappets.
	Broken valve spring.	Valve springs.	Install new spring.
Hollow clicking sound with cool engine under load.	Loose pistons.	Put tablespoonful heavy oil in cylinder suspected. Crank engine with ignition off to lubricate piston. Then start engine. If noise not present, indicates loose piston or piston rings.	If noise only slight and disappears when engine warms up, no immediate attention needed. Otherwise return unit to depot for repairing.

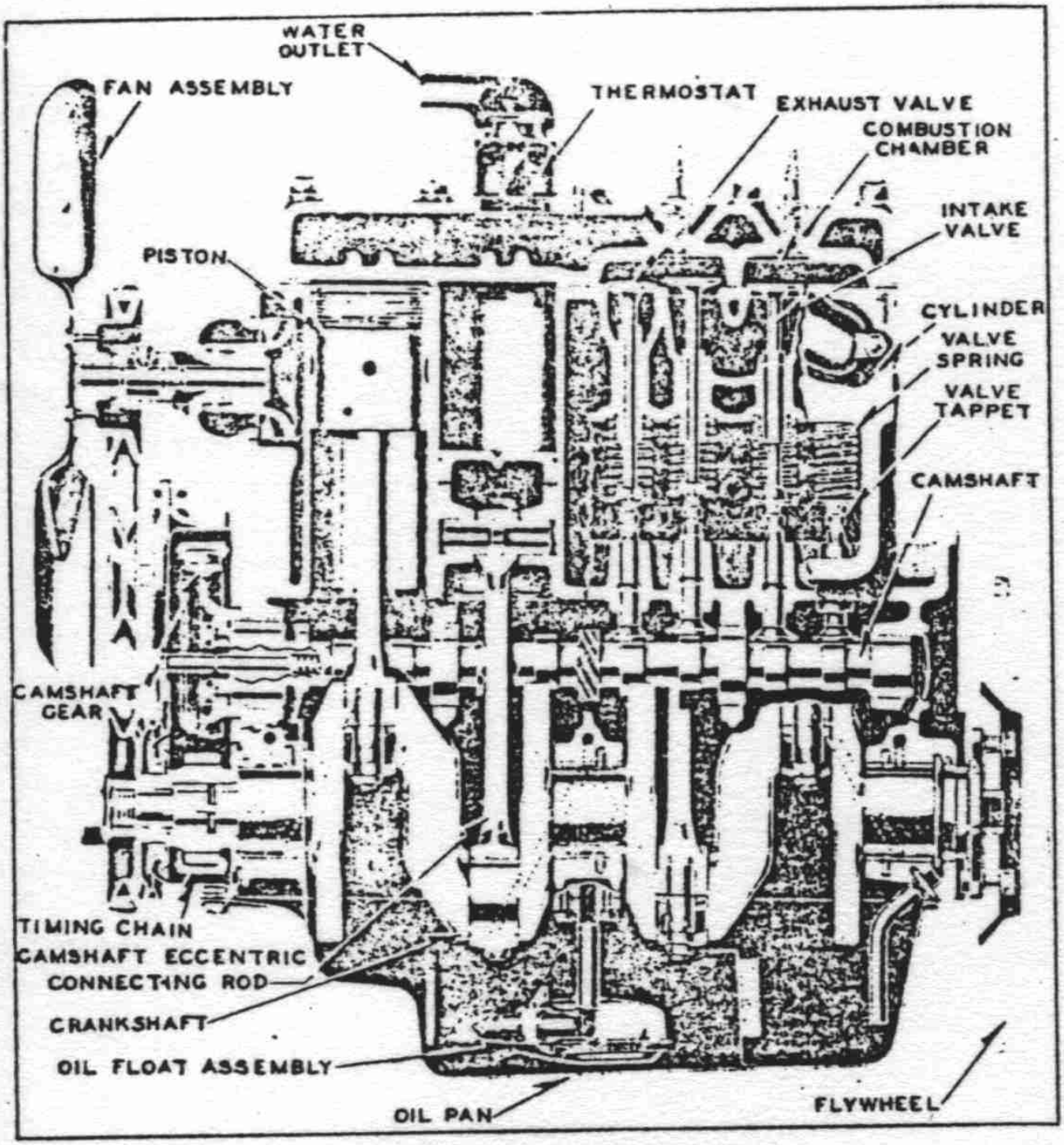

FIG. 7 SIDE SECTIONAL VIEW OF ENGINE

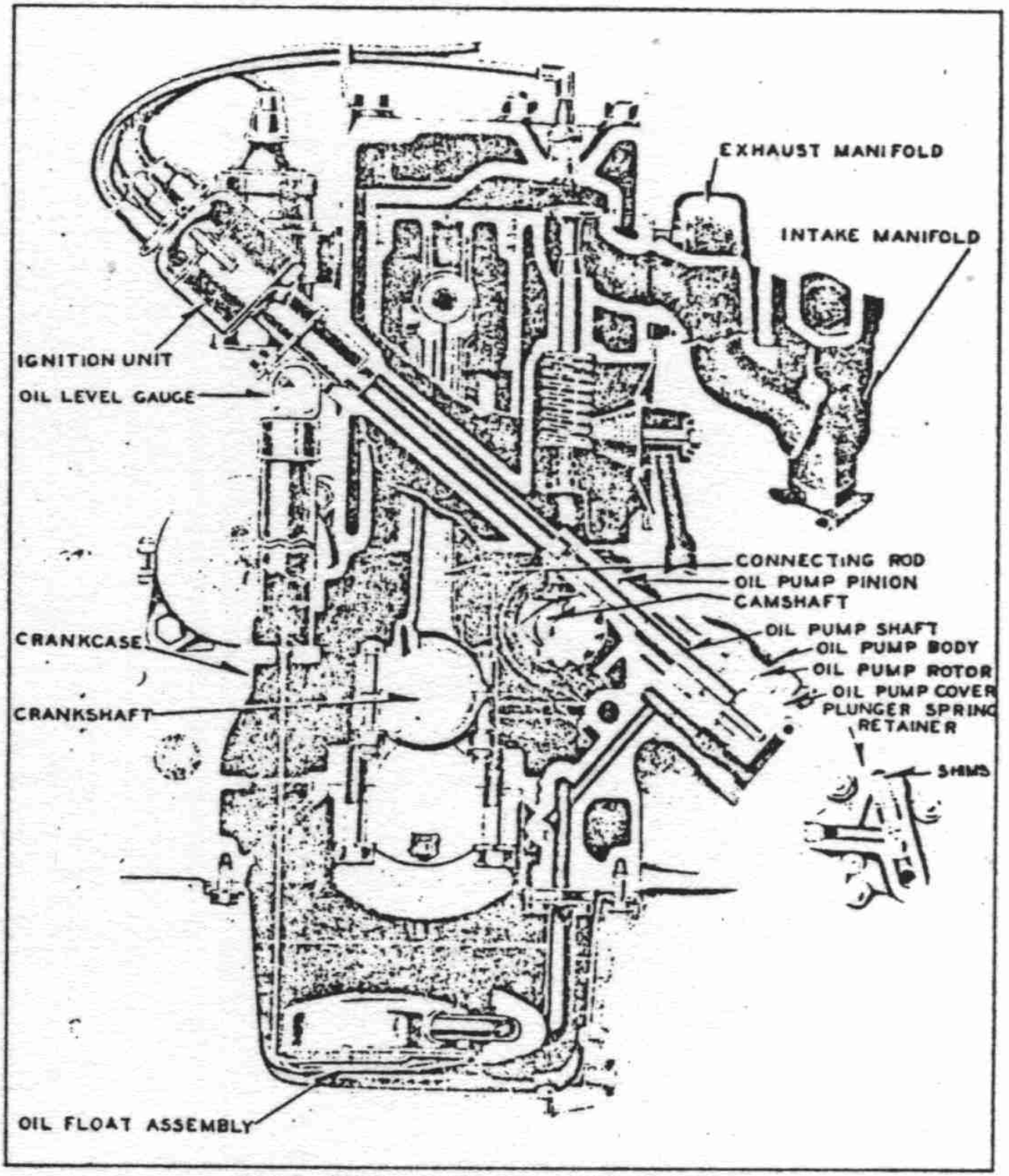

FIG. 8 FRONT SECTIONAL VIEW OF ENGINE

11. Engine.—

a. Four Stroke Cycle.—The engine, Figs. 2, 7 and 8, used in this power unit is a conventional automotive type of internal-combustion, gasoline engine. Such engines develop their power by burning a mixture of gasoline and air under compression in the cylinders and applying the resulting expanding force on the heads of the pistons. The resulting downward motion of pistons is transmitted through connecting rods to the cranskshaft, resulting in rotary motion of the crankshaft. This engine operates on the usual four-stroke-cycle principle, the action of which may be considered as being a repetition of a cycle of four different strokes. The action of each cylinder is the same, but is 180° of crankshaft travel later than that of the preceding cylinder. Firing order is 1-3-4-2.

(1) *Intake Stroke.*—The piston travels downward while the intake valve is open and the exhaust valve is closed. The resulting reduction in pressure within the cylinder allows air to rush in through the air cleaner, carburetor, intake manifold and intake valve port. As the air passes through the carburetor the proper proportion of gasoline is mixed with it.

(2) *Compression Stroke.*—The piston travels upward with both valves closed and compresses the fuel mixture in the combustion chamber at the upper part of the cylinder. As the piston reaches the top of the stroke a spark occurs at the spark plug and burning of the fuel mixture begins.

(3) *Power Stroke.*—Burning of the fuel mixture continues, developing great heat and pressure. Both valves are closed. The piston is forced downward, transmitting its power to the crankshaft.

(4) *Exhaust Stroke.*—The piston travels upward with exhaust valve open, intake valve closed, and forces the exhaust gases from the cylinder. These gases pass out through the exhaust port, exhaust manifold, exhaust pipe and muffler.

b. Power.—The amount of power developed by the engine, and hence its speed under a given load, is determined by the position of the throttle valve in the carburetor which regulates the amount of fuel mixture that enters the cylinders. The throttle valve is automatically controlled by the engine governor.

c. Valves and Camshaft.—The valves are operated in proper sequence and timing by tappets which ride on a series of cams on the camshaft. The camshaft is driven by a chain from a sprocket on the crankshaft and turns at just half the speed of the crankshaft. The valves are closed by spring action. A gear on the camshaft drives the oil pump and ignition unit.

d. Cooling.—Water is circulated around the cylinders, valve ports and combustion chambers to conduct heat away from the engine. The water flows from the outlet at the top of the cylinder head, to the radiator where it is cooled, then returned to the water jacket. Circulation is maintained by a centrifugal type water pump. Air circulation is maintained by a pusher type fan. A thermostat in the water outlet at the top of the cylinder head tends to maintain a uniform water jacket temperature under varying operating conditions by regulating the water circulation. The radiator cap is designed to maintain a pressure of four pounds per square inch before releasing vapor through the overflow pipe, thus to save water.

e. Lubrication.—Lubrication is provided within the engine by pumping oil from the oil pan to the main, connecting rod and camshaft bearings from which it sprays to other interior parts. The oil pressure registers on the ENGINE OIL PRESSURE gauge on the control panel and is regulated by a pressure relief valve in the pump body.

12. Oil Filter.—

The oil filter, (Fig. 6), on the left side of the engine filters particles of dust, carbon and other foreign material from the crankcase oil. Oil from the pressure lubricating system of the engine passes into the filter near the top, then through the filter and out at the bottom connection, from which it is conducted to the timing chain cover and returns to the crankcase. In service the filter element becomes filled with foreign material collected from the oil and no longer can perform its function. It must then be replaced with a new element. Only a portion of the oil leaving the pump passes through the oil filter, but all the oil in the crankcase passes through frequently enough to be kept in a clean condition if the filter element is changed often enough. As soon as the oil becomes dark, the element should be changed.

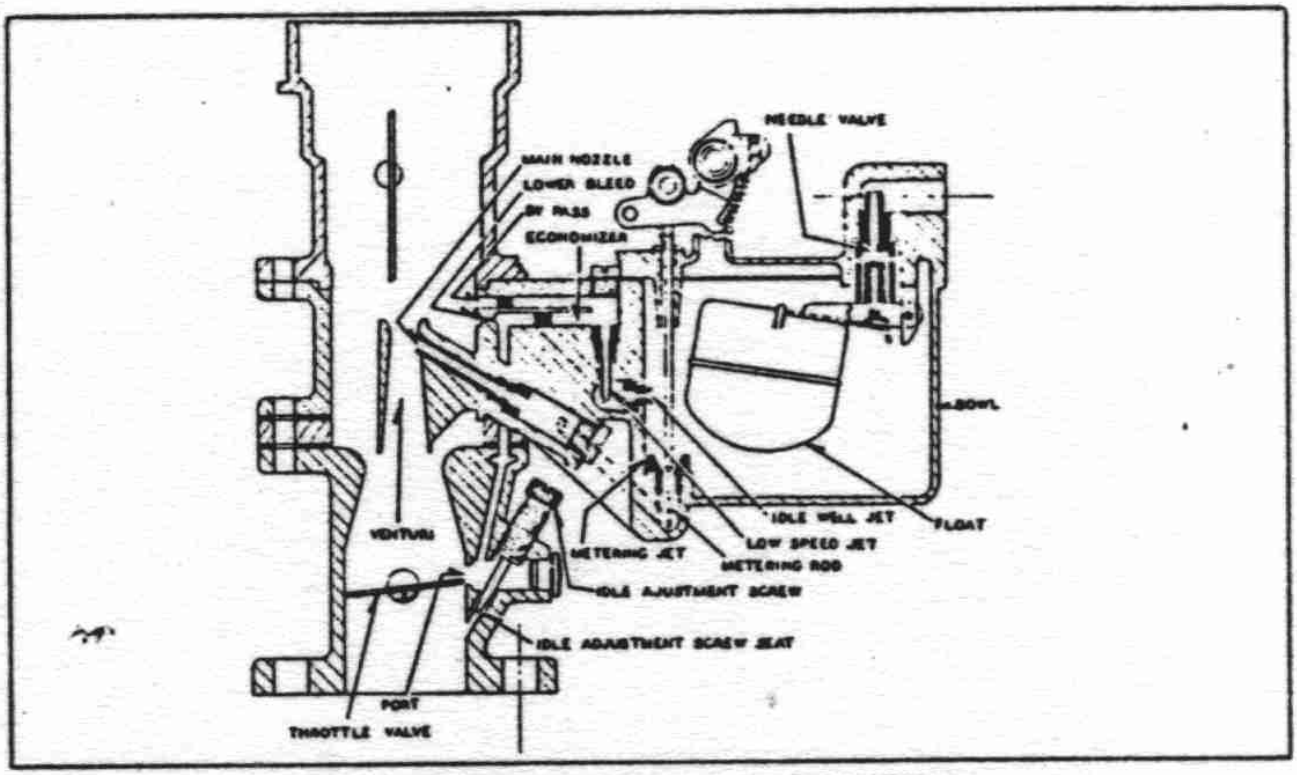

FIG. 9 CARBURETOR FUNCTIONING DIAGRAM

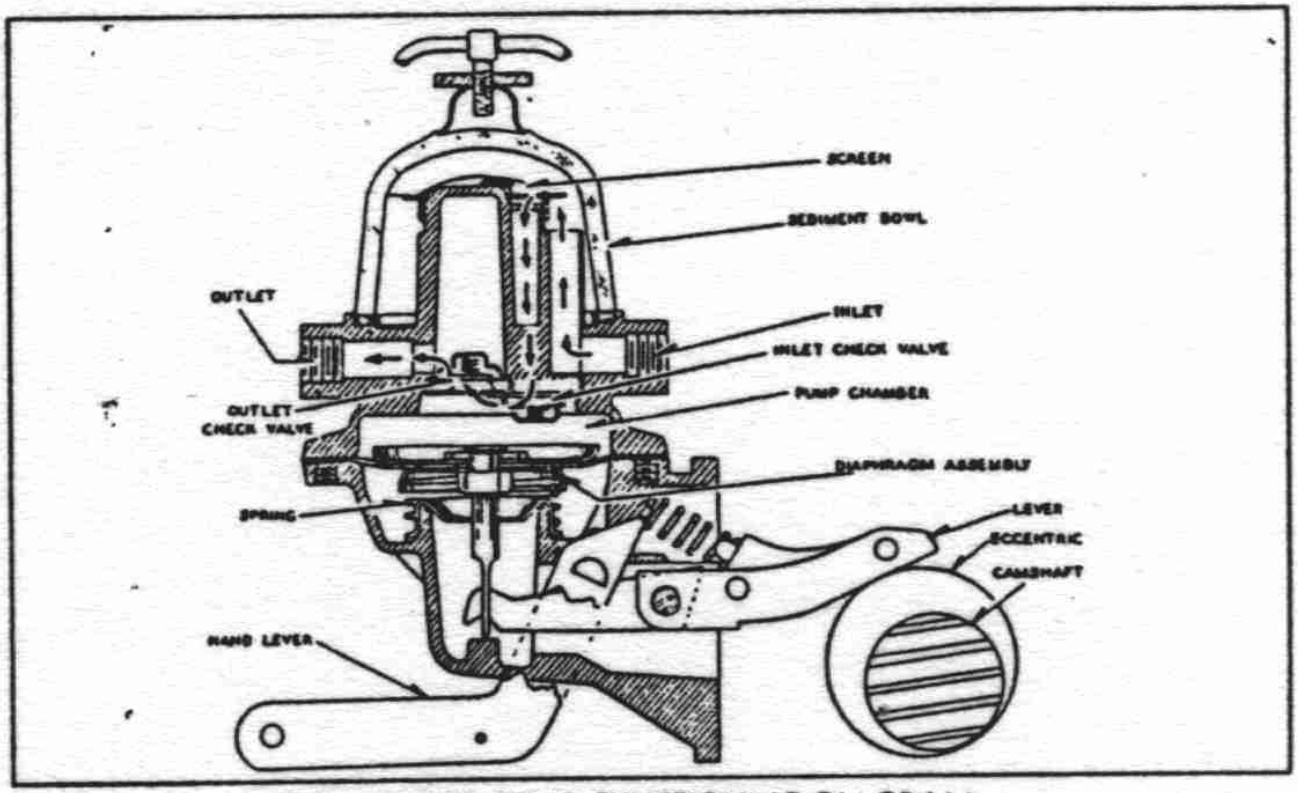

FIG. 10 FUEL PUMP FUNCTIONING DIAGRAM

13. Engine Governor.—

The engine governor, (Fig. 5), is of the conventional fly-weight type, driven by a V-belt from a pulley on the crankshaft. It controls the engine speed and, thus, the frequency of the alternating current generator. The governor arm is connected with the throttle arm of the carburetor and the action is such that an increase in engine speed tends to close the throttle, and vice versa. The engine speed may be adjusted by adjusting the spring tension. The governor is lubricated by oil from the pressure lubricating system of the engine.

14. Carburetor.—

This power unit is equipped with a Carter, No. 572 S, downdraft, metering jet type carburetor, Figs. 5, and 9, the prime function of which is to deliver a proper mixture of fuel and air to the engine under all load conditions.

a. Gasoline enters the carburetor bowl through the float-operated needle valve assembly, the level to which it rises in the bowl being controlled by the float.

b. When operating at very light load, the throttle valve is nearly closed and most of the gasoline enters the fuel mixture by way of the idle well jet, low speed jet, economizer, near which point it combines with streams of air from the by-pass and lower bleed, and then through passage to the port and the idle adjustment screw seat. This mixture is richer than required, but upon further mixing with air from the venturi provides a suitable mixture, the combined richness being adjustable by means of the idle adjustment screw.

c. At about 30% of full load the throttle valve opens so far that little fuel passes through the path just described. However, at this throttle position the reduction of air pressure at the tip of the main nozzle allows fuel to pass from the carburetor bowl through the metering jet, through the passage and the main nozzle, and into the main air stream. The amount of fuel through this path depends on the degree of reduction of pressure at the tip of the main nozzle below atmospheric pressure and upon the effective opening through the metering jet.

d. As the throttle valve opens further under increasing load, the pressure at the tip of the main nozzle is further reduced and the metering rod is raised by mechanical linkage with the throttle so as to increase the effective opening through the metering jet. The various parts are so proportioned as to provide a suitable mixture at all operating loads.

e. The pump with which the carburetor is equipped is not required and should be disconnected.

15. Fuel Pump.—

The diaphragm type fuel pump, Figs. 5 and 10, operates continuously while the plant is in operation and supplies fuel from the fuel tank to the carburetor. It is mounted on the right side of the engine and driven by an eccentric on the camshaft.

a. A special lever arrangement transmits motion to the diaphragm assembly. When the diaphragm assembly is drawn downward, the pressure within the pump chamber is reduced and fuel flows from the fuel tank, through the fuel line and into the pump inlet. It passes upward through the inverted sediment bowl, through the screen and inlet check valve into the pump chamber. Upward movement of the diaphragm forces fuel from the pump chamber through the outlet check valve and the pump outlet. From the pump outlet the fuel passes through a fuel line to the carburetor.

b. The diaphragm is pulled downward by the lever arrangement, but is returned upward by the action of the spring. After the carburetor bowl becomes filled with fuel, the diaphragm returns upward only as permitted by the flow of fuel through the needle valve of the carburetor.

c. A hand lever permits operating the pump manually for the initial filling of the carburetor bowl after it has been drained or has run dry because of an empty fuel tank.

16. Air Cleaner.—

The air cleaner, (Fig. 6), cleans the air which enters the carburetor intake. Air enters near the top of the cleaner, passes down and over or through a pool of oil in the cup at the bottom. Some oil is carried up and deposited in the metallic filter element. Surplus oil which does not adhere to the filter element runs back into the cup. Dust and foreign particles in the air adhere to the oily surface of the element and are constantly washed back into the cup where they settle to the bottom. Cleaning the cup and filter and filling to the proper level with clean oil when necessary keeps the cleaner in good functioning condition.

17. Ignition System.—

a. *Purpose*.—The compressed gases of the fuel mixture in a cylinder are ignited by a spark which jumps the gap between the spark plug electrodes. The high voltage required to produce this spark is furnished by means of the ignition coil, (Fig. 6),

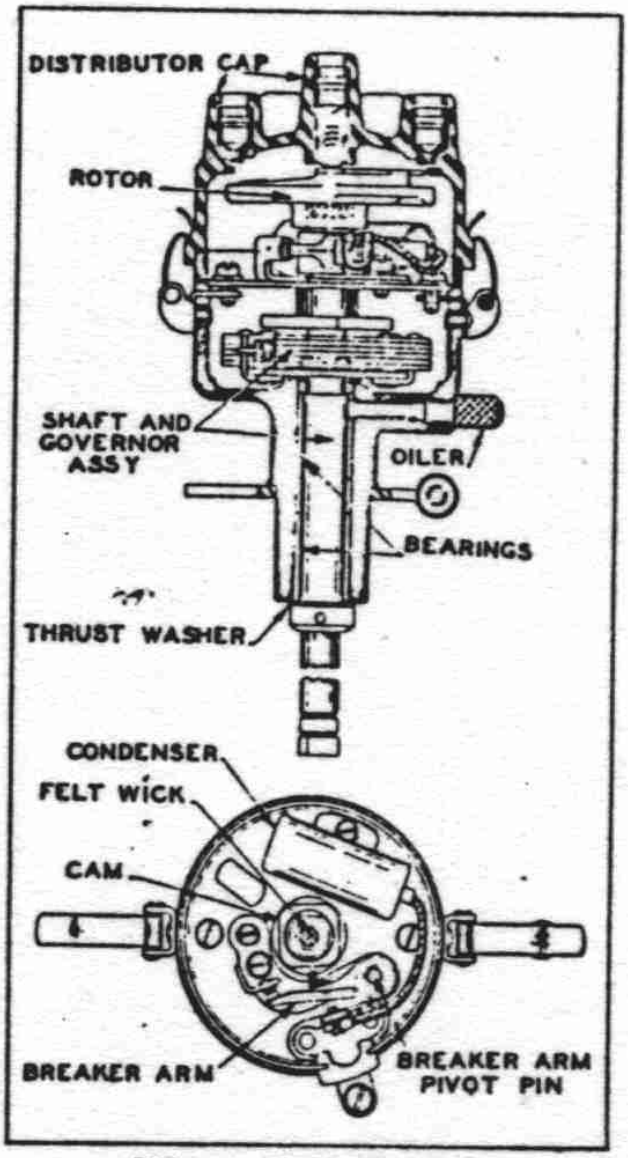

FIG. 11 IGNITION UNIT FUNCTIONING DIAGRAM

which obtains its electrical energy from the storage battery or from the exciter generator. The spark must occur at the proper time with respect to the upward travel of the piston near the top of its compression stroke and it must occur in each cylinder in its proper sequence of firing order, which is 1-3-4-2. The ignition unit, (Figs. 6 and 11), which regulates the timing of the spark and its distribution to the spark plugs in proper sequence, is mounted on the left side of the engine and driven by a gear on the camshaft.

b. Breaker Mechanism.—The breaker contacts are connected in series with the primary winding of the spark coil. The cam revolves at one-half the engine speed and opens the breaker contacts four times each revolution. Each time the breaker contacts open, a spark is produced at a spark plug gap. The mechanism is properly timed so that the spark occurs when the piston has almost reached the top of its compression stroke. As the engine speed increases, the governor assembly in the lower part of the case automatically advances the timing with respect to piston position.

c. Condenser.—The condenser is connected in parallel with the breaker contacts. Its action is to greatly increase the intensity of the spark and to increase the life of the breaker contacts.

d. Ignition Resistor. — The ignition resistor mounted on the rear end of the cylinder head serves to limit the voltage applied to the 6-volt ignition coil.

e. Distributor.—The high tension current travels from the spark coil to the spark plug by way of the distributor. It enters the distributor at the center tower, passes through the metal strip of the revolving rotor and out at the tower under which the metal strip is passing. Thus the sparks are distributed to the spark plugs, in proper sequence.

18. Spark Plugs.

The spark plugs, (Fig. 7), are important parts of the ignition system. Each consists of a center electrode highly insulated from the base which carries another electrode. The ignition spark jumps across the gap between the electrodes and it is quite important that this gap be kept adjusted at approximately .030". The original spark plugs are Champion, No. J9, and replacements should be of the same type.

19. Storage Battery.—

The 12-volt storage battery, (Fig. 1), consists of two 6-volt automotive type batteries connected in series. It supplies power for electric cranking, electric choking, ignition during the starting period and for operating certain controls. It is recharged automatically by the exciting generator while the power unit is in operation.

20. Battery Charging System.—

a. General.—The storage battery is recharged by current supplied by the 28-volt exciting generator while the power unit is in operation. Included in the battery charging system are the battery charging relay, the battery charging regulator with its group of resistors, and the BATTERY CHARGE RATE ammeter, (Figs. 3 and 4).

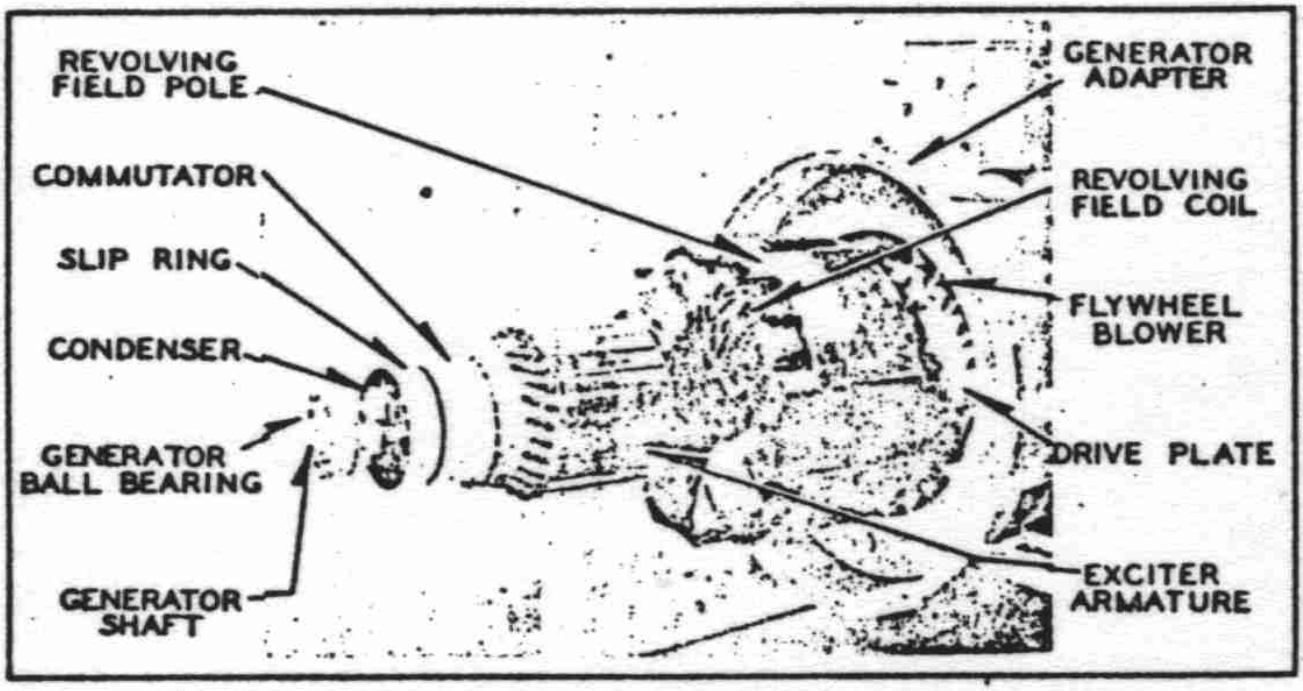

FIG. 13 ROTOR ASSEMBLY

b. Battery Charging Relay. — The battery charging relay connects the battery to the exciter circuit while the power unit is in operation. The coil of this relay is connected across the exciter and the exciter voltage is impressed on it. As the exciter voltage rises, upon starting the engine, the magnetism set up by the coil of the battery charging relay overcomes the resistance of the spring and closes the relay contacts, thus connecting the battery to the exciter circuit. The contacts remain closed and the battery continues to receive charging current until the exciter voltage drops considerably below the battery voltage. Then the contacts open and disconnect the battery. This occurs when the power unit stops and prevents the discharge of the battery through the exciter while the power unit is not operating.

c. Battery Charging Circuit.—The closing of the battery charging relay contacts connects the storage battery across the exciter which then supplies charging current. See wiring diagram (Fig. 14). This current passes from the exciter to terminal 5, through the battery charging resistor and regulator group, through the battery charging relay contacts, through the BATTERY CHARGE RATE ammeter, to terminal 3, through the battery, through the frame of the power unit, to the exciter.

d. Battery Charging Regulator and Resistor Group.—The battery charging rate is regulated by the battery charging regulator and resistor group, (Fig. 4). The regulator coil is connected across the battery while the battery charging relay contacts are closed. When the battery charge is low the voltage across the coil is low and the regulator contacts remain closed. Charging current flows through all three resistors, providing the maximum charging rate of approximately 10 amperes. As the battery approaches a full charge, the voltage across the coil increases and the contacts are opened. This opens the circuit through the two 2-ohm resistors, and reduces the charging rate to approximately 2 amperes, which flows through the 2.5-ohm resistor.

21. Electric Choke Control.—

The electric choke control, (Fig. 5), is of the electromagnetic type with thermostatic compensator. The magnet coil is connected in parallel with the start solenoid circuit and thus the carburetor is choked automatically while engine is cranked electrically. Motion of the magnet armature is transmitted through a U-shaped bimetal thermostatic spring within the lower part of the case. The arrangement is such that when the engine is cold the choking is more forceful than when the engine is warm.

22. Generator.—

a. Purpose.—The generator, Figs. 13 and 40, receives mechanical power from the engine and converts it to electrical power. It consists of a d-c exciting generator and a revolving field type of alternator.

b. Exciter.—

(1) Residual magnetism remains in the magnetic circuit of the exciter when not in operation. When the engine is started, the armature revolves and carries its conductors by the field poles. The cutting of magnetic lines of force by these conductors as they pass poles of alternate polarity induces alternating voltages in the conductors. The conductors are connected with commutator bars which revolve under, and in contact with, the exciter brushes. The various parts are so placed that the commutator bars in contact with any given brush always have the same polarity and direct current flows in the exciter circuits outside the armature.

(2) A small portion of this current passes through the exciter field winding and increases the field strength which, in turn, greatly increases the voltage induced in the conductors. The exciter voltage thus builds up to a maximum of approximately 28 volts at normal operating speed.

(3) The greater portion of the exciter output is used to excite the alternator revolving field, being connected with the alternator field windings by means of the brushes and slip rings.

(4) The exciter also operates as a starting motor and cranks the engine electrically. When the storage battery is properly connected to the exciter, strong magnetic fields are set up in the armature and field and cause the armature to revolve, thus cranking the engine. The series field winding adds greatly to the strength of the magnetic field and to the cranking power. The battery is connected to the exciter by means of the solenoid starting switch which is controlled by the START button on the control panel.

c. Alternator.—The revolving field of the alternator is magnetized by direct current from the exciter. The field poles, of alternate polarity, revolve by the conductors of the stator and induce alternating voltages in them. Those conductors are connected in two groups and the groups are connected to the control panel. If the exterior circuit is complete, alternating current will flow in it. No collector rings and brushes are required in the a-c circuit.

d. Alternator Connections.—One end of each of the three phase windings of the alternator stator is connected to a separate terminal post on the control panel. Each of these terminal posts is sep

arately connected through an ammeter and one pole of the circuit breaker to one of the three A.C. OUTPUT terminal posts A, B, and C, see wiring diagram. The other three ends of the three phase windings are connected together within the generator and this common junction is connected through a lead direct to the N (neutral) terminal post on the output terminal block. Three-phase, 230-volt power may be taken through A.C. OUTPUT terminal posts A, B, and C. Single-phase, 220-volt power may be taken through terminal posts A and B, B and C, and C and A. Single-phase, 127-volt power may be taken through terminal posts A and N, B and N, and C and N.

e. A.C. Voltage Regulation. — No means is provided for adjusting the voltage independent of the engine speed. At normal frequency, and after reaching normal operating temperature, the voltage is within the limits of approximately 215 volts at no load to 235 volts at full load at unity power factor. This voltage regulation is due to inherent characteristics obtained by strongly saturating parts of the magnetic circuit.

23. High Water Temperature Cut-Out Switch.—

a. Description.—The high water temperature cut-out switch, (Fig. 6), is electrically connected to the STOP button circuit. It automatically stops the engine if the temperature of the water in the engine water jacket rises higher than the temperature for which the dial is set. A temperature element extends down into the cooling liquid and contains a volatile liquid. This element is connected through a small tube to the diaphragm or bellows which operates the switch contacts. As the temperature within the water jacket rises, the liquid within the temperature element expands the bellows which closes the switch contacts, thus stopping the engine. The engine may be started again in the usual manner after the temperature drops about 10°. The cause of the high temperature should be determined and corrected before again starting the engine.

b. Adjustment.—The temperature at which the engine will be stopped may be adjusted by turning the dial so that the desired stopping temperature is exactly under the pointed indicator at the top of the dial. The dial should be set to stop the engine at a temperature at least several degrees below the boiling point of the cooling liquid. For water at sea level, the setting should be 208. This should be decreases 3° for each 1000 feet above sea level. Other cooling liquids may require different settings.

24. Low Oil Pressure Cut-Off Switch.—

The low oil pressure cut-off switch, (Fig. 5), is a small switch operated by oil pressure. When the oil pressure builds up to approximately 6 lbs. per square inch the switch contacts open. They are so connected with the control system that if the pressures drops below 6 lbs., the ignition is cut off and the engine stops.

25. Relays.—

On the back of the control panel are mounted the start, stop and ignition relays, (Fig. 4). Each relay includes a coil of insulated copper wire wound on a soft iron core. An iron armature is hinge-mounted near one end of the iron core and held away from the core by means of a spring. When electric current flows through the coil, the core becomes magnetized and the iron armature is attracted so strongly that it moves toward the core, thus opening or closing the relay contacts. When the circuit to the coil is opened and current no longer flows through it, the core loses most of its magnetism and the spring pulls the armature away from the coil, reversing the action of the contacts. All three relays are connected in the d-c control circuits.

26. Electrical Control System.—

a. Starting Cycle.—

(1) The storage battery supplies the power for electric starting. With the MANUAL START—REMOTE START ignition switch on Remote Start position the power unit is started by pressing the START button. This energizes the coil of the start relay and closes the two pairs of contacts on that relay. See Figs. 3, 4 and 14.

(2) The closing of the start relay contacts (A) supplies current to the ignition coil, the current passing through the remote start contacts of the ignition switch and through the voltage dropping ignition resistor before reaching the ignition coil. It also supplies current to the coil of the ignition relay, closing its contacts (C). The current through the ignition relay coil passes through the stop relay contacts (D) and to ground.

(3) The closing of the start relay contacts (B) supplies current to the electric choke, thus choking the carburetor, and to the start solenoid which closes the start switch contacts (E).

(4) The closing of the start switch contacts (E) supplies current to the exciter, passing through its series field winding, causing the exciter to operate as a motor and to crank the engine.

(5) At this stage of the starting cycle the ignition has been switched on, the carburetor is being choked and the engine is being cranked. The engine

starts. The speed increases and the oil pump builds up pressure in the lubricating system. When this pressure rises to approximately 6 pounds, the contacts of the low oil pressure cut-off switch open. The exciter builds up voltage and supplies ignition current through another circuit. This current passes from terminal 5, through the battery charging resistor and regulator group, through the ignition relay contacts (C), to the remote start contacts of the ignition switch, through the ignition resistor, to the ignition coil.

(6) The START button is released. This opens the circuit to the start relay coil, and allows the contacts (A) and (B) to open.

(7) The opening of contacts (B) stops the electric choking and allows the start switch contacts to open, which opens the cranking circuit.

(8) The ignition current being supplied by the exciter does not pass through contacts (A) and, therefore, the engine does not stop when the contacts (A) open. However, if the contacts (A) open before the exciter voltage has built up high enough to supply proper ignition current, the engine will stop upon release of the START button. The engine will stop if the START button is released before the oil pump has built up enough pressure to open the contacts of the low oil pressure cut-off switch.

(9) The coil of the battery charging relay is connected across the exciter at all times and when the exciter voltage rises sufficiently the contacts (F) close, thus connecting the battery charging circuit.

(10) The FUEL GAUGE and the fuel gauge tank element are connected to the ignition switch in such manner that the gauge registers while the ignition system is supplied with current. If it is desired to have the gauge register while the engine is not operating, this may be done by switching the MANUAL START - REMOTE START ignition switch to the MANUAL START position. The switch should be returned to the REMOTE START position as soon as the FUEL GAUGE reading has been observed.

b. Operation.—While the power unit is in operation the exciter supplies current for ignition and for battery charging. The greater portion of the exciter output is used to excite the revolving field of the alternator. The a-c windings of the stator are connected to the A.C. OUTPUT terminals, with an A.C. AMMETER and one pole of the 3-pole CIRCUIT-BREAKER in series with each phase. The CIRCUIT-BREAKER serves as a load switch and disconnects the load automatically in case of severe overload. After opening automatically, the CIRCUIT-BREAKER must be reset by pushing the handle down before it can be closed, in the meantime the load should be reduced to within the capacity of the power unit. The selector switch permits connecting the A.C. VOLTMETER across any one of the three load phases to read the voltage of the phase. An A.C. AMMETER is connected in series with each of the three A.C. OUTPUT terminals A, B, and C to indicate the load amperage. See subject OPERATION for further information.

c. Stopping Circuit.—The engine is stopped by pressing the STOP button which energizes the stop relay and opens its contacts (D). The opening of these contacts de-energizes the ignition relay, allowing its contacts (C) to open, thus opening the ignition circuit and stopping the power unit. As the engine speed drops, the exciter voltage drops and allows the battery charging relay contacts (F) to open, thus preventing the discharge of the battery while the power unit is not operating.

d. Manual Start-Remote Start Ignition Switch.—When the MANUAL START-REMOTE START switch is in the MANUAL START position, ignition current is supplied direct from the battery to the ignition coil, thus by-passing all the relays and protective circuits. With the switch in this position the engine may be started by hand cranking. This makes it possible to use the power unit in an emergency when there may be trouble in a relay circuit. It will be necessary to throw this switch to the REMOTE START position before the engine can be stopped by means of the STOP button.

e. Remote Control.—Remote control circuits, if used, are merely extended circuits connected in parallel with the START and STOP button circuits on the control panel. Remote start and stop buttons are used in the same manner as the START and STOP buttons on the control panel.

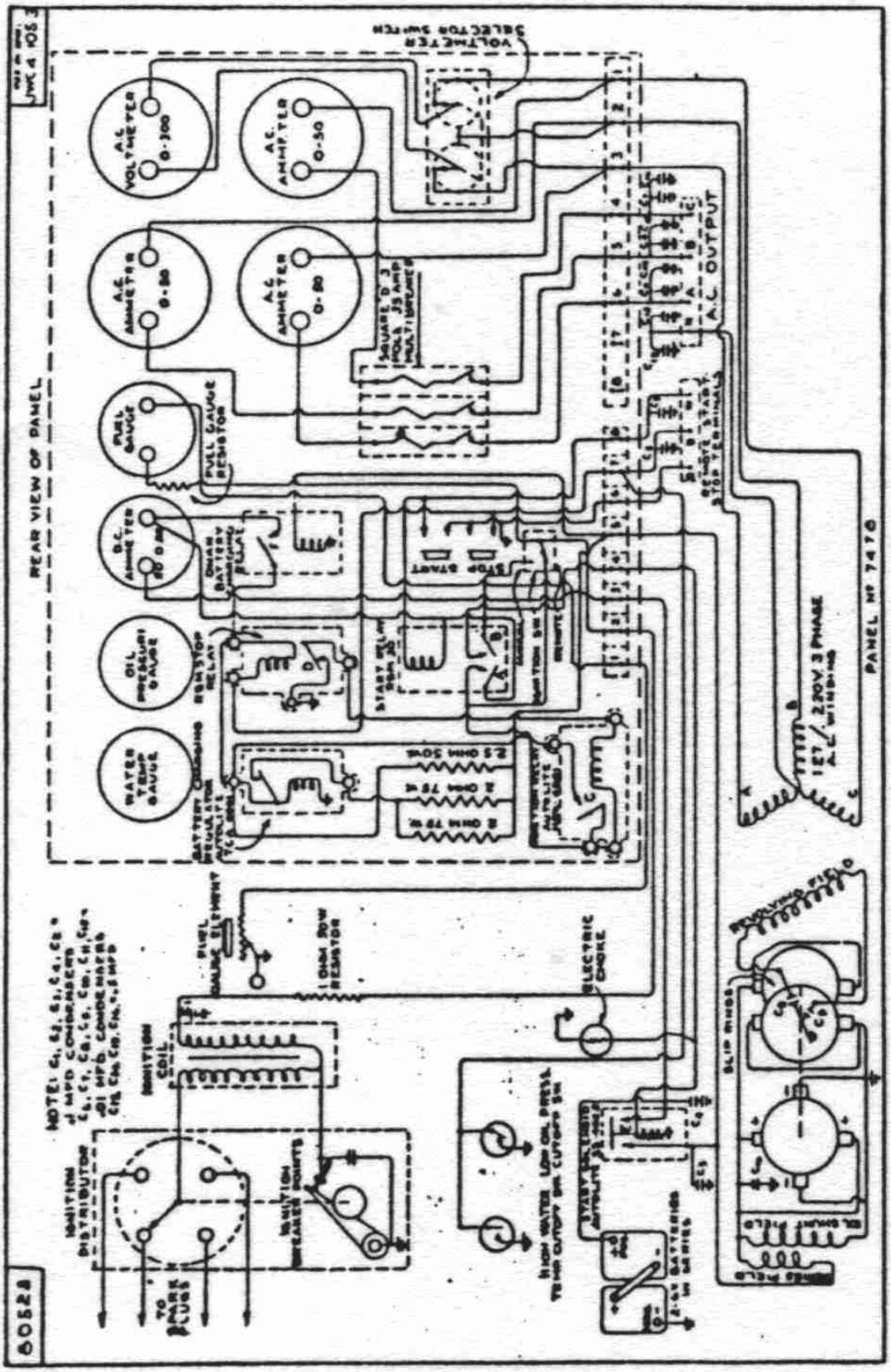

FIG. 14 WIRING DIAGRAM

27. Routine Attention.—

a. Important.—It is important to follow a definite schedule of inspection and service operations to maintain a high level of operating efficiency. The keeping of a log book as a continuous operating check is advised.

(1) *Caution.*—The periodic servicing schedule which follows in this paragraph is based on the use of fuels having low lead content. When using Army 80 octane fuel, aviation 100 octane fuel, or other fuel containing more than 2 cubic centimeters of lead per gallon, refer to subject, USE OF LEADED FUELS immediately following the front page, "CAUTION."

b. Daily Service.—Check the following at least once a day:

(1) *Radiator.*—Check the cooling liquid level. Do not fill so high as to cause unnecessary loss of liquid through the overflow. Never allow the level to fall below the top of the upper hose. Under continuous use or in hot weather more frequent attention may be needed.

(2) *Oil Level.*—Check the crankcase oil level. Under continuous service check more frequently. Never operate the power unit when the oil level is near the EMPTY mark on the bayonet gauge. Fill to the FULL mark on the gauge with the proper oil as specified in paragraph 8 *a* (7) and 9 *i* (1).

(3) *Fuel Supply.*—Check supply of fuel, shown on the FUEL GAUGE on the instrument panel, as often as necessary to assure a sufficient supply in the tank at all times. The tank holds 10½ gallons. When operating at full load, the plant consumes about 2 gallons per hour. Check the supply of fuel in the auxiliary tank also, if such tank is connected to the power unit.

(4) *Control Panel.*—Check the various gauges frequently and take any corrective measures indicated. Normal readings are given in paragraph 9 *d*.

c. Weekly Service.—Check the following weekly, or every 50 operating hours, whichever occurs first:

(1) *Daily Check.*—Check all points mentioned above under Daily Service.

(2) *Crankcase Oil and Oil Filter.*—

(*a*) Lift out the bayonet oil gauge and examine the oil that adheres to it. If the oil is discolored, install a new oil filter element. If necessary on the basis of lubricating instructions contained in paragraph 9 *i* (1), change the oil. Drain the oil while the engine is warm. Close the drain valve securely and refill the crankcase to the FULL mark on the gauge with clean, fresh oil of proper kind and grade.

(*b*) To install a new filter element, remove the filter cover and the drain plug and drain the filter. Remove and discard the old filter element and clean all sludge and sediment from the filter body. Replace the drain plug and tighten securely. Install the new filter element and replace the filter cover, using a new gasket. Start the engine and check for leaks, correcting any found. After the engine has run about 10 minutes, stop it and check the oil level. The filter will have retained some oil. Add oil, if necessary, to again raise the level to the FULL mark on the gauge.

(3) *Ignition Unit.*—Place 5 drops of cylinder oil in the oil cup on the side of the ignition unit. Remove the distributor cap and rotor and place 1 drop of oil on the wick at the center of the shaft and 1 drop on the breaker arm post. Use the same kind and weight of oil as used in the crankcase. Wipe the cam clean and apply a very small amount of light grease to the rubbing surface.

(4) *Air Cleaner.*—

(*a*) If the power unit has been operated under dusty conditions, clean the oil type air cleaner. If the power unit has been operated only under clean air conditions, the servicing of the air cleaner may be included under Monthly Service.

(*b*) To clean the air cleaner, remove the cup and clean it thoroughly. Remove the filter element and clean it thoroughly by sloshing up and down in a suitable cleaning fluid or in gasoline. Allow it to dry or dry it by using an air hose. Fill the cup to the level mark with clean oil of the same grade as used in the engine crankcase. Reassemble the cleaner.

(5) *Battery.*—

(*a*) Test the battery by means of a hydrometer. All cells should test 1,250 or higher, unless they were filled with 1.200 electrolyte for tropical use. If filled with 1.200 electrolyte for tropical use, the numeral one (1), should appear on the lead top connector at the positive cell, near the battery type-number (17K2-R). See paragraph 8*a* (5) (*b*) and (*d*). If filled with 1.200 electrolyte for tropical use, the cells should test 1.200, or higher. A test of approximately 1.100 indicates a discharged cell. A difference as great as 50 points between individual cell readings in a 6-volt unit probably indicates that the unit should be replaced with a new one to avoid a definite failure. The same is true when all cells of a unit test uniformly low, unless the low test can be accounted for by excessive starting in comparison with running hours, or by the power unit's not having been used for 2 or 3 weeks. In either case, check the battery unit daily for several days under normal use of at least several hours a day. If its condition does not improve, replace it.

(b) Fill the cells to $\frac{3}{8}$" above the tops of the separators, using distilled water or water known to be non-injurious to lead-acid batteries. Do not fill high enough to cause overflowing while charging.

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

d. Monthly Service — Check the following monthly, or every 200 operating hours, whichever occurs first:

1 *Weekly Check.*—Check all points mentioned under Weekly Service.

(2) *Spark Plugs.*—Remove the spark plugs. Clean them, if needed, and inspect for cracked or badly eroded porcelains. Discard any spark plugs not in good condition and replace with new ones of correct type. Adjust the gaps to .030". When installing, make sure the gaskets are in place. Tighten securely.

3 *Battery Terminals.*—Check the battery terminals, cleaning and tightening them if needed. Apply a coating of petroleum jelly. Replace the cables if not in good order.

4 *Ignition Unit* —Remove the distributor cap and wipe it clean, inside and outside. Inspect the breaker contacts. If badly pitted, replace with new ones. Turn the engine with the hand crank until the contacts are wide open. They should open .020". Check with a wire gauge and adjust if necessary. If contacts are the least pitted, they should be resurfaced with a carborundum or similar hone before adjusting.

5 *Ignition Timing* —Check the ignition timing by using a neon timing light, if available, and make any adjustment needed. A small arm attached to the throttle shaft arm may be turned over and forward to a position that will hold the throttle at an idle position and cause the engine to operate at the moderate speed necessary for use of the neon timing light. If the neon timing light is not available, crank the engine very slowly by hand, stopping exactly when the breaker contacts separate at firing position for No. 1 cylinder. Then check the position of the IGN mark on the flywheel, (Fig. 16) as seen through the timing hole in the flywheel housing on the left side of the engine. Timing is correct if the IGN mark is at the center of the hole at the instant the points separate. Repeat the checks a time or two for accuracy. If necessary to adjust the timing, loosen the clamp bolt, turn the distributor body to the proper position and tighten the bolt. Then recheck to verify the correctness of the new setting.

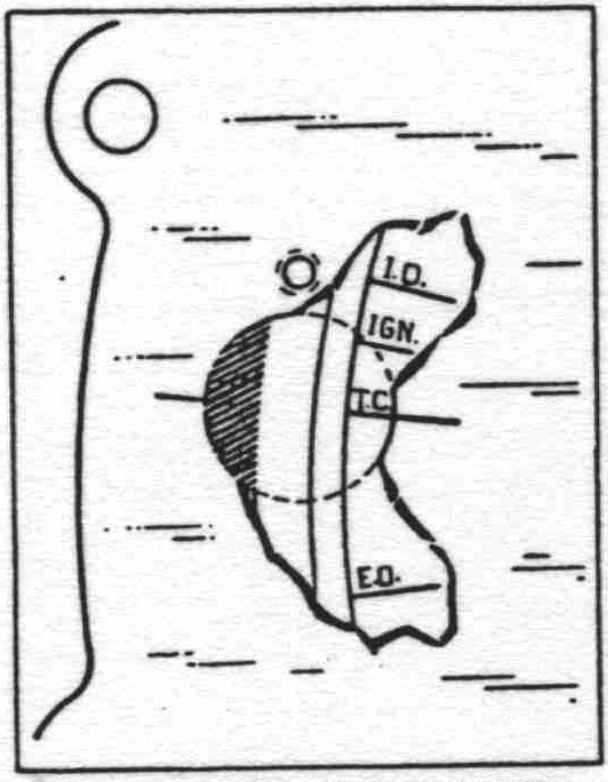

FIG. 16 TIMING MARKS (FLYWHEEL)

(6) *Valve Tappets.* — Disconnect the tubes from the valve spring cover, remove the cover screws and the cover. Crank the engine slowly by means of the hand crank and note when the intake valve of No. 1 cylinder begins to open. Then turn the crank one full revolution further. This places the camshaft in the correct position for checking or readjusting both tappets of No. 1 cylinder. Check the clearances with a feeler gauge, (Fig. 17). The

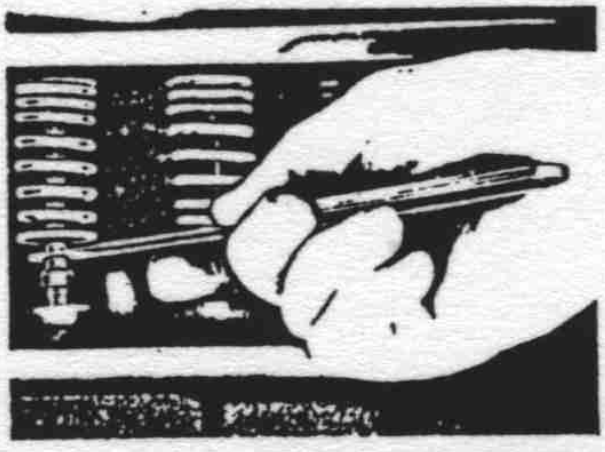

FIG. 17 VALVE TAPPETS AND SPRINGS

correct clearance is .014" hot or cold. Adjust the tappets if necessary. Locate the correct positions for each of the remaining cylinders and check and adjust the remaining tappets. In locating the correct position for any cylinder, turn one revloution after the intake valve on that cylinder begins to open. See that the cover gasket is in good order, replace the cover, tighten the screws and connect the tubes.

(7) *Fuel Screens and Sediment Bowls.*—Close the 2-way fuel shut-off cock. Remove and clean the sediment bowl on the fuel pump and the one under the fuel tank. Clean the strainers if necessary. When replacing the bowls, make sure that gaskets are in good order and that the retaining nuts are tightened sufficiently to hold the bowls tightly on the gaskets. Remove the drain plug and strainer from the bowl of the carburetor. Clean and replace. Open the fuel shut-off cock. By means of the lever on the fuel pump, pump the carburetor bowl full of fuel. Examine the sediment bowls and the carburetor for leaks, correcting any found.

(8) *Fan and Governor Belts.*—Inspect the fan and governor belts. If not in good condition, replace with new ones. Adjust the belt tension so that the top side of the belt can be depressed about 1¼" to 1½". The fan belt is adjusted by loosening the clamp bolt in the slotted bracket at the idle pulley, moving the idle pulley to obtain proper tension, then tightening the bolt. Slotted holes in the governor bracket permit adjusting the governor belt in a similar manner. See Fig. 18.

(9) *Exhaust System.*—Inspect all exhaust connections, replacing or tightening all parts requiring attention. Include the manifold connections and the flexible exhaust pipe. Permit no leaks that will allow gas to escape inside a building. If the exhaust system requires cleaning, clean it. Continued operation with excessive back pressure will eventually cause trouble even if not bad enough to noticeably affect the engine performance at the time of inspection.

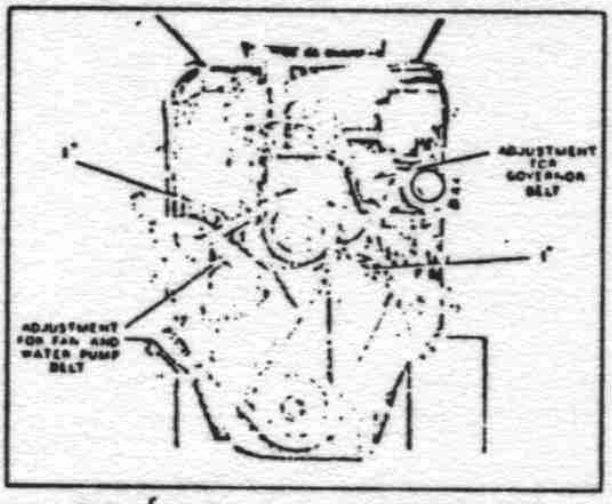

FIG. 18 FAN AND GOVERNOR BELT ADJUSTMENTS

(10) *Carburetor.*—With no load on the power unit, but with the engine at normal operating temperature, and with the throttle held so that the engine is operating at about half normal speed, adjust the idle adjustment screw so that the engine will idle smoothly.

(11) *Crankcase Ventilator Metering Valve.*—Disconnect the crankcase ventilator metering valve, open it, remove the plunger and clean all parts thoroughly in acetone. Reassemble and tighten all connections securely.

(12) *High Water Temperature Cut-Out Switch*—Check the operation of the high water temperature cut-out switch. With the power unit operating at normal temperature, turn the dial counter-clockwise (to left) very slowly and note the reading at which the switch stops the engine. Compare with the reading of the Engine Water Temperature Gauge. If the readings differ more than 5 degrees, check the accuracy of both switch and gauge as instructed in paragraph 46.

(13) *Crankcase Oil.*—Be sure to include an oil change in the monthly service. Drain the crankcase oil and refill to the FULL mark on the bayonet gauge with proper oil as indicated on the lubrication chart (Fig. 64) and as instructed in paragraph *8a*(7) and *9 i.*

(14) *Generator.*—Inspect the commutator and slip rings. Clean them, if needed, by holding a clean piece of canvas against them while the engine is operated slowly by holding the throttle partially closed. For safety attach the canvas over the square end of a narrow piece of dry wood to serve as a handle. In normal service, the commutator and collector rings acquire a mahogany-colored surface. If this surface is smooth, it requires no attention. Do not attempt to maintain a bright, newly-machined appearing surface. Check the brushes for good seating contact, free fit in holders and uniformly good spring tension. If brushes are worn to ¾" length, or less, install new brushes. New brushes must be properly fitted. Refer to paragraph *50, a.* for instructions on fitting brushes.

(15) *General.*—Inspect the power unit thoroughly for leaks, loose electrical connections and other external items which may need attention. Make needed corrections.

28. Valve Servicing.—

a. When to Grind Valves.—

(1) Lack of power in an engine may be caused by poor seating of the valves in the valve seats, which allows the gases in the compression chamber to escape into the intake or exhaust manifold.

(2) By the use of a cylinder compression gauge one can readily determine which valves are not properly seating. Compression gauge readings should all be within 10 pounds of each other and not less than 70 pounds.

(3) If no gauge is available, turn the engine by the hand crank and note whether the compression is uniformly good on all cylinders. Compression should rock the crank backward forcibly if allowed to do so when well up on the compression stroke. Compressed gases leaking past an exhaust valve cause a hissing noise at the exhaust outlet. If leaking past an intake valve, a hissing noise may be heard through the carburetor. Disconnect the air cleaner horn at the carburetor and the exhaust line at the power unit and have someone crank the engine while you listen for these sounds, if you have reason to suspect that valves are leaking. Any valve leak present after the tappets are properly adjusted should be corrected by grinding all valves.

b. Grinding Valves.—Extreme care should be used whenever valves are ground to maintain factory limits and clearances, as only by maintaining these can one expect to get good engine performance. Proceed as follows:

(1) Drain radiator by opening drain cock at the bottom of the radiator.

(2) Disconnect governor oil supply line at governor.

(3) Remove oil filter and bracket by removing the nuts on the cylinder studs, and lay filter on idle pulley bracket.

(4) Remove fuel line from fuel pump to carburetor.

(5) Remove carburetor air cleaner horn and tube.

(6) Remove electric choke control rod. Disconnect throttle control rod at governor end and the manual choke wire at carburetor end.

(7) Remove nuts holding carburetor to manifold and remove carburetor.

(8) Disconnect the governor oil return tube and the crankcase air vent tube.

(9) Remove the cylinder head nuts which hold the governor bracket and remove the governor assembly.

(10) Remove nuts and bolt holding exhaust pipe to manifold.

(11) Remove manifold stud nuts and manifolds.

(12) Disconnect wires from the ignition resistor, remove holding bolt and ignition resistor.

(13) Remove the upper radiator hose. Remove all spark plugs. Remove the cylinder head cap screws, stud nuts and the temperature gauge bulb, then lift head from engine block. Removal is made easy by using lifting hooks screwed in No. 1 and 4 spark plug holes. **Do not drive screw driver or any other sharp instrument in between the cylinder head and the block to break the head loose from the gasket.**

(14) Remove the valve spring cover screws and the cover. Care should be taken not to lose the copper gasket on each screw as well as the screen and gasket. With a piece of cloth or cotton waste over the three holes in the valve chambers to prevent the valve keys dropping into crankcase upon removal.

(15) With valve spring compressor inserted between valve tappet and spring retainer, raise springs on those valves which are in closed position and remove valve locks. Turn crankshaft with crank or by fan belt until those valves which are open become closed and repeat the operation.

(16) Remove valves and place them in a valve carrying board, so that they can be identified as to cylinders from which they were removed. Remove valve springs. The valve springs should be tested for pressure which should show 116 lbs. when valves are open (spring compressed, length 1¾") or 50 lbs. pressure when closed (springs extended length 2 3/64"). The free length of the valve spring is 2½". Any springs which are distorted or do not fall within these specifications should be replaced with new springs.

(17) Clean carbon from cylinder head, top of pistons, valve seats and cylinder block. Clean valve guides with guide brush. Clean valves on a wire wheel brush, making sure that all carbon is removed from the top and bottom of the heads. Remove any gum which may have accumulated on the stems.

(18) The clearance between the intake valve stem and the valve guide is .0015" to .00325", the exhaust valve stem clearance to guide is .002" to .00375". Excessive clearance between the valve stem

and the valve guide will cause improper seating and burned valves. If there is too much clearance between the inlet valve stem and the valve guide, on the suction stroke there will be a tendency to draw oil vapors up the guide into the combustion chamber causing excessive oil consumption, fouled spark plugs and poor low speed performance. Check the wear of each valve guide by inserting a new valve in it and feeling the clearance by moving the valve stem back and forth. If the clearance is excessive, install a new valve guide as instructed in paragraph 28 c.

(19) Check the clearance of each valve in its guide and discard any having excessive clearance. Reface the usable ones to a 45° angle. Replace discarded valves with new ones. If seats in the block show excessive pitting, reface the seats.

(20) Then, by hand, touch up the valves to the seats with fine valve grinding compound.

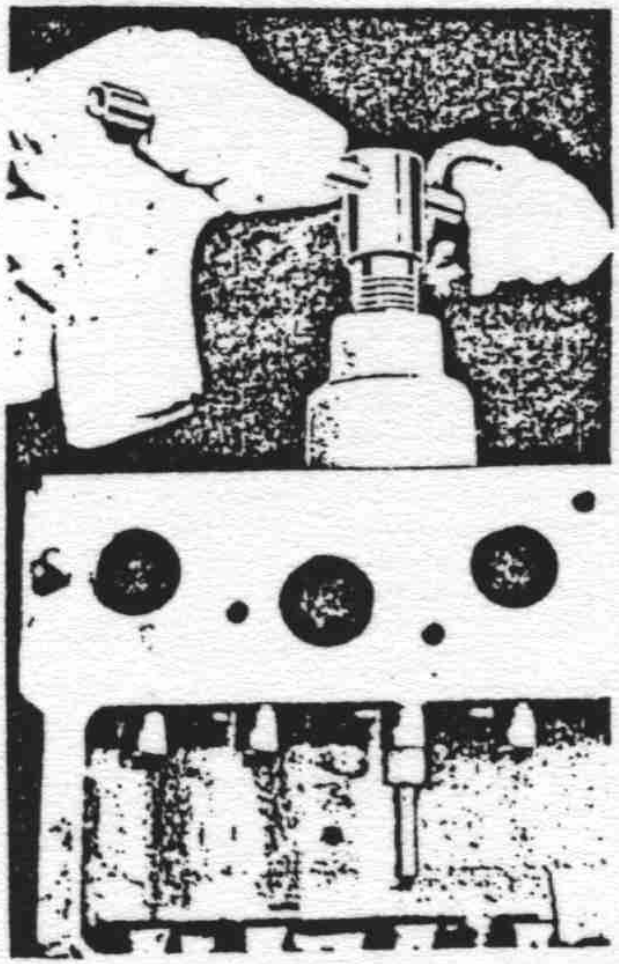

FIG. 19 REMOVING VALVE GUIDES

c. Removing and Replacing Valve Guides.—

(1) When removing the valve guides use a valve guide puller to prevent damage to cylinder block. See (Fig. 19). If a regular puller is not available, a suitable tool can be made from a 2" pipe, 6" long and a ⅜" bolt 10" to 12" long with a long threaded end, a small hexagon nut which will pass through the hole in the cylinder block and a 2" washer with a ⅜" hole in it.

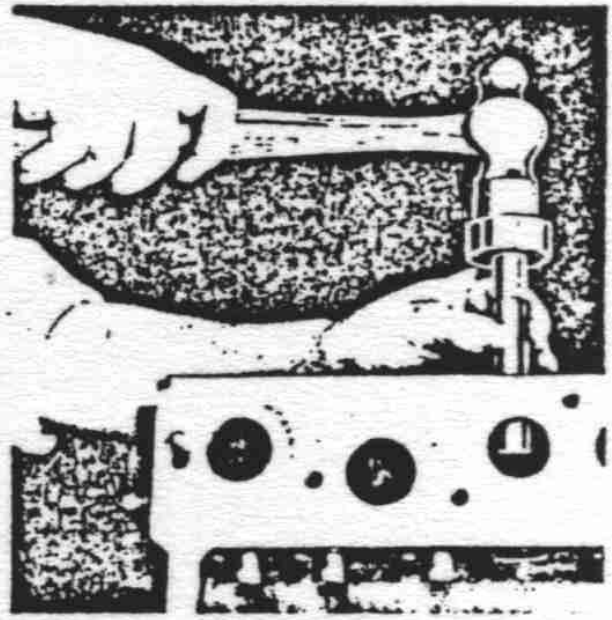

FIG. 20 INSTALLING VALVE GUIDES

(2) The valve guides are installed with a replacer or a driver as shown in (Fig. 20). Taking a piece of half-inch round stock 6" long and turning down one end to ⅜" diameter 2" long will make a suitable driver.

(3) The exhaust valve guide is installed in the cylinder block so that there will be a distance of 1" from the top of the guide to the top of the block. The intake valve guide is set at 1¼" from the top of the valve guide to the top of the block, (Fig. 21).

(4) The valve tappet clearance in the guide should be .0005" to .002". It is advisable to check the clearance of the valve tappet by moving it back and forth in the guide. If the clearance seems to be excessive, it might be necessary to install a new valve tappet. This operation is covered in this section under paragraph 29.

d. Reassembling.—

(1) When assembling valve springs and retainers in engine make sure that the closed coils are

up against the cylinder block, (Fig. 17). Then install the valves, each in its proper seat. Using a valve valves which are in closed position and insert the valve spring locks with a valve key inserting tool. If no key inserting tool is available, hold keys in place by sticking them to valve stem with grease. Crank engine until other valves are closed and install the remaining keys.

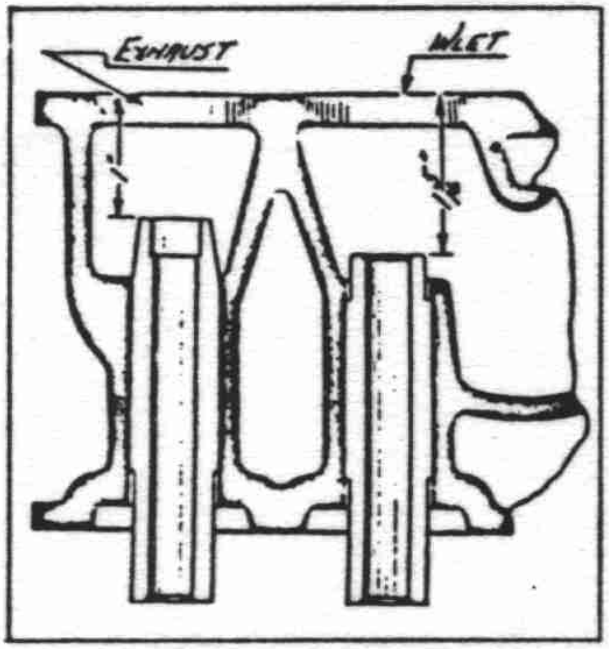

FIG. 21 POSITION OF VALVE GUIDES

(2) Adjust the valve tappet to valve stem clearance to .014", (Fig. 17). Remove cloth or waste from valve chamber.

(3) Clean top of block and pistons of all foreign matter and install cylinder head gasket. Clean carbon from cylinder head and wipe off all foreign matter, then install over studs on cylinder block. Install oil filter bracket. Install cylinder head

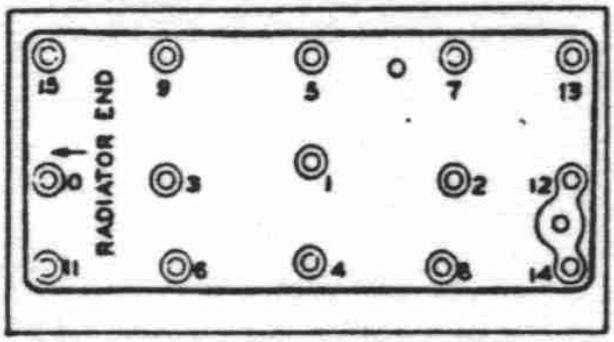

FIG. 22 CYLINDER HEAD TIGHTENING

cap screws and nuts bringing them down finger tight, then with a tension wrench tighten cylinder head screws and nuts in sequence as shown on (Fig. 22), tightening screws to 65 to 75 foot pounds or 780 to 920 inch pounds and the nuts to 60 to 65 foot pounds or 720 to 780 inch pounds.

(4) Clean and adjust spark plugs, setting the electrode gaps at .030". Install spark plugs in cylinder head to prevent any foreign matter from entering the combusion chamber during the remaining operations. Be sure to install spark plug gaskets.

(5) Install manifold with new gaskets. Install manifold clamp washers with convex surface toward manifold. Install manifold nuts drawing them up tight. Install exhaust pipe to manifold with new gasket.

(6) Install governor, adjust governor belt tension and connect governor oil supply line.

(7) Overhaul and recondition carburetor as per instructions given in paragraph 37. Install carburetor to manifold and attach controls. Install air cleaner horn and tube.

(8) Recondition ignition unit and set ignition timing in accordance with instructions given in paragraph 41. Make sure when installing distributor assembly in crankcase that it fits down in the crankcase properly. Install and connect ignition resistor.

(9) Install upper radiator hose, and all line connections. Close radiator drain cock and fill the radiator with water or anti-freeze solution as required. Arrange the end of the governor oil return tube so that returning oil will enter the crankcase through one of the three holes in the valve spring chamber. Start the engine and allow to run without load for five or ten minutes. Then stop it and recheck the tappet clearances.

(10) If necessary, install new valve spring cover gasket (shellac to cover). Install cover to engine block. Clean crankcase ventilator tube and screen and reinstall with gaskets.

(11) Install the governor oil return tube.

(12) Start the engine. After it reaches normal operating temperature, make any speed adjustment needed to provide correct voltage as shown by A.C. VOLTMETER.

29. Camshaft and Valve Tappets.—

a. Description.—

(1) The alloy steel camshaft rotates on four bearings which are lubricated under oil pressure through drilled passages in the crankcase. The front bearing carries the thrust and is a steel-backed

babbitt-lined shell. This bearing is staked in place to prevent rotation and endwise movement. See (Fig. 23).

(2) The valve tappets are lubricated through oil troughs cast in crankcase and drilled passages to valve tappet guides. The oil troughs are filled from oil spray holes at connecting rod bearing ends. A groove cut in center of valve tappet shank carries the oil up and down in the guides.

FIG. 23 STAKING CAMSHAFT BEARING

b. Removal of Camshaft or Valve Tappets.— To remove the camshaft or valve tappets, proceed as follows:

(1) Raise the power unit about 18 inches from the floor and support it securely in such manner that the oil pan may be removed later.

(2) Drain the water from the radiator. Remove the front housing top plate. Remove housing front end support and radiator assembly, See paragraph 39. Remove exhaust compartment top plate.

(3) Remove cylinder head, manifolds, valves and valve springs, following the instructions in paragraph 28.

(4) Remove oil pump and fuel pump assemblies.

(5) Drain the oil from the engine. Remove the bottom dust plate and the oil pan.

(6) Remove fan belt, fan blade assembly, governor belt and crankshaft pulley.

(7) Remove timing chain cover, camshaft sprocket screws and timing chain.

(8) Tie all valve tappets up with a string wrapped around heads of adjusting screws and attached to manifold studs.

(9) Remove sprocket from camshaft. Remove camshaft and valve tappets.

(10) Carefully inspect camshaft for scores, roughness of cams and bearings. Examine valve tappet faces where they contact cams and replace if found to be scored, rough or cracked. Check clearance of tappets to guides, renewing those which have worn excessively. Oversize available, .004".

c. Replacing Camshaft or Valve Tappets.— To install the camshaft and valve tappets, proceed as follows:

(1) Install valve tappets and tie up in place with string. Install camshaft. Install camshaft thrust washer.

(2) To set the valve timing, see instructions given in paragraph 30.

(3) For installation of oil pump see instructions in paragraph 34.

(4) Install the plunger and spring in the front end of camshaft with round end out. Inspect pin in timing chain cover to see that it stands perpendicular to the cover face. Put a light smear of cup grease on end of pin and on the end of plunger, then assemble cover to the engine.

(5) Complete the assembly by reversing the operations used for removal of the camshaft.

30. Valve Timing.—

a. Timing Chain and Sprockets.—

(1) The timing chain is non-adjustable. The lubrication is positive through drilled passages in the crankshaft and sprocket from the front main bearing. These should be checked whenever the chain or sprockets are replaced.

(2) To replace timing chain, it is necessary to remove radiator, fan blades, fan belt, crankshaft pulley and timing case cover. See paragraphs 29 and 39 *d* (2). Remove screws holding camshaft sprocket to camshaft and remove chain.

(3) When chain has been removed it will be necessary to give due attention to the valve timing when chain is replaced.

b. Timing.—

(1) To set the valve timing, turn the crankshaft so that No. 1 and No. 4 pistons are at top dead center. Top dead center is indicated by a mark TC on the flywheel which is visible through a hole in the flywheel housing, (Fig. 16).

(2) Place the camshaft sprocket on the camshaft and line up the holes for the capscrews. Screw all four capscrews in by hand. Rotate the camshaft so that the punch mark on the face of the sprocket is in line with the punch mark on the crankshaft sprocket, (Fig. 24).

FIG. 24 TIMING SPROCKETS

(3) Remove the camshaft sprocket and install the timing chain. Change the position of the camshaft sprocket, within the chain, until all four capscrew holes are matched. Unless the position of the camshaft has been changed, the punch marks on the camshaft and crankshaft sprockets will now be in line as shown in (Fig. 24). Make sure the camshaft thrust washer is in place, replace the capscrews and again check the lineup of the punch marks. Timing is correct when a straight line between sprocket centers, cuts through the punch marks on both sprockets as shown in (Fig. 24). In this position No. 4 cylinder is at top of compression stroke and the distributor arm should be under the segment for that cylinder.

(4) Tighten capscrews and lock with the special washers.

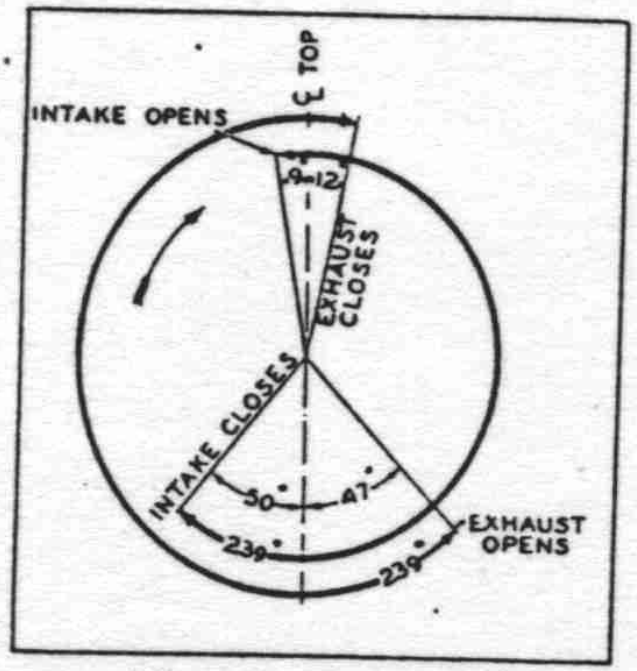

FIG. 25 VALVE TIMING

(5) Inlet valve opens 9° before top center measured on flywheel or .039" piston travel from top center. To check valve timing, (Fig. 25), adjust inlet valve tappet of No. 1 cylinder to .020". Rotate crankshaft clockwise until piston in No. 1 cylinder is ready for the intake stroke, at which time the tappet should just be tight against end of valve stem and mark on flywheel "10" in center of timing hole in flywheel housing on right side of engine, (Fig. 16).

c. Timing Chain Cover Seal.—The crankshaft oil seal is woven asbestos impregnated with graphite and oil. When necessary to install new oil seal, the steel retainer should also be renewed.

31. Crankshaft.—

a. Description.—The crankshaft rotates in three steel-backed babbitt-lined bearings, the front bearing taking the thrust. Packing at the rear bearing, (Fig. 26), prevents the escape of oil. The main bearing journal diameter and length dimensions are: Front, 2.3340"—1.920"; Center, 2.3340"—1.8125"; Rear, 2.3340"—1.75".

b. Servicing.—

(1) The steel-backed babbitt-lined bearings are made to size and are interchangeable without line reaming. The running tolerance of the bearing is established at .001" to .0025". No adjustment is

provided on the main bearing. Should they require attention they should be replaced to maintain proper control of oil. Main bearing cap screw torque wrench reading 65-70 foot lbs. If new crankshaft bearings are installed, care should be taken to see that the drilled passages line up with drilled passages in the crankcase, and that the bearings set snugly over the dowel pins. Undersize main bearings are available in .010"; .020" and .030".

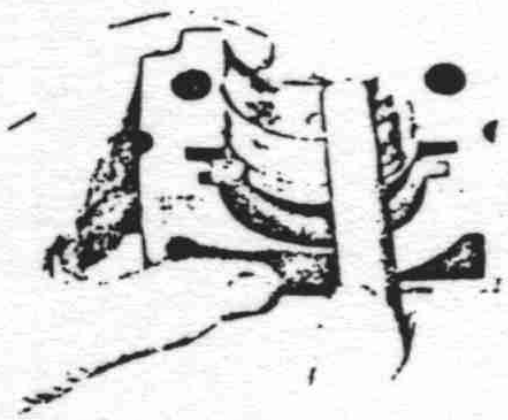

FIG. 26 REAR MAIN BEARING PACKING

(2) The end play of the crankshaft is .004" to .006" and adjusted by shims between the crankshaft sprocket thrust washer and end of main bearing. To adjust end play, the crankshaft sprocket must be removed with gear puller.

(3) Whenever it is necessary to remove the crankshaft or install new crankshaft bearings, the engine has to be removed from the housing. See instructions under Flywheel in paragraph 35.

c. *Rear Bearing Seal.*—

(1) The rear main bearing is sealed by a wick type packing, installed in grooves machined in the crankcase and rear main bearing cap, (Fig. 26).

(2) To install a new seal at the rear main bearing cap, insert the packing in the groove with the fingers. Then using a round piece of wood or steel, roll the packing into the groove. When rolling the packing, start at one end and roll the packing to the center of the groove. Then starting from the other

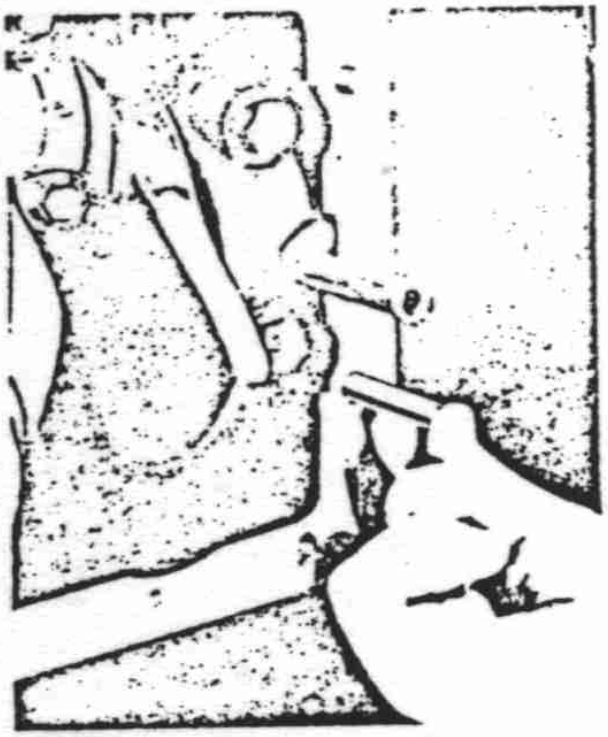

FIG. 27 REAR BEARING CAP PACKING

end again roll toward the center. By following the above procedure you are sure that the wick is firmly pressed into the bottom of the groove. The small portion of the packing which protrudes from the groove at each end should be cut flush with the surface of the bearing cap. To prevent the possibility of pulling the packing out of the groove while cutting off the ends it is recommended that a round block of wood, the same diameter as the crankshaft be used to hold the packing firmly in position while the ends are being cut off.

(3) Should it be necessary to install a new seal in the crankcase, it will require the removal of the engine from the housing and the removal of the crankshaft. The same procedure should be followed when installing a crankcase seal as when installing a seal in the bearing cap.

(4) When installing rear main bearing cap to case, a little sealer should be put on the faces of the cap where it fits against the case. The rubber seal packing that goes between the main bearing cap and the case is cut to a given length and will protrude down from the case approximately $\frac{1}{4}$". When the oil pan is installed it will force this seal tightly into the holes and prevent any oil from leaking from the engine into the generator adapter. See (Fig. 27).

32. Connecting Rod and Piston Assembly.—

a. Connecting Rod.—The connecting rods are drop forged. The babbitt bearings are of the replaceable type, steel-backed, babbitt-lined, precision cut to size and no fitting is required. Clearance on crankshaft .0005" to .0025". Total side clearance .005" to .009". Undersize rod bearings are available in .010", .020" and .030".

b. Piston.—

(1) The piston is aluminum alloy, T slotted, cam ground, tin plated and with a heat insulation groove above top ring. Pistons are available in the following over-sizes: 010"; .020" and .030" and semi-finished .030".

(2) The clearance of the piston in the cylinder bore is .003". Check clearance with .003" feeler gauge $\frac{3}{4}$" wide; feeler gauge should have from 5 to 10 lbs. pull when being removed. The gauge should extend the entire length of the piston on the thrust side which is the opposite side from the T slot in the skirt. If it is ever found necessary to install an over-size piston, the cylinder bore must be honed with a regular cylinder honing tool and the manufacturer's instructions should be carefully followed to get a true straight cylinder. Do not try to lap in a new piston using compound because it will ruin the tin plating on the piston and cause a scoring or wiping condition of both the piston and cylinder walls. See Checking Cylinder Bores and Cylinder Boring, paragraph 33.

c. Piston Rings.—

(1) Width of compression rings 3 32". Width of oil control ring 3 16". The upper compression ring is installed with the inside beveled edge up. The face of the lower compression ring is tapered .005". The letters "T-O-P" on the upper edge of the ring indicate how the ring is installed, (Fig. 28).

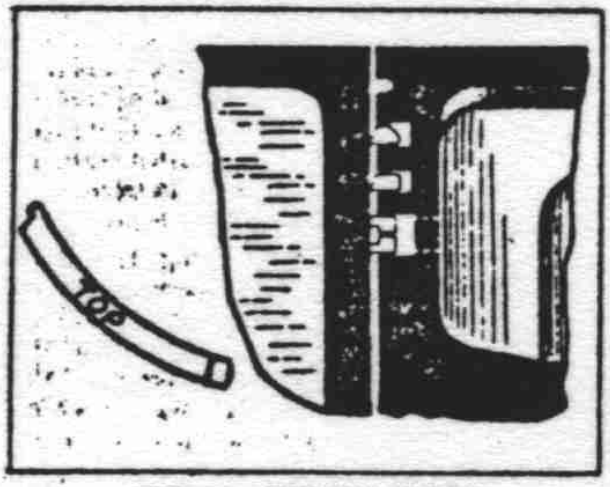

FIG. 28 PISTON RINGS

FIG. 29 PISTON RING GAP

FIG. 30 COMPRESSION RING FITTING

(2) When fitting the rings to the cylinder bores, the end gap is .008"—.013". (Fig. 29). When fitting piston rings to grooves, (Figs. 30 and 31), give them the following clearances: Compression rings, .0005"—.001"; oil rings, .001"—.0015". Oversize rings are available in the following sizes: .010"; .020"; .030". Use standard rings up to .010" oversize cylinder bores.

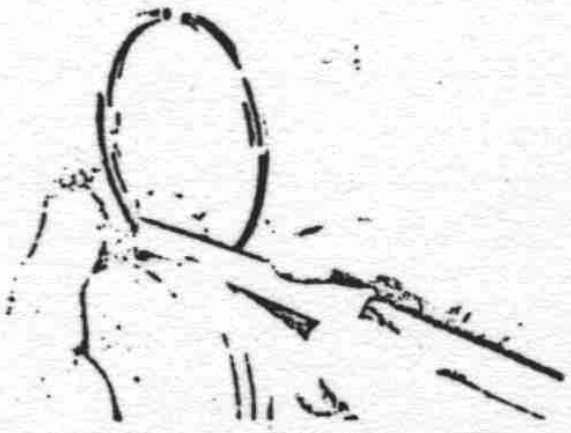

FIG. 31 OIL RING FITTING

d. Assembling Connecting rod to Piston.—

(1) Clamp connecting rod in vise using vise jaw protector shields of a soft metal or two pieces of hardwood on each side of connecting rod three inches from piston pin end.

(2) Start piston pin in piston with groove facing down. Assemble piston to connecting rod with the slot in piston, (Fig. 32), opposite oil spray hole in bearing end of connecting rod. Install piston pin clamp screw.

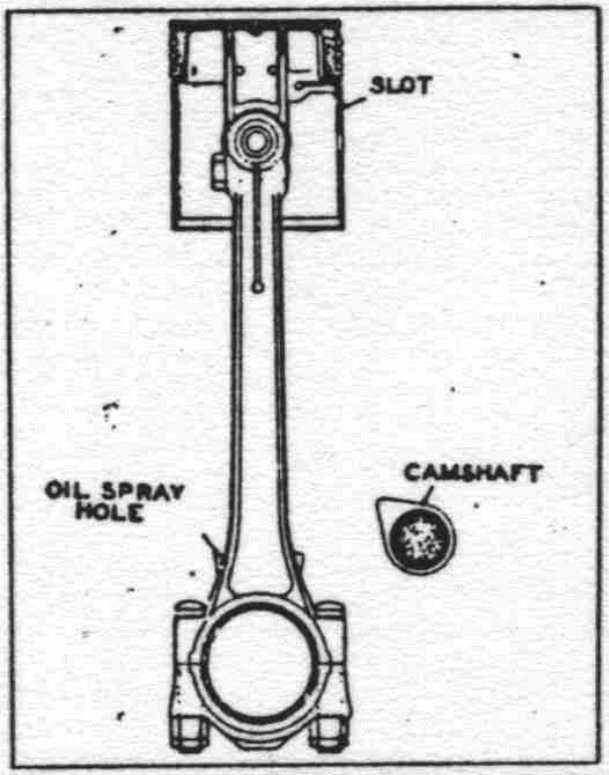

FIG. 32 CONNECTING ROD AND PISTON

(3) Center piston on pin and place assembly on connecting rod aligning fixture. Tilt piston to left with piston resting against surface plate. With feeler gauge, measure clearance between piston skirt and surface plate. Tilt piston to right and check clearance. If clearance is within .003" on both left and right positions, connecting rod is in alignment. A difference greater than .003" indicates connecting rod is twisted.

33. Cylinder Bores.—

a. Checking.—The best method for determining the condition of the cylinder bores preparatory to reconditioning is the use of a dial gauge. The dial gauge will instantly and automatically indicate the slightest variation of the cylinder bores. To use the dial gauge simply insert in the cylinder bores and move up and down its full length. It is then turned spirally or completely rotated at different points, taking readings at each point. In this manner all variations in the cylinder bores from top to bottom may be determined.

b. Refinishing.—

(1) When cylinders are more than .005" out of true it is best to rebore the cylinders. The instructions furnished by the manufacturer of the boring equipment should be carefully followed.

(2) After the cylinder has been rebored within .002" of the size desired, it should be finished or polished with a cylinder hone. Do not use a piston as a hone. In operating, the hone is placed in the cylinder bore and run up and down the full length of the cylinder wall. This procedure should be followed until the piston can be pushed through the bores with a .003" feeler gauge $\frac{3}{4}$" wide on the thrust side and show a pull on the feeler gauge of five to ten pounds.

34. Oil Circulating System.—

a. Oil Pump Assembly.—

(1) The oil pump, (Fig. 8), is a planetary gear type. It consists of two spur gears enclosed in a one piece housing. It is provided with a relief valve to control maximum oil pressure. In operation the oil is drawn from the crankcase through the floating oil intake. The oil then passes through a drilled passage in the crankcase to the oil pump from which it passes through drilled passages in crankcase to crankshaft and camshaft bearings. The oil pump is driven from a spiral gear on the camshaft.

(2) To remove oil pump from engine for dismantling, remove the three nuts on studs holding oil pump to crankcase. Slide oil pump from studs. Remove screw from oil pump cover plate which will allow cover to be removed from housing.

(3) To remove oil pump driven-gear, file off one end of straight pin and with a small drift, drive pin through oil pump shaft. The oil pump shaft with rotor can be removed from the body in an assembly.

(4) When removing oil relief plunger spring retainer, care must be taken not to lose the small shims which govern the spring tension on the relief plunger. Adding shims increases the oil pressure, removing shims decreases the pressure. The pressure at which the relief valve opens will register about 22 lbs. on ENGINE OIL PRESSURE gauge under normal operating temperature.

(5) When replacing the oil pump on engine the following procedure should be followed in order to have correct timing for the ignition. Set No. 1 piston coming up on the compression stroke, then turn flywheel so that the timing mark IGN appears on the flywheel in the center of the hole in the flywheel housing on the left hand side, (Fig. 16). Set distributor rotor at No. 1 terminal tower in distributor cap, with breaker contacts just breaking. Hold the oil pump in one hand with the oil relief valve spring retainer in the same position as it would be when installed in the engine; turn shaft so that the wide side of slot in driven-gear end is toward you, then line up the pin holding driven gear to shaft so that it will fall in line with the right side of the slot in pump body. Slide the assembly on studs in the crankcase, feed gear slowly into camshaft gear, noting when fully set, if the rotor on distributor has moved from its original setting. If so, remove oil pump and turn one tooth to obtain the correct setting.

b. Floating Oil Intake.—

(1) The floating oil intake, (Fig. 8), is attached to the crankcase with two cap screws. The construction of the float and screen cause it to float on top of the oil, raising and lowering in relation to the amount of oil in the crankcase. This construction is to prevent the circulation of water or dirt, which may have accumulated in the bottom of the oil pan, by drawing the oil horizontally from the top surface.

(2) Whenever removed, the float, screen and tube should be cleaned thoroughly in a suitable cleaning fluid to remove any accumulation of dirt. Oil pan screw torque wrench reading is 10-14 ft. lbs.

c. Oil Filter.—

(1) The oil filter, (Fig. 6), is designed to control contamination of engine oil. The filter element removes particles of dust, carbon and other foreign material from the oil which cause discoloration and sludge. The inlet line to the filter is connected to the oil distribution line at the front plug on right hand side of the engine. The outlet or oil return line to engine connects to the timing chain cover.

(2) When the oil on the level indicator in the engine filler-tube becomes dark, remove the oil filter cover; remove the drain plug and drain out the sludge after which, replace the drain plug. Next, remove the element and install a new element. Install new cover gasket; reinstall cover; start engine and check for leaks; then check oil level; add to oil supply if necessary.

d. Engine Oil Pressure Gauge. —The ENGINE OIL PRESSURE gauge is of the hydraulic type and measures the pressure of the oil applied to the engine bearings. It does not indicate the amount of oil in the engine crankcase or the need for changing the engine oil. A pressure tube connects the ENGINE OIL PRESSURE gauge to the engine. It requires no special attention other than to see that the connection to the engine is tight. If the unit becomes inoperative, it should be replaced as its construction does not permit repair or adjustment.

35. Flywheel.—

a. Description.—The flywheel is made of cast steel, machined all over and balanced to insure smooth engine performance. The flywheel is attached to the crankshaft flange by two dowel bolts and four special head cap screws.

b. Removing Pilot Bushing.—No pilot bushing is used at the center of the flywheel on this power unit. If a new flywheel has such a bushing, remove the bushing with a press or with a hammer and blunt-nosed punch before installing the flywheel. Be very careful to avoid marring the flywheel surface, particularly the inner surface of the hole and other surfaces where the flywheel fits against machined surfaces.

c. Assembling.—When assembling the flywheel to crankshaft, be sure it is properly installed in relation to No. 1 crank throw, as indicated by the timing marks, and that it fits properly to crankshaft flange, to avoid runout or looseness. To check runout use dial indicator attached to the rear engine plate. The runout should not exceed .008" on the rear face near the rim. Torque wrench reading 35-40 ft. lbs.

d. Installation In The Field.—When installing a new crankshaft or flywheel in service, it is the general practice to replace the tapered dowel bolts with straight snug fitting bolts. The crankshaft and flywheel should be assembled in proper relation, then

install the straight bolts previously used and tighten securely. Next, use a 35/64" drill to enlarge the tapered bolt holes and then ream the holes with a 9/16" (.5625") straight reamer and install two flywheel to crankshaft bolts No. 80B with two ½"-20 hexagon nuts and two ½" lockwashers, instead of the two dowel bolts formerly used. This procedure overcomes the difficulty in correctly tapering the holes in the field.

36. Engine Support Plates and Mounting.—

a. Front Support Plates.—The front engine support plate is bolted to the front face of the cylinder block and forms the back panel for the attachment of the timing chain cover.

b. Rear Support Plate.—The rear engine plate is attached to the rear of the cylinder block and provides a means for attaching the generator adapter ring which supports the rear end of the engine.

37. Fuel System.—

a. Description.—The fuel system includes the fuel tank, fuel pump, carburetor, connecting fuel lines, shut-off valves, strainers and sediment bowls. It may also include an auxiliary fuel tank. The most important servicing required is to keep it free of dirt, water and leaks. This requires care in handling of the fuel to avoid getting dirt or water into the fuel system, and periodic cleaning of sediment bowls and strainers to keep dirt and water which enter, from reaching the passages and jets of the carburetor. Fuel leaks should be corrected as soon as discovered.

b. Fuel Tank.—The 10½ gallon fuel tank is mounted above the generator. It may be removed after first removing the hold down clamps.

c. Fuel Pump.—

(1) The diaphragm type fuel pump operates continuously while the engine is operating and pumps fuel from the fuel tank to the carburetor. See paragraph 15 and Fig. 10 for further description.

(2) Remove and clean the sediment bowl and strainer monthly. When replacing, tighten the clamp screw sufficiently to hold the bowl tightly on the gasket. Check for leaks and install a new gasket, if necessary.

(3) If the fuel does not reach the carburetor bowl, check the fuel supply, the position of the shut-off valve, the fuel lines and strainer before disassembling the main body of the pump. Remove the pump from the engine when moving parts are to be inspected or replaced.

(4) Failure of the pump to function may be due to a leaking valve, gasket or diaphragm, or to a weak or broken spring. After removing the six screws from the pump body, the two main castings may be separated to permit inspection of the interior mechanism. Replace worn or damaged parts with new ones. Inlet and outlet check valves are interchangeable. The inlet check valve is installed with spring down and the outlet check valve is installed with spring up. They are held in place by a straddle plate and two screws. Check valve gaskets must be in place before check valves are installed.

(5) The vertical driving member of the diaphragm assembly hooks under the end of the lever mechanism, as shown in Fig. 10 and must be disengaged at that point before it can be removed. When installing a diaphragm assembly, hold the body casting in an upside down position to facilitate engagement of the diaphragm assembly with the hook on the lever.

(6) When reassembling, make sure that all gaskets are in place and all screws tight.

d. Carburetor.—

(1) The carburetor mixes the fuel and air in proper proportion for burning in the engine. See paragraph 14 and Fig. 9 for further description.

(2) If the engine is not performing correctly, do not hastily jump to the conclusion that the carburetor is at fault. First check carefully the ignition system, valve action, timing, compression, fuel system other than carburetor, fuel, oil, operating temperature, and the load. Only when these items are in normally good condition may the carburetor be properly adjusted. Do not attempt to compensate for a faulty condition elsewhere by changing the carburetor adjustment. Correct the fault where it exists.

(3) The carburetor requires little attention other than cleaning and this can be kept at a minimum by using clean fuel and keeping the screens and sediment bowls clean throughout the fuel system. A drain plug and screen at the bottom of the carburetor bowl should be cleaned periodically.

(4) Remove the carburetor from the engine and dismantle it for a thorough cleaning. Remove the screw plugs, jets and the idle adjusting screw. Be careful not to lose any of the fibre washers. Clean jets and passages with compressed air, if available.

(5) Do not remove the main nozzle unless necessary to replace it. It can be cleaned without removing. If a new one is installed, make sure that only one gasket is used with it and that the diagonally cut inner end stands in a vertical position when tight. (See Fig. 9).

If necessary, a soft copper wire may be used to clean jets and bleed. Never use an iron or steel wire. A slight enlargement or distortion of these holes may make it necessary to replace the part. Replace any parts that are damaged or badly worn.

(6) Remove the float and inspect the needle valve. If worn, or known to be leaking, install a complete new needle and seat assembly. Shake the float. If it contains gasoline, it leaks. Install a new one.

(7) Check the float level. Hold the cover and float assembly in an upside down position and allow the float to set at the position determined by its own weight. The vertical distance from the gasket surface of the cover to the float should be $\frac{3}{8}$". If measured with gasket in place, make allowance for gasket thickness. Take the measurement at the top surface of the float, near the end opposite the float arm. A simple way to take this measurement is to use a sheet metal gauge 2 or 3 inches long and 11 32" wide with parallel edges. When set on edge across the inverted cover, with gasket in place, the float should barely touch the gauge by its own weight. Any change in level adjustment should be made by bending that portion of the float arm which rests against the needle valve. Bend very slightly. Do not roughen or destroy its curvature. Do not stretch the needle valve spring.

(8) Do not disturb the position of the metering rod, unless necessary to replace it. In that case, set the new rod at same position. If this rod is set too high, the full load fuel mixture will be too rich and vice versa.

(9) In reassembling the carburetor make sure that all fibre washers and gaskets are in place and that all jets and plugs are tight.

(10) The pump on this carburetor is not required in constant speed service and should be made inoperative by removing the connecting link between the pump arm and the pump plunger rod.

(11) Since a dirty air cleaner may place too great a restriction on the flow of air to the carburetor always clean it as described in paragraph 27 c (4) when servicing the carburetor. Also, make sure that the choke opens properly.

(12) After reassembling the carburetor to the engine, start the engine. With the power unit operating at no load, turn the idle adjustment screw in (clockwise) until the engine begins to run unevenly due to lean fuel mixture. Then slowly turn this screw in the opposite direction until the engine runs smoothly and the power unit develops maximum voltage. Do not open far enough for the voltage to begin to drop. Recheck this adjustment after the engine has been running half an hour. Proper adjustment is between $\frac{1}{2}$ and $1\frac{1}{2}$ turns open (counterclockwise) from a completely closed position.

e. Fuel Lines.—The fuel lines require little attention except routine inspection for leaks. Replace leaking fuel lines with new ones.

f. Sediment Bowl and Strainer.—The sediment bowl and strainer beneath the fuel tank require periodic cleaning.

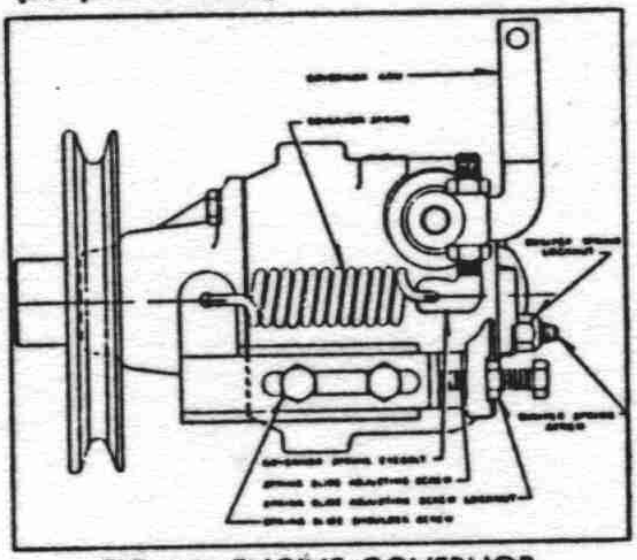

FIG. 33 ENGINE GOVERNOR ADJUSTMENTS

38. Engine Governor.—

a. Description.—The governor is of the flyweight type, driven by a V-belt. The outside length of the belt is 48", maximum width, 33/64", angle of V, 40°. The governor controls the speed of the engine and the frequency of the alternating current generator. It is lubricated from the oil pressure system of the engine normally requires little attention, but it is essential that it function properly. Check and adjust the belt tension periodically to assure correct speed control. Correct belt tension permits one side of the belt to be pushed inward $1\frac{1}{4}$" to $1\frac{1}{2}$" by applying thumb pressure midway between pulleys. It is adjusted by shifting the position of the governor assembly as permitted by slotted holes, Fig. 18. It is adjusted by shifting the position of the governor assembly as permitted by slotted holes, (Fig. 18). A sealed, vacuum operated governor on the intake manifold limits the top speed of the engine in case of belt breakage, but the belt should be replaced before breakage occurs.

b. Regulation Limits.—It is advisable to refer to the A.C. VOLTMETER while adjusting the governor. At no-load, the voltage should not exceed 235 volts. At full load, unity power factor, the voltage should not be lower than 215 volts.

c. Adjustment.—If necessary to adjust the governor, do so with engine at normal operating temperature. Proceed as follows:

(1) With spring tension on the governor spring, Fig. 33, adjust the length of the throttle control rod so that the carburetor throttle lever clears the wide open stop by 1 64".

(2) Loosen the bumper spring screw locknut and turn that screw out far enough to prevent its functioning. Loosen the spring slide shoulder screws so the slide may move endwise. Start the engine. Loosen the spring slide adjusting screw locknut and turn that screw as necessary to obtain correct speed.

(3) If the governor surges under full or part load, adjust the governor spring eyebolt downward until surging stops. For close regulation, keep the governor spring eyebolt as high as possible without causing surging. Each time its adjustment is changed, readjust the spring slide adjusting screw for correct speed.

(4) If the governor surges at no load, turn the bumper spring screw in until surging stops, but not far enough to increase the engine speed.

(5) Tighten all locknuts and shoulder screws."

39. Cooling System.—

a. Description.—The performance of an engine is dependent to a great extent upon the proper operation of the cooling system. This system includes the engine water jacket, radiator, connecting hose, circulating pump, thermostat and the ENGINE WATER TEMPERATURE gauge.

b. Draining Cooling System.—To drain the cooling system open the drain cock located at the lower right hand corner of the radiator, just under the water outlet, also the drain cock at lower left front corner of cylinder block.

c. Filling the Cooling System.—

(1) *Instructions.*—Close the drain cocks on the cylinder block and radiator. Fill the radiator with clean water or, during cold weather, with an anti-freeze solution. Do not overfill the radiator while anti-freeze solution is being used, because the solution expands when heated and an appreciable amount of liquid would be lost through the overflow. The solution should be 1" from the bottom of the filler neck. The capacity of the cooling systems is 15½ quarts.

(2) *Caution.*—Should water be lost from the cooling system and the engine overheat, do not add water immediately but allow the engine to cool, then add water slowly while the engine is running. If cold water is poured into the radiator while the engine is overheated, there is danger of cracking the cylinder block and head.

d. Radiator.—

(1) *Servicing.*—The radiator is designed to cool the water under all operating conditions, however, the radiator core must be kept free from corrosion and scale in addition to the maintenance of other cooling units to obtain satisfactory service. At least every 1000 operating hours remove the radiator and clean it inside and out in a cleaning solution. At the same time examine core for leaks or damaged cells and make any needed repairs. After radiator and cooling system have been cleaned and flushed out, it is advisable to use a corrosion preventative. Rust and scale may eventually clog up water passages in both the radiator and water jacket of the engine unless a rust inhibitor is used. This condition is aggravated in some localities by the water available.

(2) *Removing and Replacing Radiator.*—To remove the radiator, proceed as follows:

(*a*) Remove the front side panels from the housing and slide the front top plate back.

(*b*) Open the radiator drain cock and drain the radiator.

(*c*) Loosen the top, front hose clamp and either of the clamps on the hose connected to the water pump. Disconnect the water inlet elbow after loosening the clamp.

(*d*) Remove the four bolts from the front ends of the front housing top-plate guide-rods.

(*e*) Remove the three nuts which hold the fan guard. Bend the top radiator support brackets outward slightly and remove the fan guard.

(*f*) Remove the four bolts which hold the front of the exhaust compartment top plate to the housing front support.

(*g*) Remove the four bolts which hold the bottom corners of the housing front support to the skids.

(*h*) Remove four bolts from the sides of the housing front support.

(*i*) Tip the front support, with radiator, slightly forward and remove carefully.

(*j*) Remove the two nuts which hold the bottom of the radiator to the crossmember of the front support.

(*k*) Remove the four nuts from the two top radiator supports and lift the radiator from the support.

(*l*) While radiator is removed, install any new radiator hose needed, but do not tighten the clamps until all other connections are made after installing the radiator.

(*m*) Install the radiator by reversing the above order of procedure. Tighten the hose clamps last, and inspect the connections carefully for leaks after the radiator is filled. Stop all leaks.

(3) *Emergency Repairs.*—Emergency repairs in case of puncture by bullet or shrapnel; if a tube is not completely severed, cut it or break it off with a pair of pliers. With pliers, strip fins from tube above and below break for $\frac{1}{2}$" or necessary distance to enable bending of the tube around itself and flatten, both above and below the break thereby stopping the flow of water.

e. Thermostat.—The cooling system is designed to provide adequate cooling under the most adverse conditions; however, it is necessary to employ some device to prevent overcooling during normal operations and to quickly warm up the engine from a cold condition. This is accomplished by use of a thermostat, (Fig. 7), which is located in the water outlet on top of the cylinder head. The thermostat opening is set by the manufacturer and cannot be altered. The thermostat opens at a temperature of 145° to 155° F. To test thermostat, heat sufficient water to 170° F. and submerge thermostat. The valve should open to the limit at this temperature. If valve fails to open, a new thermostat will be required.

f. Engine Water Temperature Gauge. — The ENGINE WATER TEMPERATURE gauge is connected to a thermal element in the cylinder head by means of a capillary tube. If the gauge becomes inaccurate or inoperative, it should be replaced with a new one including thermal element and capillary tube. See paragraph 45 e.

g. Fan and Water Pump.—

(1) *Description.*—The fan and water pump, (Fig. 34), are mounted on the same shaft. The pump is of the centrifugal type and circulates the water in the cooling system.

(2) *Bearing.*—The double-row ball bearing is integral with the shaft and is packed with a special high melting point grease at the time of manufacture so it requires no lubrication. The ends of the bearings are sealed to retain the lubricant and prevent dust and dirt from entering.

(3) *Construction.*—The bearing is retained in the housing by a retaining wire, which snaps between the bearing and the water pump body. The seal washer has four lugs which fit into the slots in the end of the impeller. One side of the seal washer bears

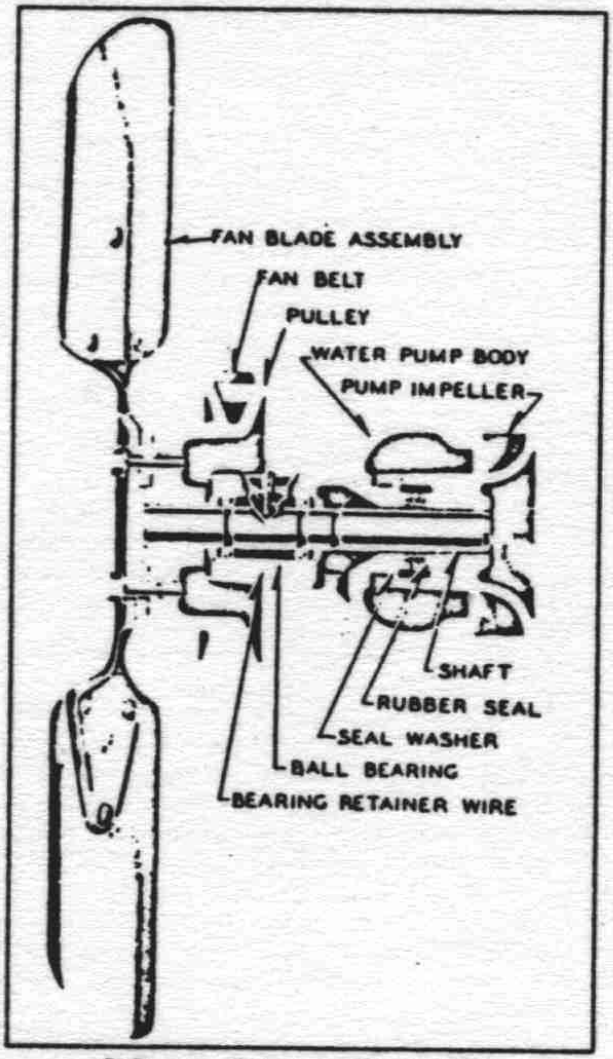

FIG. 34 FAN AND WATER PUMP ASSEMBLY

against the ground surface of the pump body and the other against the seal. The rubber seal bears against the machined surface on the inside of the impeller. The seal maintains a constant pressure against the seal washer and impeller assuring positive seal. The drain hole in the bottom of the housing prevents any water seepage past the seal washer from entering the bearing. The impeller and pulley are pressed on to the straight shaft under 2500 pounds pressure.

(4) *Dismantling.*—Remove the fan belt and fan blade assembly and then the water pump from

the engine. Remove bearing retaining wire. Place water pump body on an arbor press face-plate and press water pump shaft through impeller and pump body. Remove the seal washer and seal. Place pump shaft and fan pulley on press so that the bearing will clear in the opening and press shaft from pulley.

(5) *Reassembling.*—To reassemble the water pump, install the long end of the shaft in the pump body from the front end until the outer end of bearing is flush with the front end of the pump body. Dip the seal and the seal washer in brake fluid and install in the impeller. Place the impeller on an arbor press and press the long end of shaft into the impeller, until the end of the shaft is flush with the impeller. Support assembly on impeller end of shaft and press the fan pulley onto shaft so the end of shaft is flush with the face of the fan pulley. Move the shaft in the pump body so grooves in the bearing and pump body line up and install bearing retaining wire. Install fan blade assembly with spacer.

h. Fan Belt.—The fan is driven by a 42° angle V-belt. Length outside 44¼". Width, maximum, 11/16". To install fan belt loosen clamp bolt on slotted bracket at idle pulley and move idle pulley toward engine. Slide belt over crankshaft pulley, up through fan blade assembly and over fan pulley, then over idle pulley. Adjust the fan belt by moving the idle pulley away from the engine to a point where the fan belt can be depressed 1" midway between fan pulley and idle pulley, (Fig. 18). The driving of the fan and generator is on the sides of the V-belt; therefore, it is not necessary to have the fan belt so tight as to cause excessive wear on bearings.

i. Anti-Freeze Solution.—

(1) *When Required.*—Where air temperatures require, it is necessary to protect the cooling system with some type of anti-freeze solution so as to prevent damage resulting from freezing.

(2) *Alcohol.*—When alcohol is used in an anti-freeze solution care must be taken not to spill any of the solution on the finished portions of the housing; if so spilled, it should be washed off immediately with a good supply of cold water, without wiping or rubbing. The evaporating point of a water and alcohol cooling solution is approximately 170° F. Therefore, when such solution is used in warm weather, it must be checked frequently with a hydrometer as there may be considerable loss of alcohol through evaporation, thus raising the freezing point and resulting in damage due to freezing.

(3) *Ethylene Glycol Solution.* — Ethylene glycol anti-freeze solutions have the distinct advantage of possessing a higher point of distillation than alcohol and consequently may be operated at higher temperatures without loss of the solution through evaporation. Ethylene glycol has the further advantage that in a tight system only water is required to replace evaporation losses, however, any solution lost mechanically through leakage or foaming must be replaced by additional new solution.

40. Exhaust System.—

a. Exhaust and Intake Manifolds.—

(1) *Description.*—The exhaust and intake manifolds make a unit in which the hot exhaust gases are thermostatically controlled and directed around the intake manifold to assist in vaporizing the fuel when engine is cold, thereby aiding in warming up the engine and reducing oil dilution. It also minimizes the use of the carburetor choke control and results in proper temperature of the incoming gases under all operating conditions.

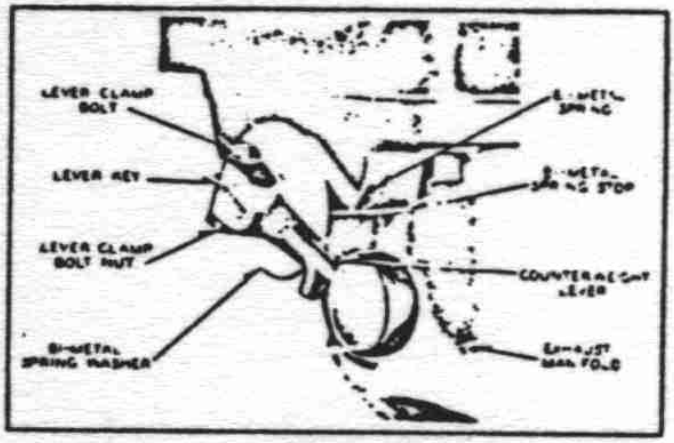

FIG. 35 HEAT CONTROL VALVE

(2) *Functioning.*—When the engine is cold, the counterweight lever closes the heat control valve and directs the hot exhaust gases against the intake manifold. See (Figs. 5 and 35). As the engine warms up, the Bimetal spring expands and opens the valve directing the exhaust gases into the exhaust pipe.

(3) *Servicing.*—All parts are replaceable but little servicing is required. When assembling the manifolds to the cylinder block, new gaskets should be installed and the nuts drawn up evenly until they are all tight to avoid gas leakage. Torque wrench reading, 31-35 ft. lbs.

b. Muffler.—The exhaust manifold is connected by steel tubing to the muffler mounted in the muffler

compartment below the radiator. The muffler outlet is at the lower left front corner of the housing. Ten feet of flexible exhaust tubing may be connected at the outlet to carry the exhaust gases away from the power unit.

c. Caution.—Do not operate the power unit inside a closed room without first having connected an exhaust line that will carry all exhaust gases out of doors. Exhaust gases are poisonous and may cause death.

d. Servicing.—If the exhaust system becomes clogged with carbon it will create a back pressure on the engine that will prevent its developing full power and will cause combustion chambers and valves to become covered with carbon to the extent that a carbon removal and valve grinding job will become necessary. Keep the exhaust system free of excessive carbon. Keep all joints tight. If the flexible pipe leaks, replace it.

41. Ignition Unit.—

a. Breaker Contacts.—The breaker contacts in the ignition unit, (Fig. 8), eventually become pitted and must be replaced. When not too badly pitted they may be resurfaced by means of a carborundum hone. They must be removed to do this. Surfaces should be finished to a very slightly convex form, almost flat. When properly adjusted they must open .020" and when closed they should contact at the central areas of their surfaces. Spring tension is adjustable and should be between 17 and 20 ounces, measured at the contact of the breaker arm just as the contacts separate.

b. Condenser.—If spark is weak and breaker contacts are badly burned and have a sooty appearance it is probable that a new condenser is required. The condenser may fail without such symptoms. The condenser capacity should be between .18 and .26 microfarads. Replace with a new one if outside these capacity limits.

c. Cap and Rotor.—Keep the distributor cap and rotor clean. If the cap is cracked, shows evidence of arcing or has corroded contacts, replace it with a new one. Replace the rotor when it becomes burned too short, as may be evidenced by a burned condition on top of the strip.

d. Governor.—The governor should be checked for free operation. Hold the distributor shaft and turn the cam to the left as far as it will go and release. The cam should return immediately to its original position with no drag or restriction. Inspect the distributor shaft bearing in housing, also the shaft friction spring on end of shaft inserted into the coupling on the oil pump shaft; if damaged, replace.

e. Timing.—Ordinarily the timing of the ignition unit should not be disturbed. If, however, it should become necessary to retime the unit after having removed it, the following procedure may be followed.

(1) Remove the cover from the timing hole on the flywheel housing (Fig. 16). Crank the engine slowly with the hand crank until No. 1 piston is coming up on compression, and stop when the ignition timing mark IGN of the flywheel appears in the center of the timing hole in the flywheel housing.

(2) Place the distributor arm of the rotor in line with No. 1 tower of the distributor cap and so that the breaker contacts are just opening. Set the unit in place on the engine and turn the rotor shaft slightly, as necessary, so that the driving lug on the end of the shaft engages the slot in the drive coupling. Then push the unit down and install the hold-down screw. Rotate the case until the contacts are just breaking and lock in place by tightening the clamp screw. Complete the assembly. Start the engine and recheck the timing with a neon timing light, if available. The correct timing depends somewhat on the fuel used and should be set at the point at which the constant full load voltage is highest. A further test is to switch from no load to full load at once. If there is a pinging knock during acceleration, retard the spark just enough to eliminate it. Final adjustment is made by loosening the clamp screw and turning the unit slightly, as necessary. Tighten screw. Install the timing hole cover.

42. Spark Plugs.—

Keep spark plugs clean and properly adjusted. When porcelains crack or become badly eroded, or when electrodes are badly burned, install new spark plugs of same type, which is Champion No. J-9 Set the gap between electrodes at .030". When installing, make sure gaskets are in place and tighten the plugs securely.

43. Battery.—

The battery requires certain routine attention. Follow the battery manufacturer's instructions when available, otherwise check as follows:

a. Keep the water level about $\frac{3}{8}$" above the plate separators. Use distilled water, clean rain water that has not been handled in metallic containers, or water known to be harmless to batteries. Avoid overfilling. Never allow water level to recede below tops of separators.

b. Keep the top of battery and the terminals clean. A coating of petroleum jelly on the terminals helps prevent harmful corrosion.

c. Keep the battery in a fully charged condition. If allowed to remain in a low state of charge, sulpha-

tion of plates will reduce the capacity and greatly shorten the life of the battery. A discharged battery will freeze at 20° F. above zero.

44. Solenoid Starting Switch.—

If it is suspected that the solenoid starting switch, (Fig. 5), is not closing properly, test by touching a heavy jumper wire across its two large terminals. If the engine is not cranked as a result, there is trouble elsewhere. If the engine is cranked, as a result, touch a jumper wire from its positive terminal to which the positive battery cable is connected, to the smaller front terminal. If the engine is not cranked as a result, the solenoid starting switch is at fault and a new one should be installed.

45. High Water Temperature Cut-Off Switch.—

a. Description.—The setting and functioning of the high water temperature cut-off switch, (Fig. 6), are explained in paragraphs *8 a* (13) and 23. To assure proper functioning, its accuracy may be checked in the following manner.

b. Checking Accuracy.—Remove the radiator cap and insert the bulb of a good Fahrenheit thermometer in the water in the radiator. Set the dial at 220. Cover the radiator and operate the engine until the water temperature exceeds 180° F. Then slowly turn the dial counter-clockwise until the ignition is switched off. Then the dial reading should coincide with the thermometer reading. If the readings differ, the dial scale should be adjusted.

c. Adjusting.—The factory setting of the dial scale is sealed by applying sealing compound to a small area of both the scale and the central disc of the dial. **Do not break this seal unless it is necessary to adjust the dial.** Then, after checking with a thermometer as just described, loosen the two screws in the central disc of the dial without disturbing the dial setting. With the screws loosened, break the seal and set the scale so its reading corresponds with the thermometer reading just taken. Tighten the screws. Set the cut-out switch for a higher temperature to permit starting the engine. Repeat the test to verify the correctness of the adjustment.

d. Adjusting when a Thermometer Is Not Available.—Water in an open vessel, such as an uncapped radiator, boils at 212° F. at sea level. The boiling point drops approximately 3° for each 1000 feet above sea level. If the elevation with respect to sea level is known, the approximate boiling point of water for that location may be calculated and that value may be used to check the switch operation. It is important that the cooling liquid be water only when making this check. Operate the engine with radiator covered, and with cap off, until the water boils freely. Turn the dial counter-clockwise until the ignition is switched off, then compare the dial reading with the calculated water temperature. If an adjustment is required, adjust the dial scale so that the reading at the instant the ignition is switched off, with water boiling, corresponds with the calculated temperature. The method of changing the dial scale adjustment is explained in the preceding paragraph. Use the thermometer method of adjusting when possible.

e. Engine Water Temperature Gauge.—The reading of the ENGINE WATER TEMPERATURE gauge should be checked against the thermometer reading or the calculated boiling point temperature. If the gauge is more than a few degrees inaccurate, install a new gauge and thermal element.

46. Low Oil Pressure Cut-Off Switch.—

The low oil pressure cut-off switch, (Fig. 5), closes when the oil pressure drops to approximately 6 pounds per square inch, operates the stop relay and switches off the ignition. If the engine stops unexpectedly and the water temperature is normal it may be due to the closing of the low oil pressure cut-off switch because of low oil pressure. If the oil pressure will not build up to about 6 pounds per square inch and open this switch, the engine will not continue to run after the START button is released. Throw the MANUAL START-REMOTE START switch to MANUAL START position and start the engine. If the ENGINE OIL PRESSURE gauge shows that the oil pressure does not build up normally, do not operate the engine until the trouble is located and corrected. If the oil pressure builds up normally and it is suspected that the low oil pressure cut-off switch is at fault, disconnect the wires from it, throw the MANUAL START-REMOTE START switch to REMOTE START position and start the engine electrically. If the engine runs normally and with normal oil pressure, but stops as soon as the wires are connected to the low oil pressure cut-off switch, the cut-off switch is at fault and a new one should be installed. The engine may be operated temporarily without the protection afforded by this switch, if necessary. If this is done, connect the two wire terminals together and tape the joint. Give special attention to the lubrication during the emergency and install a new low oil pressure cut-off switch at the first opportunity.

47. Battery Charging Regulator and Resistor Group.—

a. Battery Charging Regulator.—If the battery charging regulator fails to function properly as explained in paragraph *20 d*, it should be replaced

with a new one. If the charging rate continues at about 10 amperes after all battery cells are known to be fully charged, it may be due to an open circuit in the regulator coil or to sticking regulator contacts. If the charging rate does not rise higher than about 2 amperes when the battery is known to be in a low state of charge it may be due to the regulator contacts not closing properly or, if closing, not making good electrical contact. If trouble in the battery charging regulator is suspected, substitute a new relay. If the new relay corrects the conditions, discard the old one.

b. Resistor Group.— Whenever the power unit is in operation, heat should be generated in the 2.5-ohm resistor No. 608. If it remains cold while the power unit is in operation it probably is defective. Substitute a new one. If the new one functions normally, discard the old one. Heat is generated in the two 2-ohm resistors only while the battery is charging at the high rate of about 10 amperes. If one of these resistors is defective the high charging rate will be reduced and no heat will be generated in the defective resistor. Replace the defective resistor with a new one.

48. Relays.—

a. General.- The relays on the control panel require no attention under normal conditions. All relays are of direct-current type. In case of failure of any relay the power unit may be operated temporarily by starting manually. The functioning of the relays is explained in paragraphs 25 and 26. By referring to wiring diagram (Fig. 14) and using it in connection with paragraph 26 the various relay circuits may be checked and any relay trouble may thus be traced to a certain relay. Substitute a new relay for the one suspected of being at fault, and observe whether the condition is corrected. The battery charging relay may be repaired, if necessary. A defective start, ignition or stop relay should be replaced with a new one.

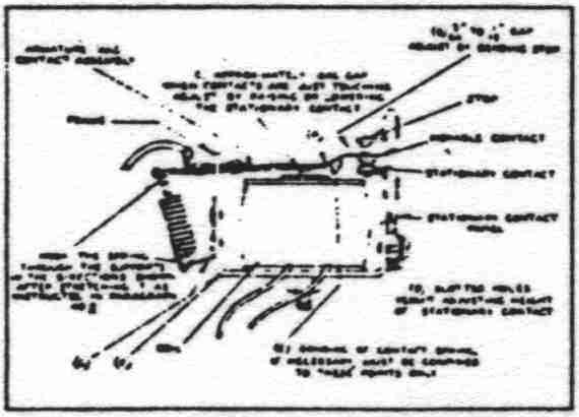

FIG. 37 BATTERY CHARGING RELAY

b. Battery Charging Relay. — The battery charging relay requires little attention. Do not disturb the factory adjustment unnecessarily. If the adjustment has been disturbed, or a new part has been installed, a definite procedure must be followed in making correct adjustments. Refer to (Fig. 37) in connection with these instructions.

(1) With the coil assembly installed in the frame and the nut securely tightened, place the armature and contact assembly in position. The contact spring rests against the armature at the point (A) with a pressure of about one pound. If this tension has been lost, install a new armature and contact assembly.

(2) Install the stationary contact panel with contact. The screw holes are elongated to permit adjusting.

(3) Adjust the gap (C) to approximately .040" by raising or lowering the stationary contact as permitted by slotted holes (D). Measure this gap with a thickness gauge when contacts are just touching.

(4) See that contacts set squarely together when the armature is entirely down and that they make contact at the centers of the contact surfaces. If necessary, bend the frame slightly at point (F) and the contact arm at points (E) to obtain correct alignment. After bending at either point it will be necessary to readjust gap (C).

(5) Adjust gap (B) to between 3/64" and 1/16" by bending the stop as required.

(6) If a new spring is to be installed, it must be stretched very carefully before assembling. The coils of a new spring rest tightly together with some tension. Stretch just enough so a very small clearance remains between coils when released, just enough clearance so coils do not touch. If clearance is too great, discard the spring.

(7) Install the spring with the hooks attached in exactly the directions shown in (Fig. 37).

(8) Adjust the spring tension so that 10 volts direct-current applied to the coil will close the contacts forcibly but 8 volts will not be sufficient to close them. Use 5 cells of the battery to obtain 10 volts, 4 cells to obtain 8 volts. To increase the spring tension, bend the lower loop up closer to the first coil. If more tension is needed than obtainable in this manner, bend the support downward at (G). To reduce the tension, bend the support upward.

49. Changing Engines.—

a. Removing the Engine.—To remove the engine from the power unit, proceed as follows:

(1) Remove the front housing support and radiator as instructed in paragraph *39 d* (2) (*a*) through (*i*).

(2) Remove the rear housing superstructure and the entire generator, following instructions contained in paragraph *50 e* through *f*.

(3) Remove the electric choke control rod. Disconnect the exhaust pipe from the exhaust manifold.

(4) Remove the two front engine support bolts.

(5) Attach a hoist to the engine and lift it from the skids.

b. Installing the Engine.—

(1) Lower the engine carefully into the skids by means of a hoist. Place substantial blocking under the rear of the oil pan to support the engine about half an inch above its normal position. While still attached to the hoist, install the front engine support bolts loosely. Remove the hoist.

(2) Install the generator by reversing the procedure of disassembly and giving particular attention to the instructions contained in paragraph *50 f* (1) through (3).

(3) Install the front housing support and radiator by reversing the procedure of disassembly.

(4) Connect the exhaust pipe to the manifold, using a new gasket and tightening the nuts securely.

(5) Install the electric choke control rod.

50. Generator.—

a. Routine Servicing.—

(1) *Brush Inspection.* — Remove the cover from the exciter every 200 operating hours and inspect the commutator, collector rings and brushes. Make sure that brushes move freely in holders and have uniformly good spring tension. Correct spring tension is 14.5 to 19.5 ounces for the slip ring brushes; 30 to 40 ounces for the exciter brushes when the end of the spring is even with the top of the brush holder. Replace any brushes worn to less than ¾" length.

(2) *Sanding Brushes.*—Sand new brushes to a good seating contact. This may be done by drawing a strip of No. 00 sandpaper around the commutator, sanded side out, while the brush rests on the sanded surface of the paper with normal spring tension. See (Fig. 38). Make sure that the sandpaper contacts a large area of the commutator both directions from the brush. Draw the sandpaper in the normal direction of armature rotation. Raise the brush for the return stroke. Repeat until a proper seating surface is obtained. Slip ring brushes are sanded in the same manner.

(3) *Commutator.*—The commutator acquires a mahogany-colored surface after being in service a short time. If smooth, this surface requires no attention. Slight roughness may be improved by holding a piece of No. 00 sandpaper against the surface while the engine operates slowly. Brushes should be lifted in holders while doing this operation.

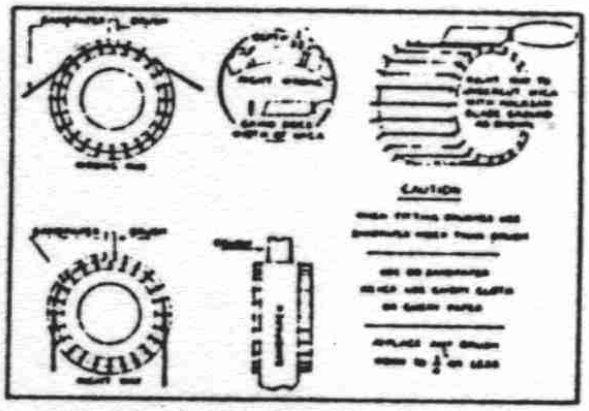

FIG. 38 CARE OF COMMUTATOR AND BRUSHES

A badly worn, burned or pitted commutator will require refinishing in a lathe. After refinishing the commutator, or whenever the copper has worn down flush with the mica insulation which is between the bars, the mica must be undercut 1 32" as shown in (Fig. 38). These operations should not be attempted by unauthorized personnel.

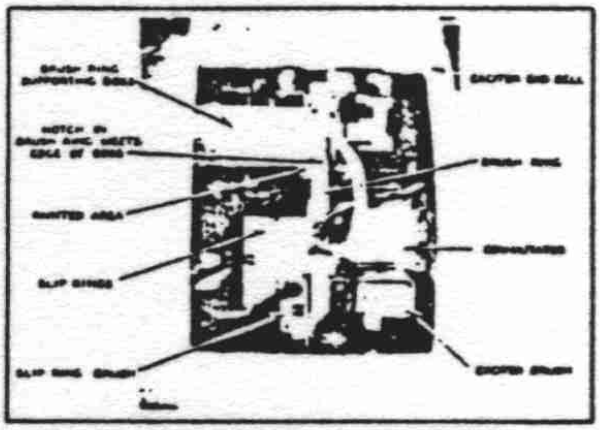

FIG. 39 NEUTRAL POSITION OF EXCITER BRUSHES

(4) *Neutral Position of Exciter Brushes.*—The edge of the exciter brush ring has a small indentation that coincides with the edge of supporting boss when the ring is in proper neutral position. See (Fig. 39). This spot is marked with yellow paint on both the ring and the support boss. This setting of the brush ring in neutral position should be maintained.

(5) *Slip Rings.*—The slip rings require the same attention as the commutator except that there is no mica to be undercut.

(6) *Cleanliness.*—After servicing the commutator, slip rings and brushes, blow the sand, copper and carbon dust from the generator.

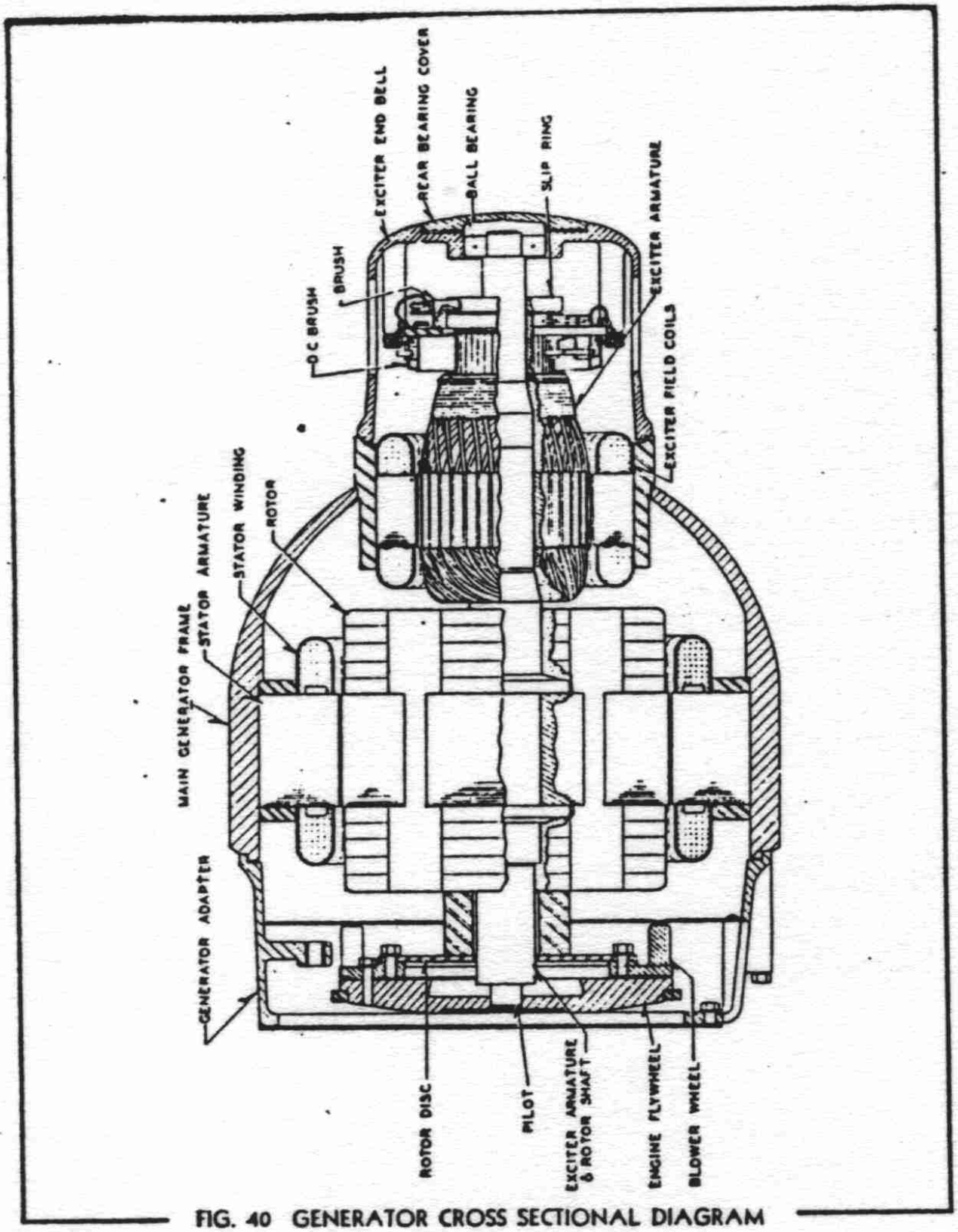

FIG. 40 GENERATOR CROSS SECTIONAL DIAGRAM

(7) *Generator Ball Bearing.*—Every three months, or 600 operating hours, whichever occurs first, remove the bearing cover from the generator end bell. Clean the old grease from the bearing recess and repack with an approved ball bearing lubricant. Do not use common hard oil. Replace the cover, using a new gasket, if needed. Be sure the retaining clips which hold the outer race of the ball bearing from turning in the end bell are in place.

b. Major Servicing. — Replacement of exciter field coils, rotor or stator (Fig. 40), will require removing major parts of the generator. The housing super-structure must be removed before such major servicing of the generator can be done.

c. Removing Housing Super - structure. — When it becomes necessary to remove a major part of the generator, the housing super-structure must be removed. It is best to remove it as a complete assembly, using the following schedule of operations:

(1) Disconnect all wires leading from the power unit.

(2) Remove the side and top panels from the housing. To remove the front top panel it will be necessary to remove the bolts by which the retaining chains are attached to the panel.

(3) Disconnect all battery cables at the battery. Remove the four thumb screws and the top frame which hold the battery down. Remove the battery and the sliding battery tray.

(4) Remove three screws from the top edge of the control panel and tip the panel out and down to a horizontal position.

(5) Disconnect from the panel the bond strap extending from the exciter end bell. Disconnect the four main generator leads at the a-c terminal block. Attach numbered tags to the wires as they are removed, to assure proper connections when reassembling.

(6) Close the control panel and replace the center screw.

(7) Remove the tape from the wire harness assembly which extends forward over the generator.

(8) Disconnect the larger cable from the right hand terminal of the solenoid starting switch.

(9) Disconnect the wire from the electric choke.

(10) Disconnect the two wires from the low oil pressure cut-off switch.

(11) Disconnect the oil pressure gauge line at the fitting near the low oil pressure cut-off switch.

(12) Disconnect the wire from the clip of the ignition resistor above the rear end of the cylinder head.

(13) Disconnect the wire from the high water temperature cut-off switch.

(14) Open the radiator drain cock and drain the radiator. If the cooling system contains an anti-freeze or a rust inhibitor, the liquid should be drained into a clean container and saved for re-use.

(15) Remove the thermal element from the left side of the cylinder head. To do this, remove only the smaller of the two brass hexagonal nuts. Disconnect the bond strap from the capillary tube. Lay the thermal element back in the right side of the housing, being careful to avoid making a sharp bend or kink in the capillary tube.

(16) Close the 2-way shut-off valve beneath the main fuel tank by turning the valve handle to the rear. Disconnect the fuel line at the sediment bulb. If an auxiliary fuel line is used, disconnect it at the end near the 2-way valve.

(17) Remove the two bolts from the left hand bracket of the air cleaner.

(18) Remove the four bolts from the rear ends of the front top plate guide rods.

(19) Remove the two bolts from the bottom of the lifting yoke.

(20) Remove the eight bolts which hold the legs of the center and rear housing supports to the skids.

(21) Check to see that all necessary disconnections have been made.

(22) Lift the super-structure several inches so as to clear the generator and remove from the rear.

d. Removing Exciter Frame.—After the housing super-structure has been removed, the exciter may be removed. Proceed as follows:

(1) Remove the cover band from the exciter. Lift all brushes high in their holders and set the ends of the springs against them to hold them high.

(2) Remove the end bearing cover from the exciter end bell. Remove the screw and lock which hold the outer race of the ball bearing from turning.

(3) If the entire generator frame is to be removed, omit the next three operations and proceed to paragraph 50 *d*.

(4) Disconnect the shunt field lead near the upper left exciter brush holder, and the series field lead near the lower left brush holder.

(5) Remove the cap screws which hold the exciter to the generator frame. Remove the end bell.

(6) If the exciter field assembly is to be removed, first remove the outlet cover from the top of the generator frame; untape the group of lead wires and separate the exciter series field lead from the four a-c leads. Then the exciter frame may be removed. It may be tapped on either side with a lead hammer

to break the joint. Then insert small prying bars in the joint at opposite sides of the frame and complete the removal.

e. Supporting the Rotor.—After the end bell or the complete generator frame is removed, the rotor has no rear support and care must be used to avoid placing any weight on this exposed end. At whatever stage the disassembly is stopped, place wood blocking under the bearing end of the rotor shaft to carry the weight of the rotor, (Fig. 13). To leave it unsupported for a considerable time may result in distorting the shaft. Do not put blocking under the commutator or slip rings. If the blocking is done with the bottom dust plate in place, blocks must be placed below the dust pan as well as above it.

f. Removing Generator. — After the housing super-structure has been removed, the generator frame may be removed. This may be done without removing the exciter from the generator frame, if desired. Proceed as follows:

(1) Remove the eight bolts which hold the spare parts box supports to the skids and remove the box assembly.

(2) Remove the eight screws which hold the bottom dust plate to the skids and remove the bottom dust plate.

(3) Remove the cover band from the exciter. Lift all brushes high in their holders and set the ends of the springs against them to hold them high.

(4) Remove the end bearing cover from the exciter end bell. Remove the screw and lock which hold the outer race of the ball bearing from turning.

(5) Loosen, but do not remove, the two front engine support bolts. Loosen the upper radiator hose connections.

(6) Remove the two cap screws and four bolts which attach the generator mounting blocks to the skids.

(7) Remove the screw from the top center of the generator frame and screw in an eye bolt with which to lift the generator. The thread is $\frac{1}{2}$"-13.

(8) Attach a hoist to the eye bolt and raise the generator about half an inch. Then place substantial blocking under the generator adaptor ring so as to support the rear end of the engine after the generator frame is removed. Lower the weight onto the blocking and make sure there is sufficient blocking to hold the generator supports about $\frac{1}{4}$" off the skids. Be careful not to raise the generator so high as to cause damage to the connections at the front of the engine or to jam the fan against the radiator core.

(9) Again support the weight of the generator by means of the hoist, but do not raise the adapter ring from the blocking.

(10) Remove the nuts from the studs which hold the generator frame to the adapter housing. Slide the generator frame assembly to the rear until it clears the rotor assembly. Be careful that the frame assembly does not ride on the rotor assembly as it is being removed.

(11) If the rotor assembly is not to be removed, support the bearing end of the rotor on blocks just sufficiently high to carry its weight without distorting the shaft, (Fig. 13).

(12) If the rotor is to be removed, attach a rope around the shaft near each end of the assembly and support its weight with a hoist. Then remove the cap screws which attach the drive flange to the flywheel. Remove the rotor assembly from the flywheel carefully so as not to damage the pilot which fits in a recess in the engine flywheel.

(13) If the adapter ring is to be removed, place blocking under the rear end of the engine, ahead of the adapter ring so as to support the weight of the engine. Then remove the blocks from under the adapter ring. Remove the bolts which attach the adapter ring to the engine. Slide the adapter ring back until free of the engine.

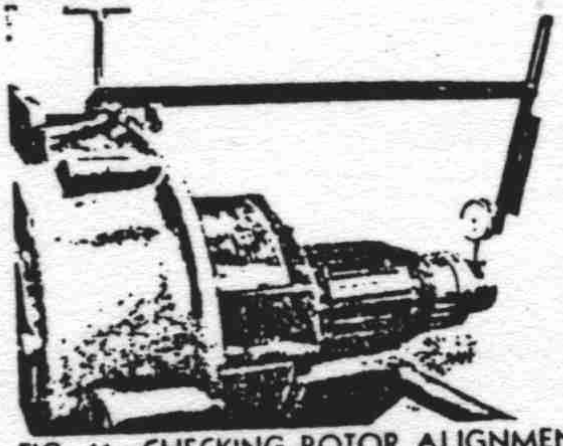

FIG. 41 CHECKING ROTOR ALIGNMENT WITH DIAL GAUGE

g. Assembling Generator to Power Unit.—

(1) Reassembly is accomplished by a reversal of the operation used in disassembly. Use care. Make sure that all contact surfaces between parts are clean before fitting together. Tighten all nuts, screws and connections securely. Use lockwashers in all places where they were used originally, preferable new lockwashers.

(2) After tightening the cap screws which attach the rotor drive flange to the flywheel, use dial gauge, (Fig. 41), and check the alignment of the rotor. The run-out should not exceed a total of .010". To correct

excessive run-out, turn by means of hand crank until high side is up. Grasp the end of rotor in both hands and push downward, but not too forcibly. Then test again. Repeat until total run-out as shown by dial gauge is within .010". Loosening and re-tightening the cap screws may help to correct excessive run-out.

(3) Be sure to install the rear bearing lock, fitting it into the slot in the bearing race. Pack the bearing housing 1/3 full of approved ball-bearing lubricant before installing cover. Tighten the front engine mounting bolts and the hose clamps. Before starting the engine, check your reassembly carefully to make sure no operation has been omitted.

h. Testing Windings.—

(1) *General.*- Most of the following testing instructions may be used without disassembling the generator. In each instance where an exciter armature winding or an alternator field winding tests open-circuited, short-circuited or grounded, the practical repair is to install a new rotor assembly. If a stator winding tests open-circuited, short-circuited or grounded, the practical repair is to install a new stator winding assembly unless the trouble is in the leads outside the winding proper. The rotor windings and the stator windings can be successfully repaired only by a competent rewinding shop. The tests require the use of a 6-volt battery, a 3 or 4 candle-power, 6-volt lamp and socket, two test prods and the necessary connecting wire as shown in (Fig. 42). Certain tests require a d-c voltmeter. Before starting the tests, remove the cover from the exciter, lift all brushes high in their holders and set the ends of the springs against them so as to hold them high. Then disconnect the four stator winding cables from posts of the a-c terminal block and the large exciter cable from the right hand terminal of the solenoid starting switch. See wiring diagram. Tag the cables so as to avoid error in replacing them. In using test prods, make sure that good electrical connection is made at points of contact.

(2) *Testing Stator Windings for Grounds.—* Touch one test prod to the stator frame. Touch the other prod to the terminal of one of the generator leads. If the lamp lights, the stator winding is grounded. Inspect the cables throughout their lengths, since it is possible that the ground may be in the cable instead of the winding. If so, tape the defective section of the cable with several layers of half-lapped rubber tape, then with two layers of friction tape. If the ground is in the winding proper, the winding assembly will have to be replaced.

(3) *Testing Stator Windings for Open-Circuit.*—Touch one test prod to the neutral cable terminal. Touch the other test prod to one of the terminal of one of the main stator leads. If the lamp

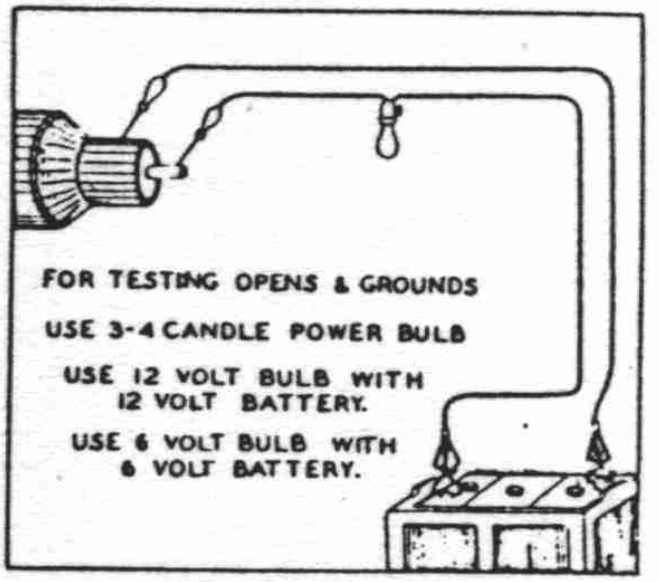

FIG. 42 TEST LAMP

does not light, that winding is open-circuited. Repeat the test, sticking the prods through the cable insulation and into the copper of the cables near the two terminals instead of touching the terminals. If the circuit does not test open on this test but tests open when contact is made at the terminals, it indicates that a terminal is loose on its cable. Sweat it on securely with solder. Test between neutral and each of the other stator leads in the same manner.

(4) *Checking Stator Windings for Short-Circuit.*—A short-circuited stator winding will become excessively heated and soon will destroy the insulation of the short-circuited portions of the winding. This condition may be determined by visual inspection of the stator winding after the alternator frame assembly has been removed from the power unit. A short-circuited stator winding should be replaced with a new one.

(5) *Testing Alternator Field Winding for Open-Circuit.*—Touch one test prod to each collector ring. If the lamp does not light, the field circuit is open-circuited.

(6) *Testing Alternator Field Winding for Short-Circuit.*—If a considerable number of turns in one coil are short-circuited, that coil will run cooler than other coils which are in good condition. Grounds at two points in the winding would short-circuit the intervening portion and the winding would test grounded.

(7) *Testing Rotor Windings for Grounds.* Touch one test prod to the rotor shaft and the other to a collector ring. If the lamp lights, the alternator field winding is grounded. Touch one test prod to the

rotor shaft and the other to the exciter commutator. If the lamp lights, the exciter armature winding or the commutator is grounded.

(8) *Testing the Exciter Armature for Open or Short-Circuit.* - This test may be made by use of an armature growler after first removing the exciter frame. Follow the instructions which accompany the growler. The voltmeter method of testing may be used by one experienced with such testing.

(9) *Testing Exciter Field Windings for Grounds.*—Disconnect the shunt field lead near the upper left exciter brush holder and the series field lead near the lower left brush holder. Disconnect the heavy exciter lead from the right hand terminal of the solenoid starting switch. Touch one test prod to the exciter frame. Touch the other test prod to any of the field leads. If the lamp lights, the winding is grounded. Inspect the leads. If the ground is in a lead, tape the defective section with several layers of half-lapped rubber tape, then with two layers of friction tape. If the ground is in the winding proper, the exciter field must be removed. Then remove the hollow-head screws which hold the field pole shoe to the frame. Remove screws from one pole shoe at a time, push the pole shoe and coil away from the frame and test again for ground. The ground is at the coil last loosened before the test indicates that the ground has been removed. Remove the pole shoe from the coil and locate the grounded spot on the coil by visual inspection. Install a new winding. If a new winding is not available, it may be possible to repair the coil by taping the defective area with several layers of carefully half-lapped friction tape, then shellacing the area. Replace after the shellac has dried.

(10) *Testing Exciter Field Windings for Open or Short-Circuit.*—The exciter field windings are connected in parallel-series and the field assembly must be removed to test for short or open circuits. Disconnect the four coil leads at the point where the shorter, heavy cable connects with the windings. This breaks the connection between the shunt and series windings and provides open ends for testing each winding as a straight series of four coils. Use the test prods to test for open circuit in either winding and for short-circuit between windings. Test for short circuit in the turns of a shunt coil by connecting the series of four shunt coils across a 6-volt battery and taking a voltage reading across each coil. If the voltage is lower on one coil than on the others, that coil has some turns short-circuited. Short-circuited turns in one or more series field coils may cause slow cranking or failure to crank at all but would not prevent generating. To test for open circuit in either the shunt or series field winding, touch one test prod to each of the two ends of the series of four coils. If the lamp does not light, there is an open circuit. Unless the trouble is located at connections between coils and easily repaired, install new coils.

(11) *Other Tests.*—The same test set may be used for many tests for grounds, open circuits or short circuits elsewhere on the power unit. When the lamp lights, obviously the circuit between prods is complete, and vice versa.

51. Suppression Equipment.—

a. General.—To reduce interference with radio, the power unit is equipped with capacitors, suppressors, bonding straps, internal-external tooth (I.E.T.) lockwashers and a metal housing. A complete tune-up would include at least a visual inspection of this equipment to make sure none of it is missing and that all connections are clean and tight. In case of excessive radio interference, a more thorough check-up must be made. The suppression equipment is intended to care for interference that otherwise would result from the normal operation of the power unit when in normally good condition. An abnormal condition of the power unit, or of the load, may result in more interference than the suppression equipment can control. Therefore, do not assume that the suppression equipment is at fault until the power unit has been checked thoroughly for such condition.

b. Metal Housing.—The metal housing serves as shielding and thus plays an important part in the suppression of radio interference. The power unit should be operated with side panels and top plates in place.

c. Loose Connections.—Check the entire power unit for loose electrical connections, loose bonding strap connections, loose bolts, nuts and screws of any kind or location. Keep all these tight at all times. At bonding strap connections and certain other points special lockwashers with internal and external teeth are used, not only for locking the screws, bolts or nuts securely, but also because the teeth make good electrical contact with adjacent surfaces. Make sure such washers are used at proper places.

d. Condensers.—The locations and capacities of suppression condensers are clearly shown on the wiring diagram (Fig. 14). Make sure all are in place

and that connections are tight. They may be removed and tested individually as any radio condenser. Replace with new ones any that test open, shorted or of incorrect capacity.

e. Bonding Straps. Make sure that all bonding straps are in place and in good order and that connections are electrically good and mechanically secure. Bonding straps are used at the following points:

(1) One from engine block to capillary tube of Engine Water Temperature gauge.

(2) One from control panel to generator end bell.

(3) One from control panel to housing at each of the four shock mountings of the control panel.

f. Commutators, Slip-Rings and Brushes.—Make sure that there is no abnormal arcing at the exciter brushes. Commutators and slip-rings must be smooth and clean. Mica must be properly undercut on the commutators of the exciter. All brushes must seat properly, with proper spring tensions and in proper positions.

g. Ignition System.—Check, clean and adjust the complete ignition system, including spark plugs. Pay particular attention to high tension cables, to the distributor cap and rotor and to the ignition condenser that may be defective. Replace with new, any parts not in good order. Make sure the suppressors are on the high tension cables and in good order.

h. Faulty Contacts.—If switch or a-c circuit-breaker contacts are suspected of making poor contact, test one at a time by connecting a jumper across its terminal when it is in a normally closed position. If a switch or the a-c circuit-breaker tests defective, install a new one. A similar jumper test may be made across the terminals of suspected contacts of a relay or the voltage regulator. Study the wiring diagram and make sure the jumper is used across the correct terminals and only while the contacts being tested are normally closed.

i. Interference from Outside Sources. Poor commutation at a motor may result from overload, poor condition of commutator and brush assembly, or from low voltage at the motor due to too small line wires. Radio interference may result. Defective lamps, transformers or appliances, or poor connections anywhere on the load circuit may result in radio interference which must be corrected at its source.

SUPPLEMENTARY DATA

52. Wiring Tables.—

a. General.—It is quite important that the line wires from the power unit to the load be large enough to avoid excessive drop in voltage between the power unit and the load. Various factors determine the correct size of wire, the chief factors being: the operating voltage; the permissable voltage drop; the distance from the power unit to the load; the spacing of the wires; the amount and characteristics of the load. In the absence of definite specifications for wire sizes for your particular requirements, the wiring tables given in this paragraph can be used as a guide. These tables are based on a voltage drop of about 5%, or less. The tables are based on the use of hard drawn copper wire. Incandescent lighting and resistance type heating are types of unity power factor loads. Inductive loads such as motors and transformers, wherein an alternating magnetic flux is maintained in a mass of iron, are loads of lower power factor. The lower the power factor, the larger the wire that will be required, if other factors remain the same. One set of tables is based on an assumed power factor of 85%, a condition that might exist with a combination of resistance type and inductive type loads.

b. Outside Wiring, 127-volt, Single-Phase Circuit, Unity Power Factor Load.

Load in Watts	Distance in Feet									
	100	200	300	400	500	600	700	800	900	1000
200	10	10	10	10	10	10	10	10	10	10
500	10	10	10	10	10	10	8	8	8	8
1000	10	10	10	8	8	6	6	6	6	4
2000	10	8	6	4	4	2	2	2	2	1

c. Outside Wiring, 230-volt, 3-Phase Circuit, 85% Power Factor Load.

Load in Watts	Amperes per Terminal	Distance in Feet									
		100	200	300	400	500	600	700	800	900	1000
1000	2.9	8	8	8	8	8	8	8	8	8	8
2000	5.8	8	8	8	8	8	8	8	8	8	8
3000	8.8	8	8	8	8	8	8	8	8	8	8
4000	11.8	8	8	8	8	8	8	8	6	6	6
5000	14.8	8	8	8	8	8	8	6	6	5	5
6000	17.8	8	8	8	8	8	6	6	5	4	4
7000	20.8	8	8	8	8	6	6	5	4	4	4
8000	23.8	8	8	8	6	6	6	4	4	4	
9000	26.7	8	8	8	6	6	4	4	4		
10000	29.7	8	8	8	6	4	4	4			

d Maximum Safe Carrying Capacities of Wires for Inside Wiring.—

Wire Size B & S Gauge	Maximum Amperes	
	Rubber Insulated	No Rubber In Insulation
14	15	20
12	20	27
10	25	37
8	35	50
6	45	65
4	55	82
2	70	100
0	100	135

e. Other Wiring Considerations.— On short lines and for wiring inside of buildings the heating of the wire may be the determining factor in selecting the wire size. The passage of current through the wire produces heat. The greater the current, or the smaller the wire, the greater will be the amount of heat produced. On most long, outside lines the value of the current in proportion to wire size is necessarily kept so low, to avoid excessive voltage drop, that the heating of the wire need not be considered. On short lines the low voltage drop may permit carrying currents so great that the heating of the wire is of great importance. Too high wire temperatures will cause rapid deterioration of insulation and in extreme cases may cause fires. The highest temperature at which a wire may be operated safely depends largely on the type of insulation. For instance, a rubber insulated wire cannot safely carry as great a current as a weatherproof insulated wire of the same size. It is recommended that reference be made to a standard wiring handbook for information regarding the safe carrying capacities of insulated wire. In the absence of more complete information, the capacities given in the preceding table-*d*, should not be exceeded. In using flexible cables for power extensions follow the manufacturer's recommendations as to maximum carrying capacity.

53. Motors.—

Motors require starting current far greater than their full load running current. Therefore, it is recommended that not larger than a 5 H.P., 220-volt, 3-phase motor be used with the power unit. Single-phase motors usually are designed so that they may be connected for either 115-volt or 230-volt service. For use with this power unit, such motors should be connected for 230-volt service and it is recommended that no larger than a 3 H.P., single-phase motor be used. A limited number of single-phase, 115-volt, fractional-horsepower motors may be used on the 127-volt output of the power unit if the motors and the types of service will permit the different operating characteristics which will result from the somewhat higher voltage. Single-phase motors should be of the repulsion-induction type wherever practicable. Capacitor type single-phase motors may be used in many instances. Avoid the use of split-phase motors when practicable. Select motors of such sizes as will operate at approximately full load. Motors too large for their loads, and motors allowed to run without load result in low power factor loads. Avoid it wherever practicable. If the entire full load output of the power unit is used to drive motors, the motors should be started singly or in small groups so as not to throw the combined starting load on at one time.

PARTS CATALOG

FOR

MODEL
JWC 4·10S·3

THIS GENERATING SET WAS POWERED BY A WILLYS JEEP ENGINE.

FOR PARTS OTHER THAN ONAN CONTACT THE PRIME MANUFACTURER.

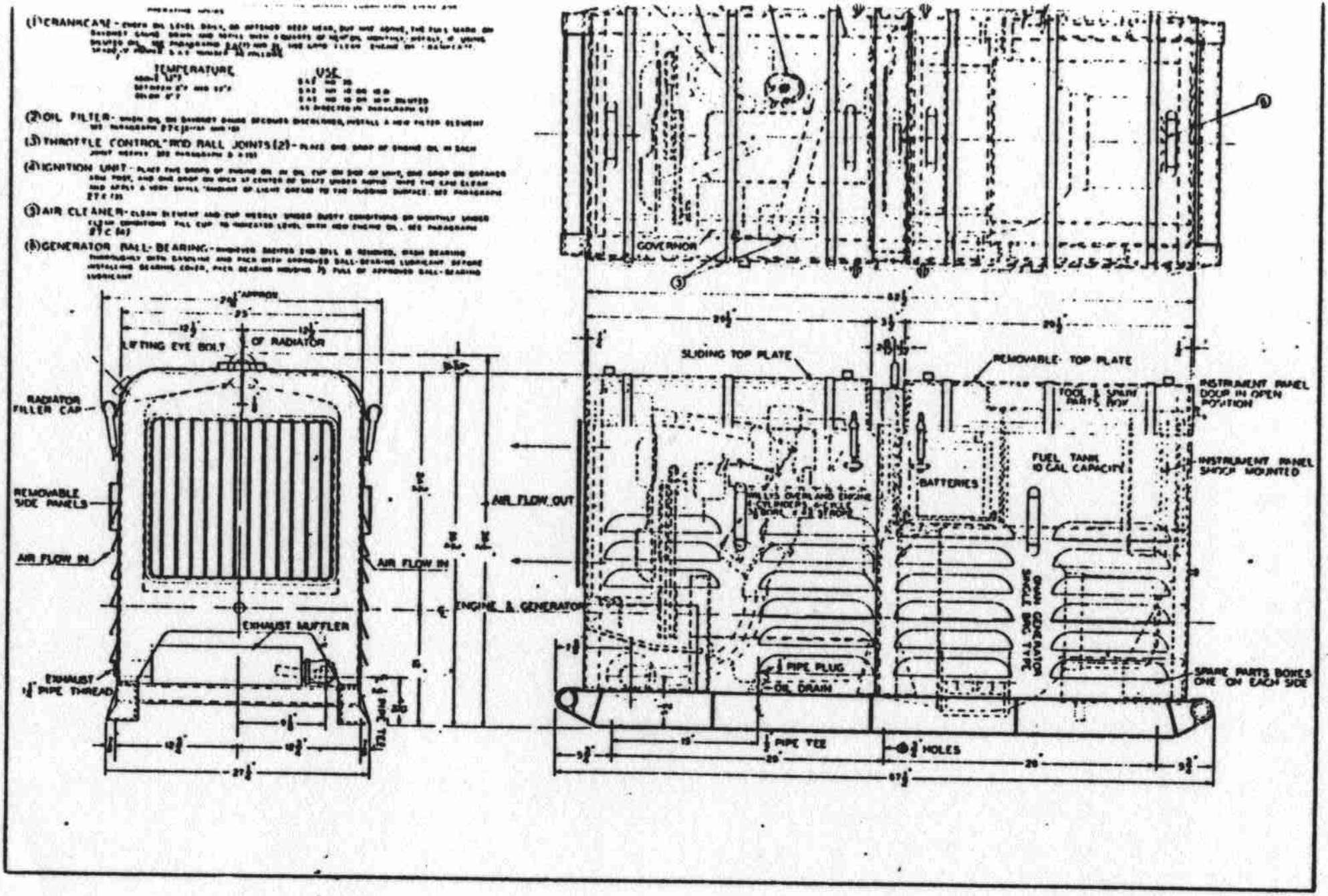

FIG. 43 LUBRICATION CHART AND ASSEMBLY OUTLINE

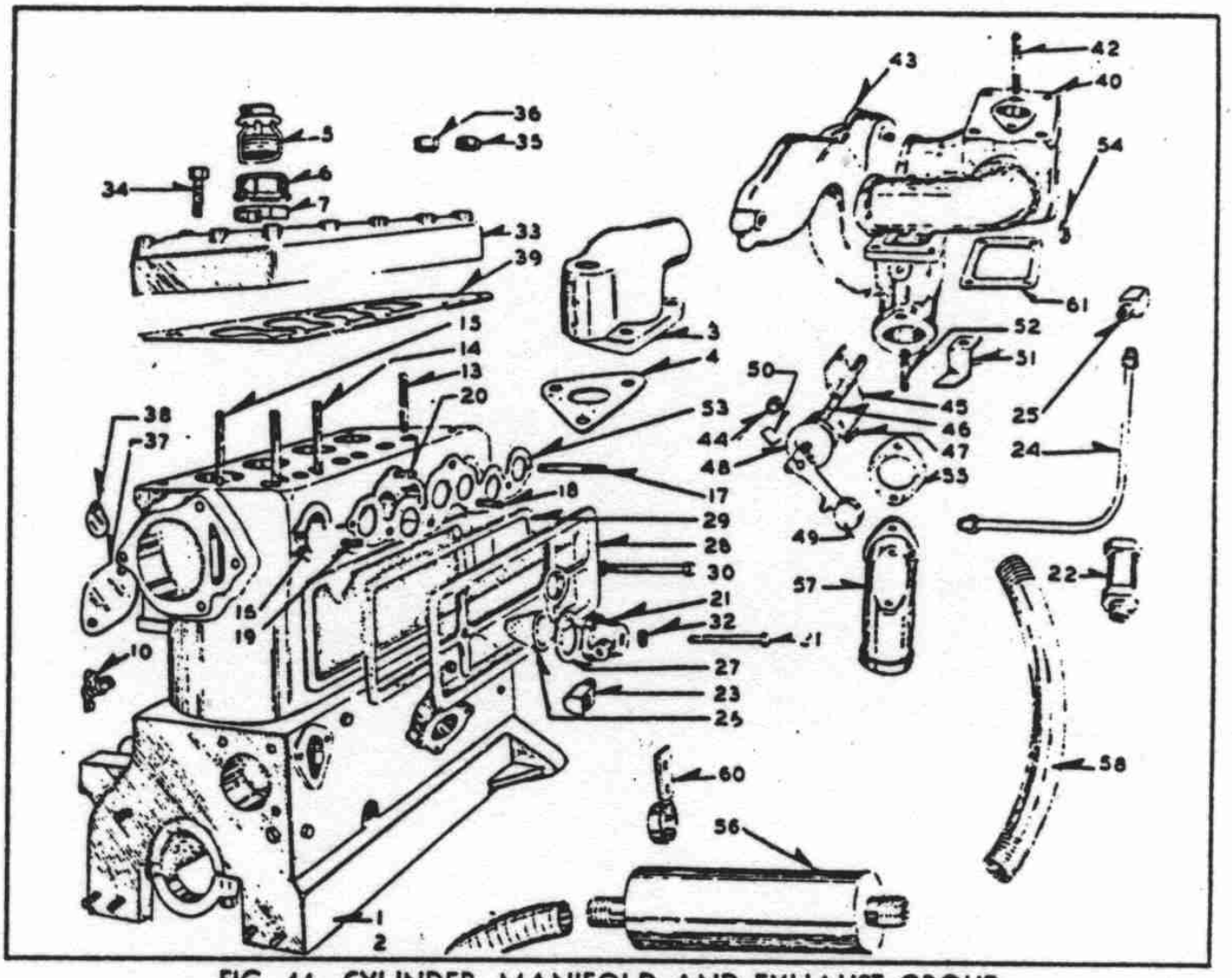

FIG. 44 CYLINDER, MANIFOLD AND EXHAUST GROUP

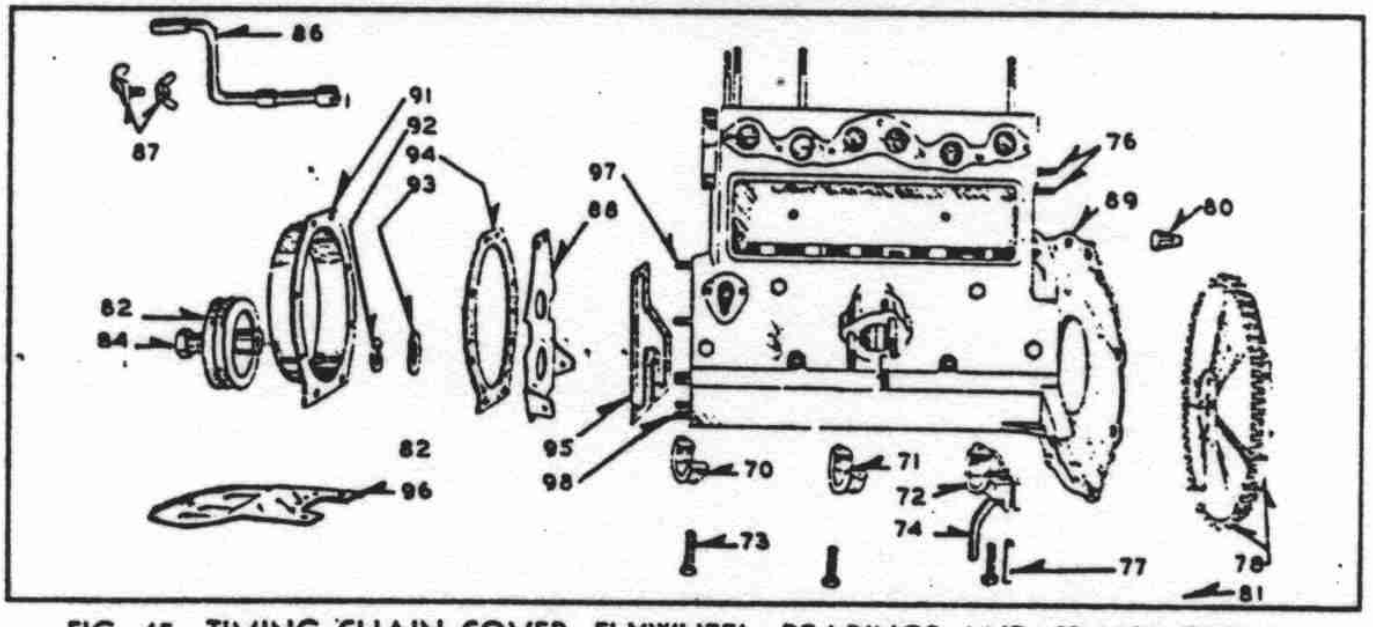

FIG. 45 TIMING CHAIN COVER, FLYWHEEL, BEARINGS AND CRANK GROUP

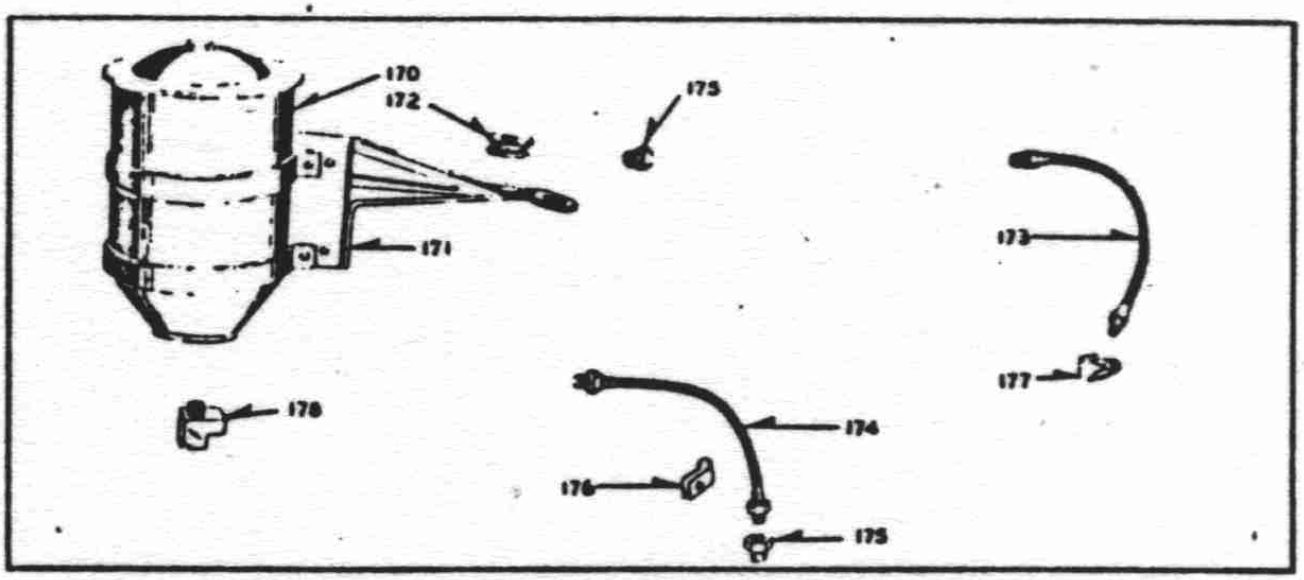

FIG. 48 OIL FILTER GROUP

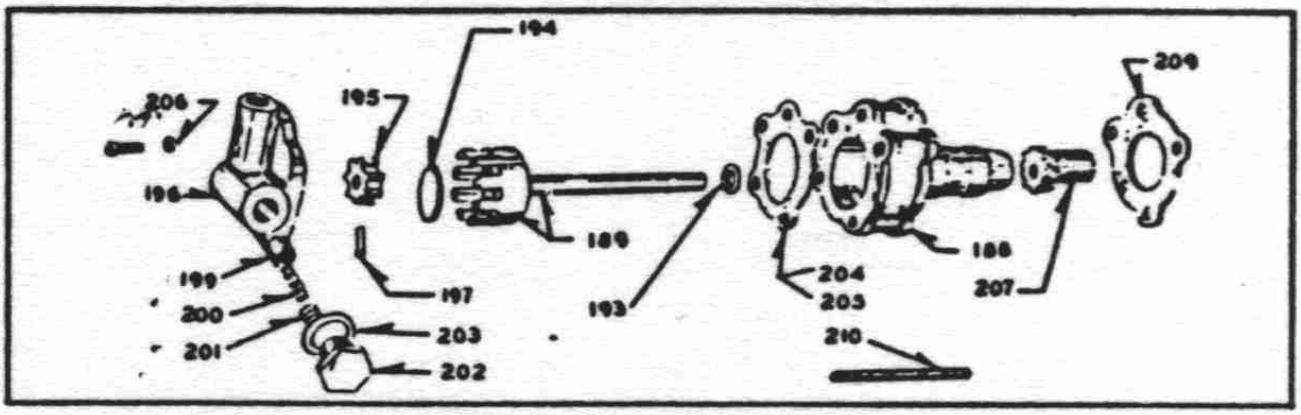

FIG. 49 OIL PUMP GROUP

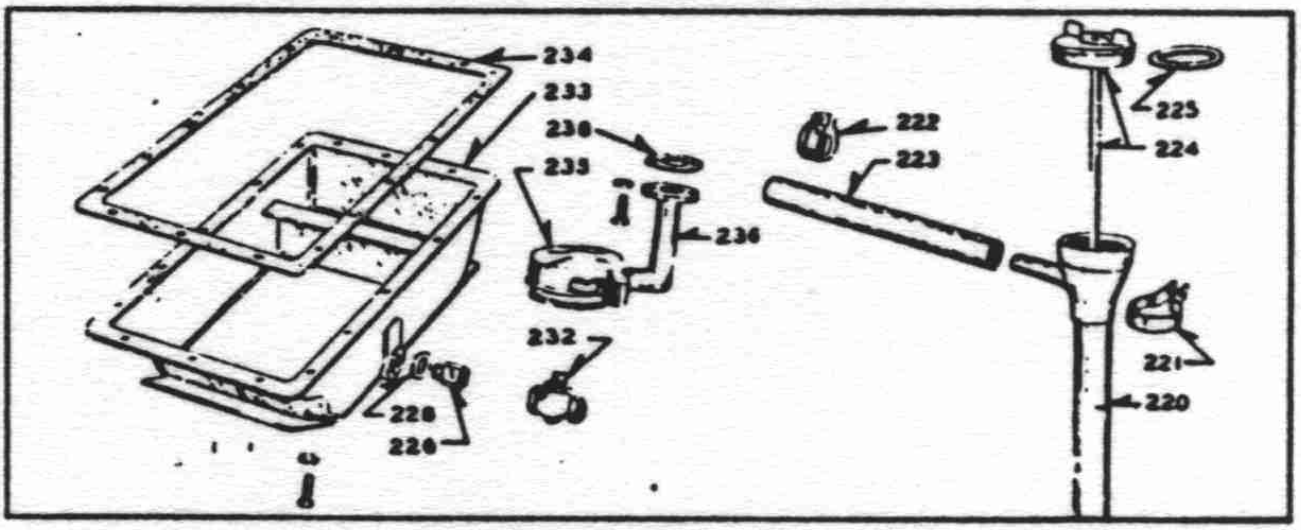

FIG. 50 OIL PAN AND FILLER TUBE GROUP

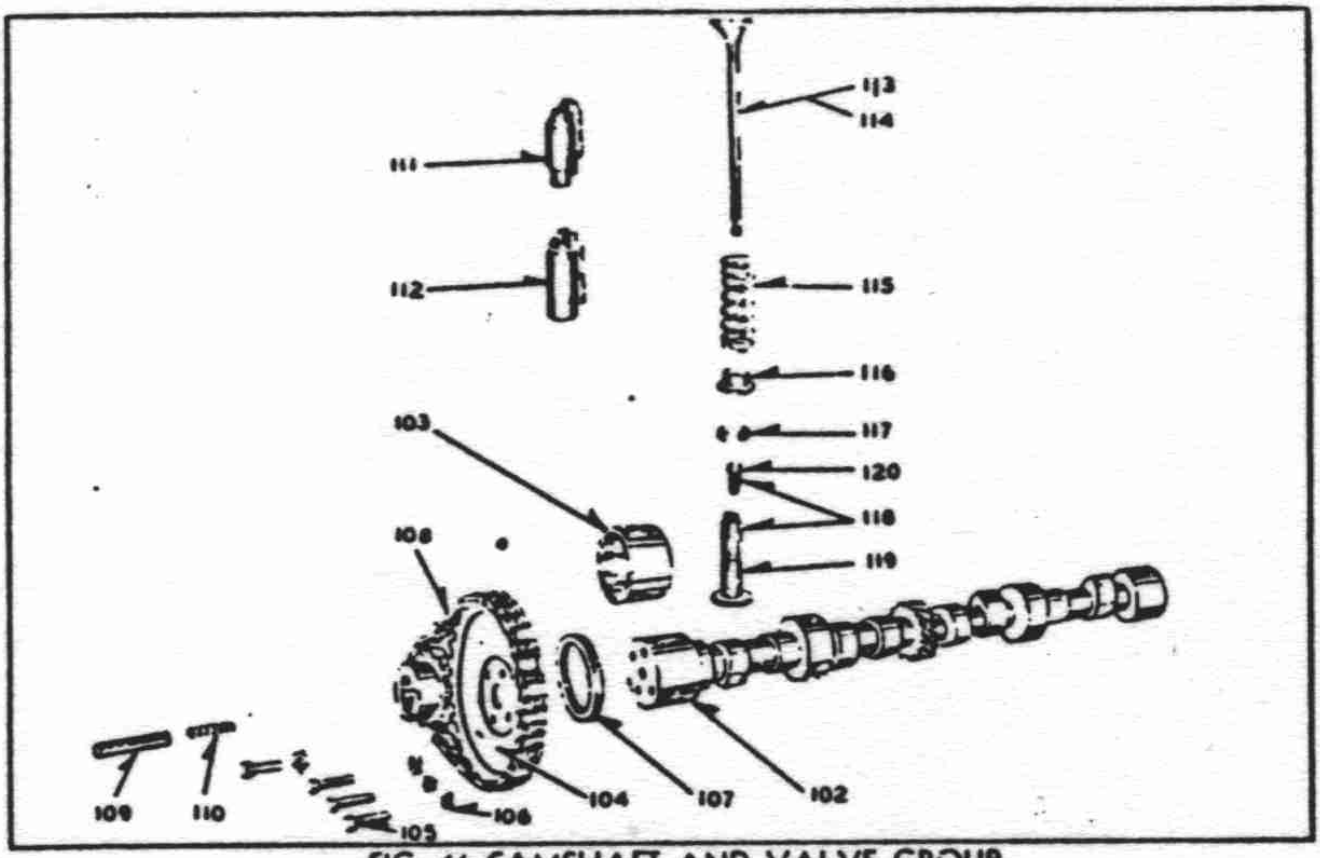

FIG. 46 CAMSHAFT AND VALVE GROUP

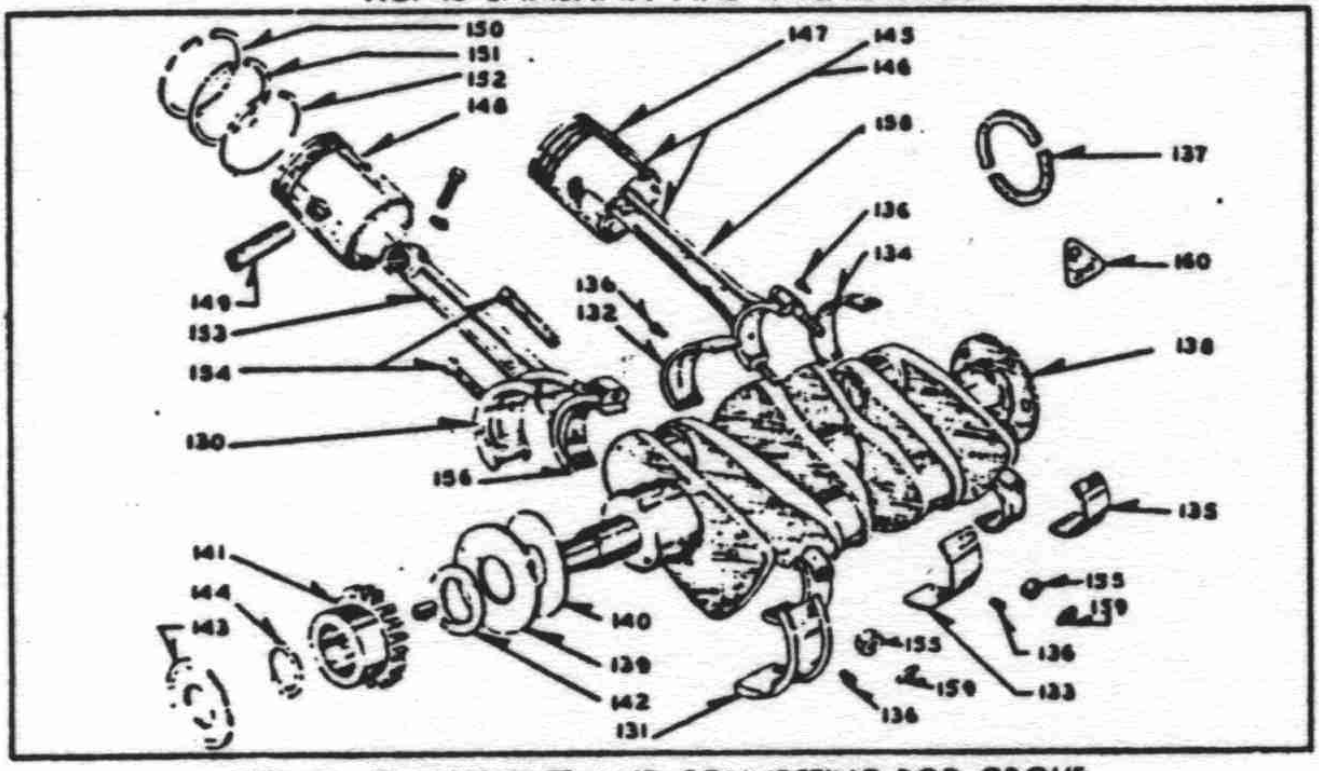

FIG. 47 CRANKSHAFT AND CONNECTING ROD GROUP

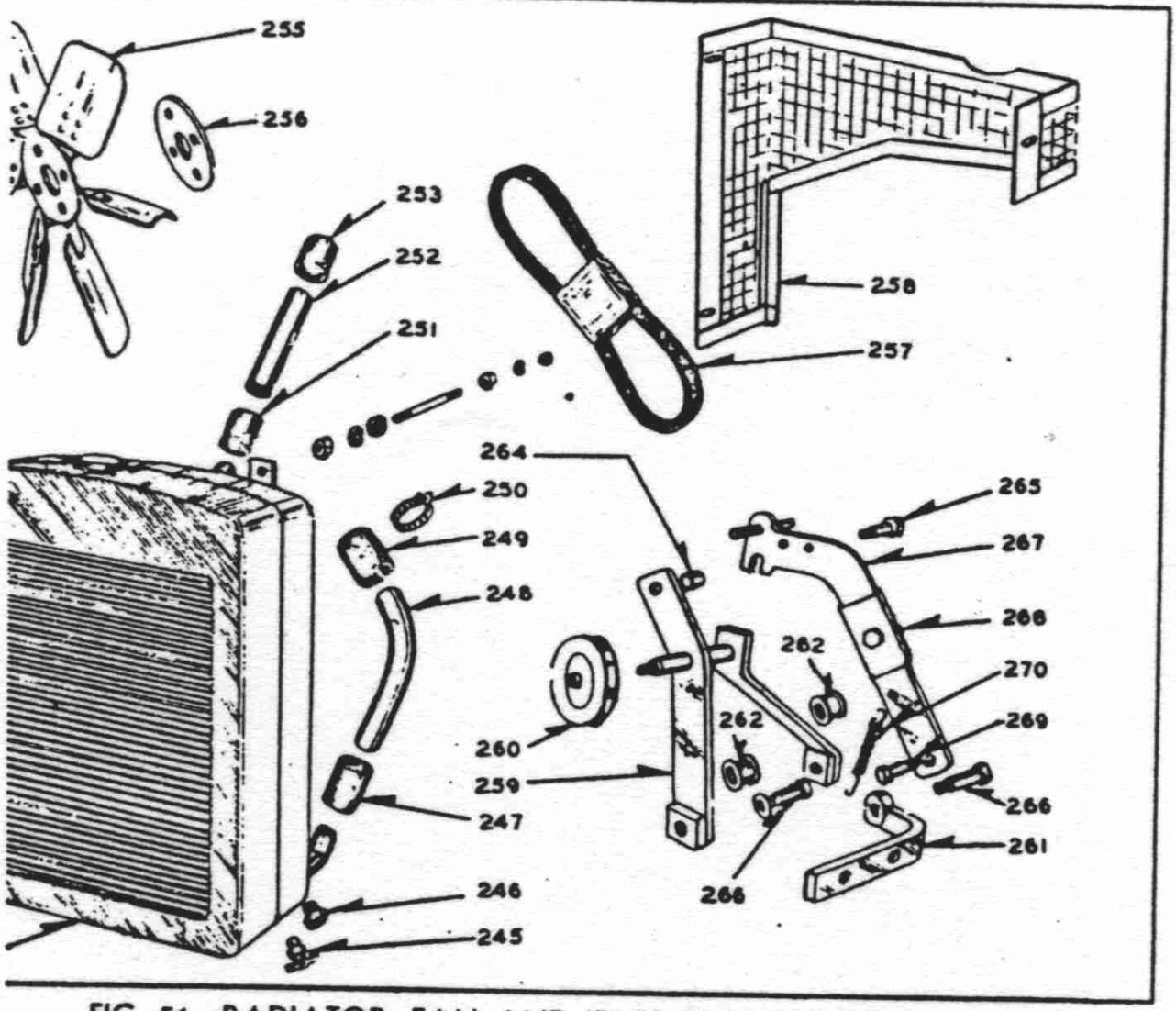

FIG. 51 RADIATOR, FAN AND IDLER PULLEY GROUP

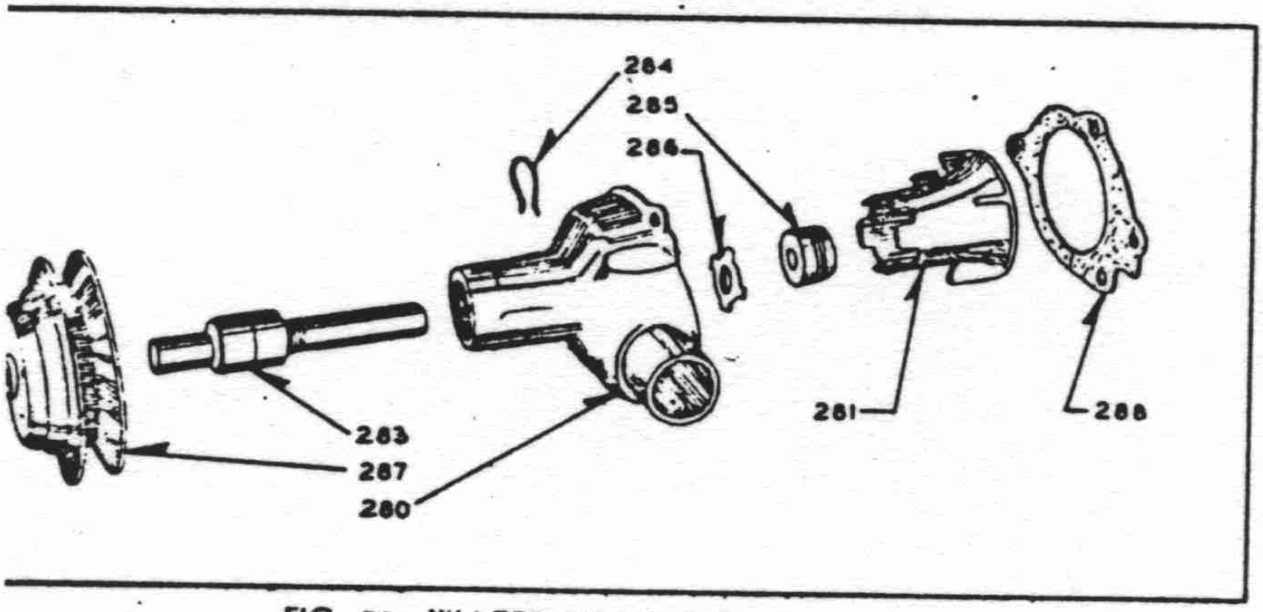

FIG. 52 WATER PUMP GROUP .

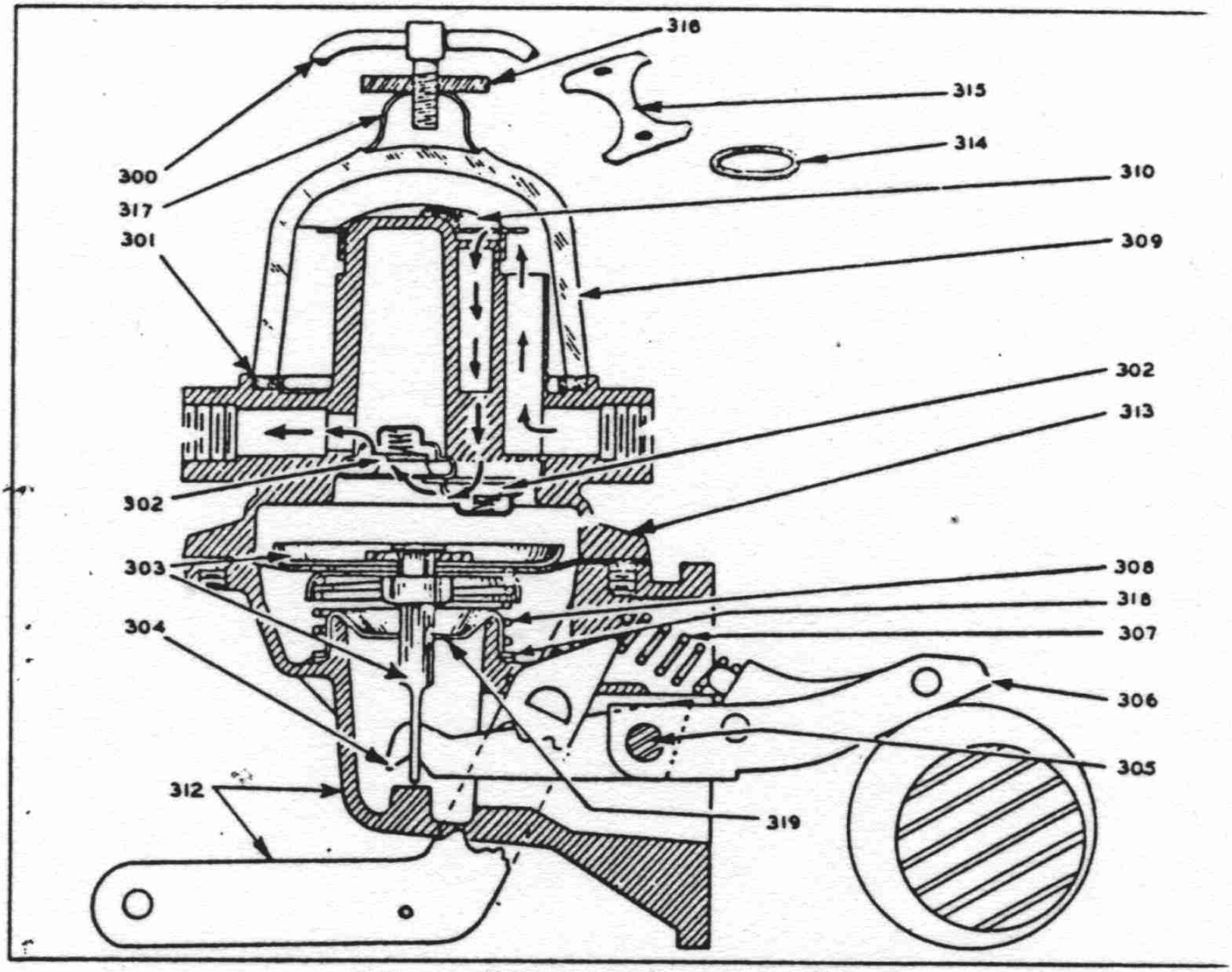

FIG. 53 FUEL PUMP PARTS GROUP

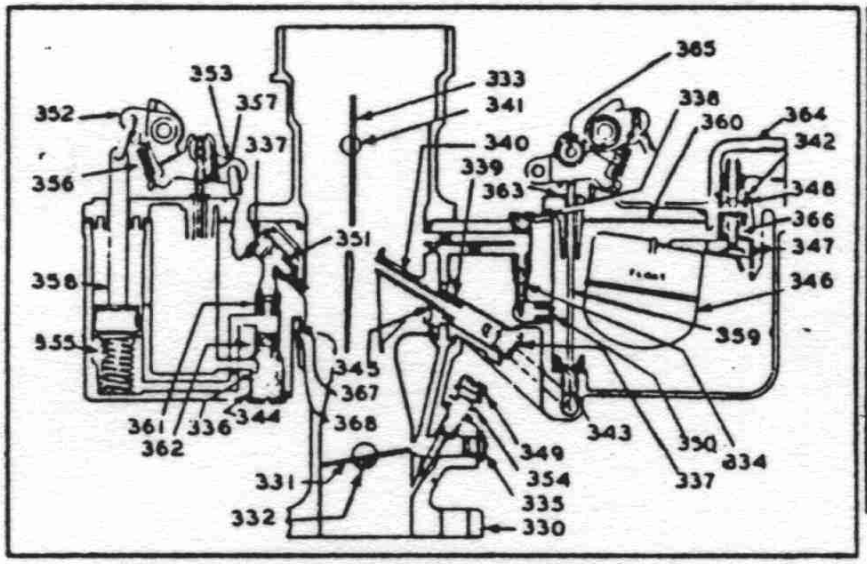

FIG. 54 CARBURETOR PARTS GROUP

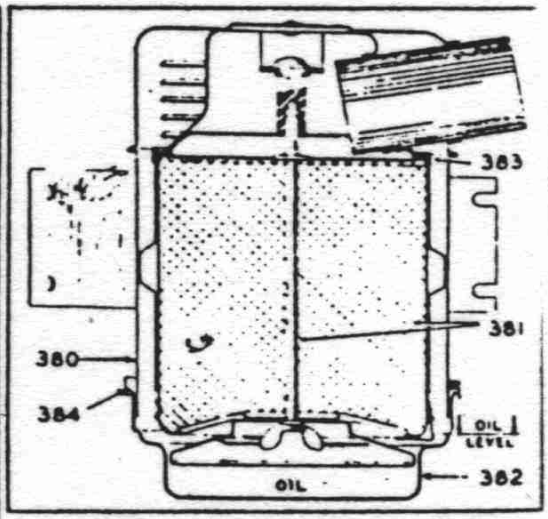

FIG. 55 AIR CLEANER PARTS GROUP

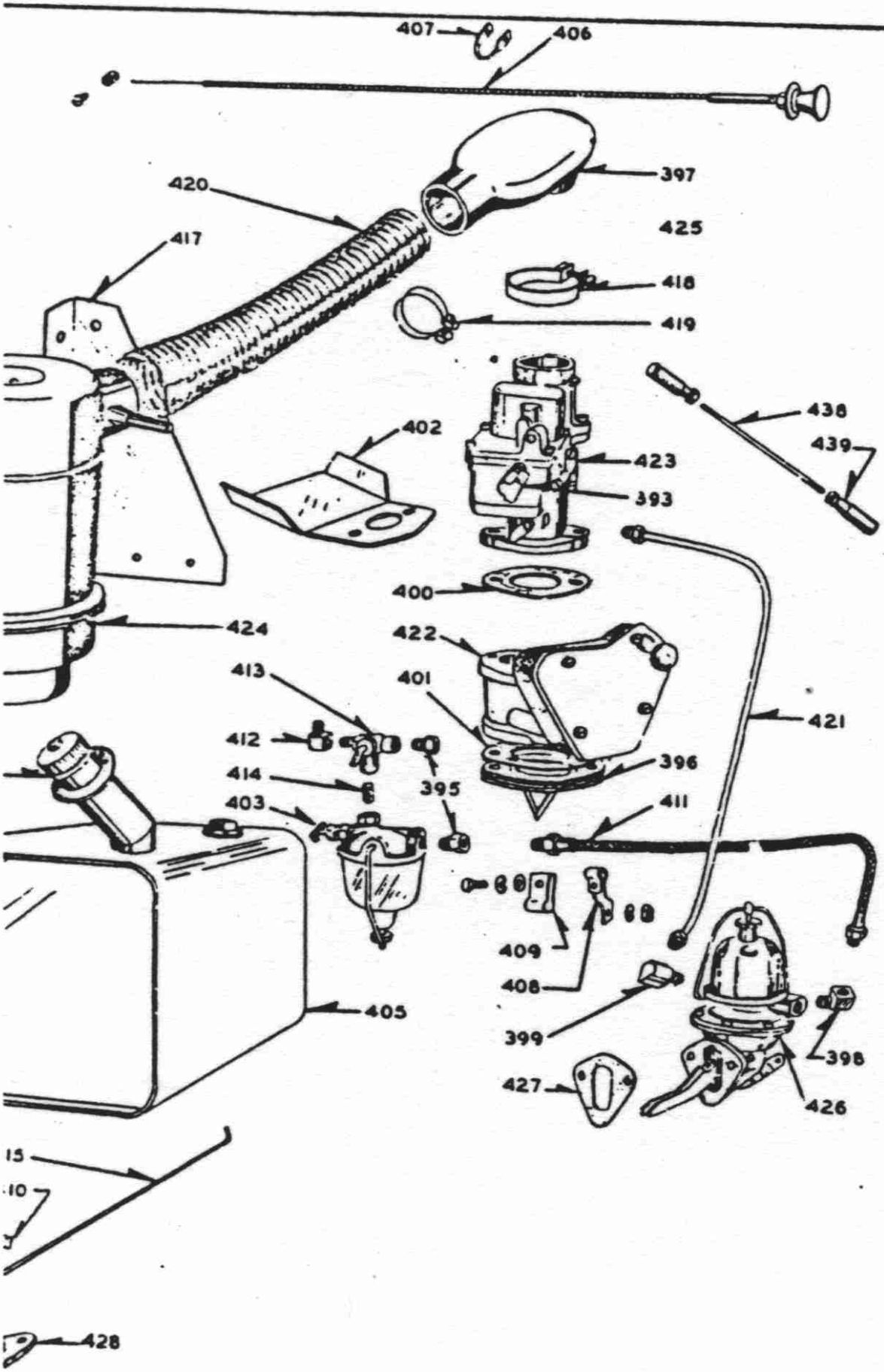

FIG. 56 FUEL SYSTEM—MISCELLANEOUS GROUP

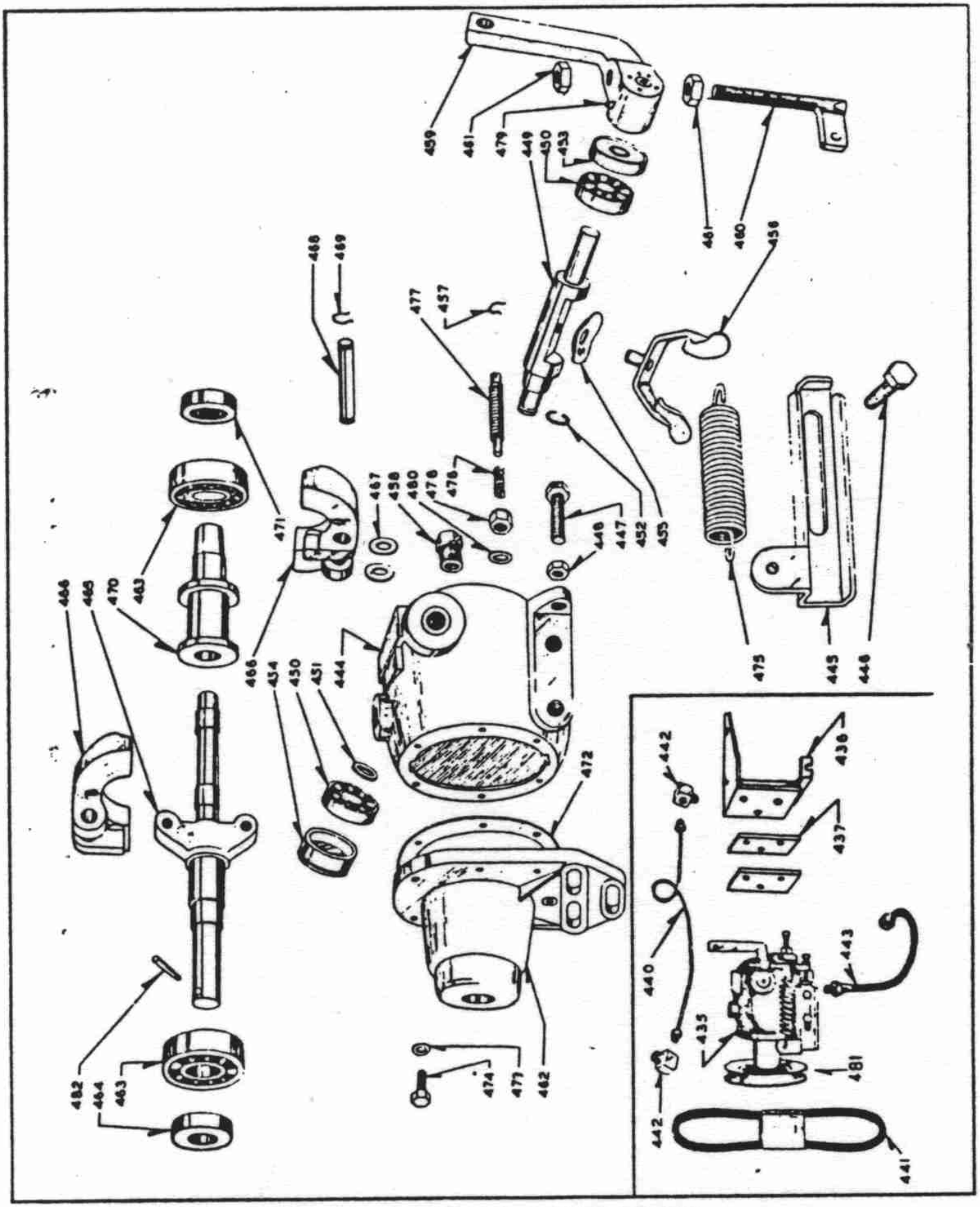

FIG. 57 GOVERNOR PARTS GROUP

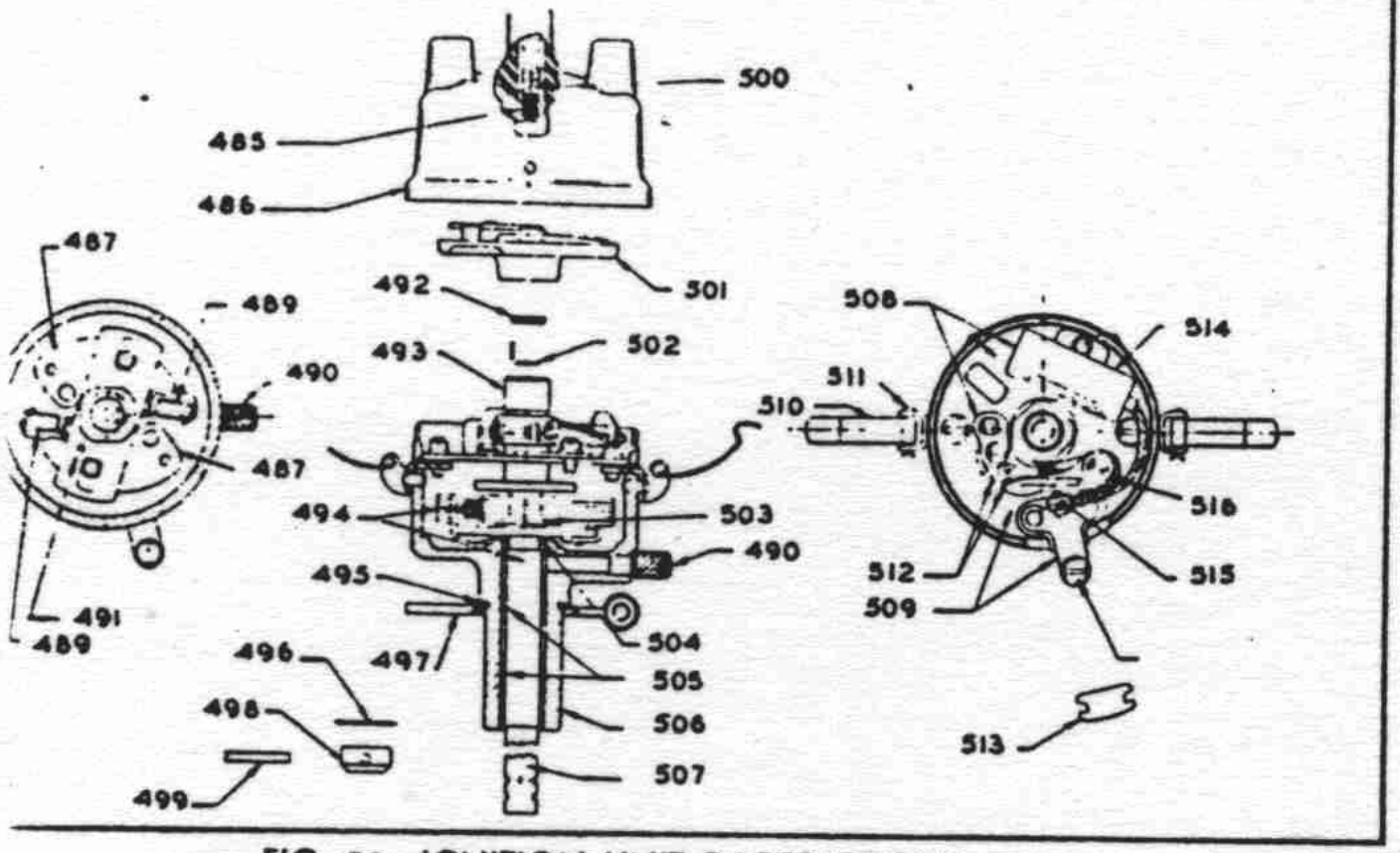

FIG. 58 IGNITION UNIT PARTS GROUP

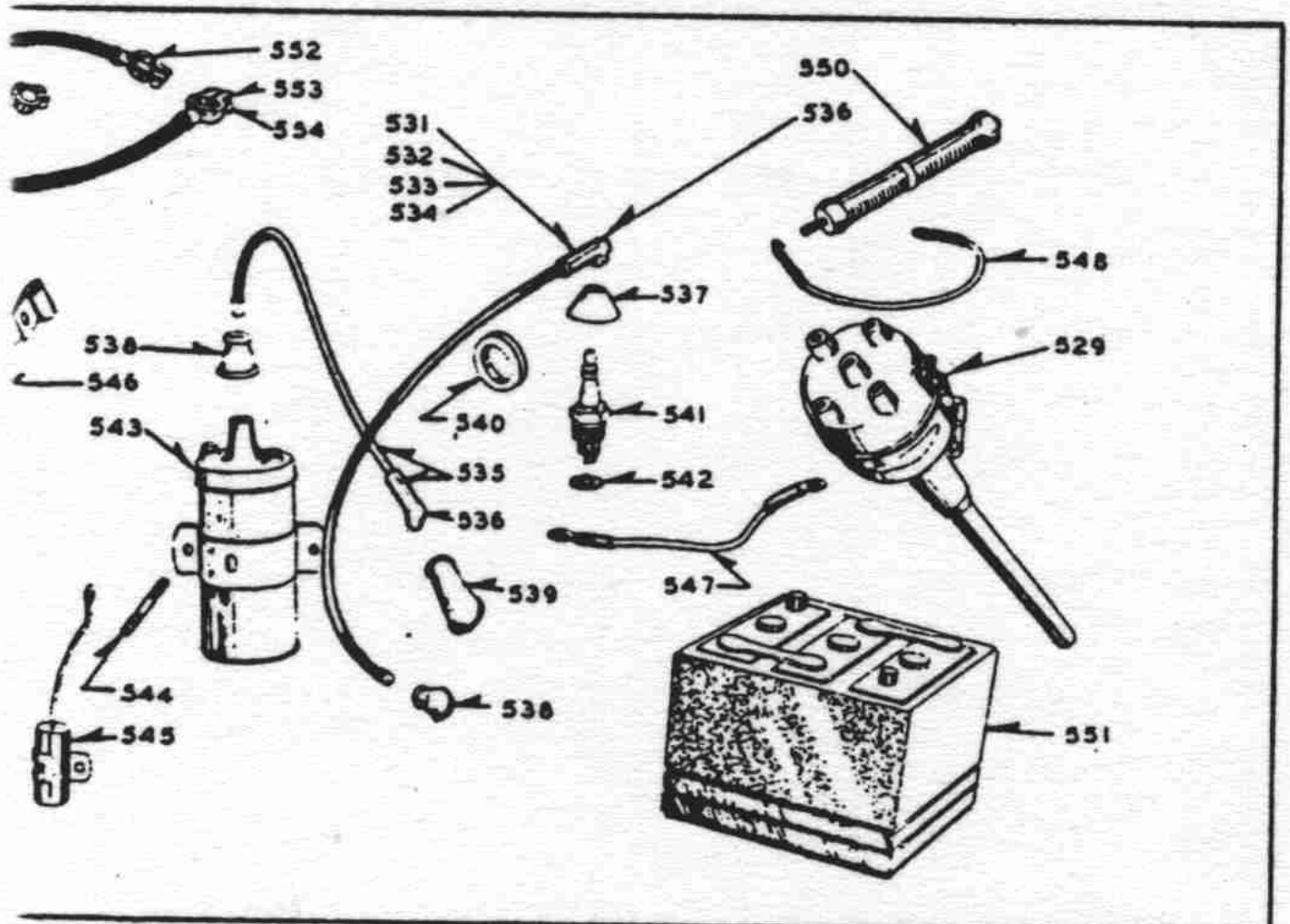

FIG. 59 IGNITION SYSTEM—MISCELLANEOUS GROUP

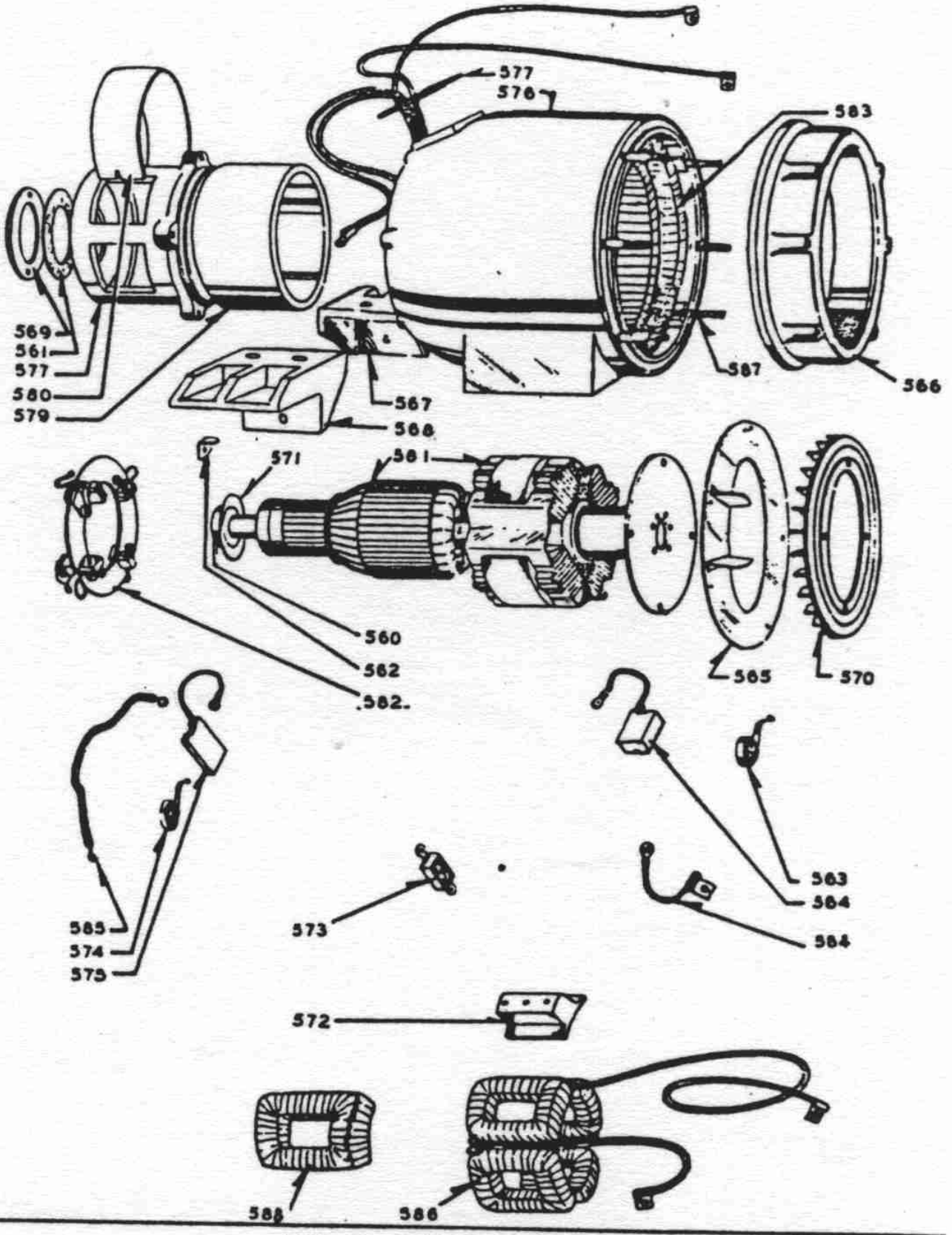

FIG. 60 GENERATOR GROUP

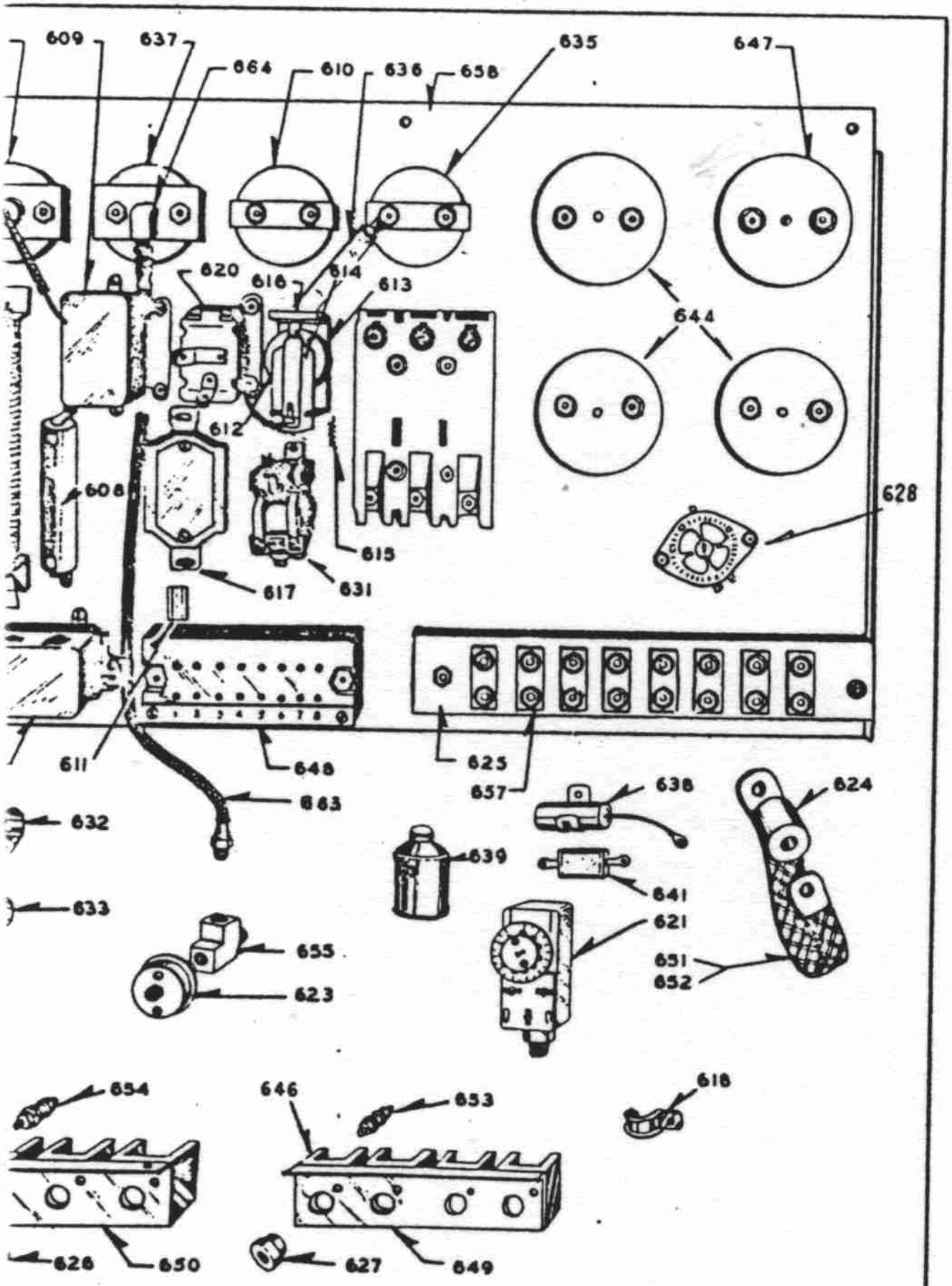

FIG. 61 CONTROL GROUP

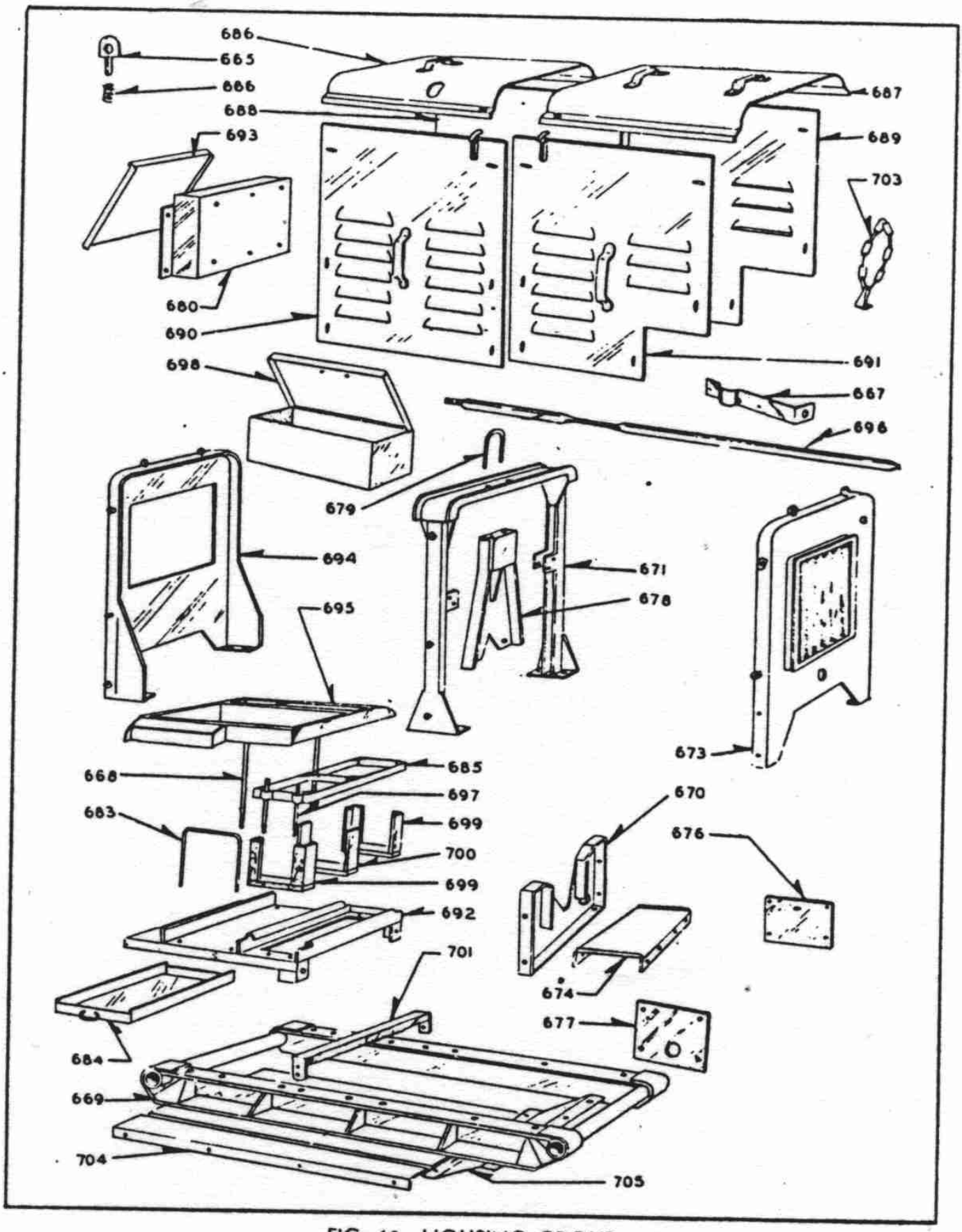

FIG. 62 HOUSING GROUP

TABLE OF REPLACEABLE PARTS

*Reference numbers are given only when referred to in text or illustrations.
**Function is given only when name and description do not suffice.
***See List of Manufacturers.

* Ref. No.	No. Req.	Name & Description	**Function	Mfgr's. Part No.	*** Mfgr.
		MAIN ENGINE PARTS (Cyl. Manifold and Exhaust Group—See Figure 44)			
1	1	Cyl. Block and Bearing Assembly—Includes expansion plugs, brgs., valve stem guides, brg. dowels, camshaft bushing, rear crankshaft brg. packing, rear brg. drain pipe & pin, water jacket drain cock & oil passage plugs		A-7714	WIL
2	1	Cyl. Block and Brg. Cap Assembly.—Includes brgs., expansion plugs and valve stem guides		638431	WIL
3	1	Water Outlet Elbow		7335	ON
4	1	Water Outlet Elbow Gasket		639650	WIL
5	1	Thermostat		637646	WIL
6	1	Thermostat Retainer		639651	WIL
7	1	Thermostat Chamber Insert		7011	ON
10	1	Drain Cock—¼"	Cyl. Water Drain Cock	145-A	WE
13	1	Stud—⅜"-14 x 3⅛"—Plated	Cyl. Head Stud—#12 Hole	A-1548	WIL
14	6	Stud—⅜"-14 x 3⅛"	Cyl. Head Stud—#5-#6-#7 #9-#11-#15 Holes	349368	WIL
15	1	Stud—⅜"-14 x 3⅛"—Plated	Cyl. Head Stud—#10 Hole	A-1549	WIL
16	1	Stud—Exhaust Manifold—⅜"-16 x 2⅛"	Assembled in Frt. Stud Hole for Ex. Manifold	A-564	WIL
17	1	Stud—Exhaust Manifold) ⅜"-16 x 1 11/16", Onan #7993	Assembled in Rear Stud Hole for Ex. Manifold	349712	WIL
18	2	Stud—Intake & Exhaust Manifold—⅜"-16 x 1 11/16"		632159	WIL
19	2	Stud—Intake Manifold—Frt. & Rear—¼"-16 x 1½"		300143	WIL
20	1	Stud—Exhaust Manifold—Center—⅜"-16 x 1½"		300143	WIL
21	1	Crankcase Ventilator Body Assembly		A-6919	WIL
22	1	Crankcase Ventilator Valve Assembly		A-6895	WIL
23	1	Elbow—¼" x ⅛"—Inverted Flared	Ventilator Body Fitting	A-6885	WIL
24	1	Crankcase Ventilator Valve Tube Assy.		A-6922	WIL
25	1	Elbow—¼" x ⅛" Inverted Flared	Ventilator Valve Tube Fitting	384549	WIL
26	1	Crankcase Ventilator Baffle		630298	WIL
27	1	Gasket—Ventilator to Valve Spring Cover Gasket		630299	WIL
28	1	Valve Spring Cover Assembly		7313	ON
29	1	Valve Spring Cover Gasket		630305	WIL
30	1	Valve Spring Cover Screw—⅛"-18 x 4⅛" Special 60° Point—Rear		632158	WIL
31	1	Valve Spring Cover Screw—Front ⅛"-18 x 3⅛"—Special 60° Point		639052	WIL
32	2	Valve Cover Screw Gasket		51875	WIL
33	1	Cylinder Head—Cast Iron		A-1534	WIL
	1	Gasket Kit—Set of Gaskets for Engine and Engine Accessories		7346	ON

34	7	Cap Screw—Hex. Head—⅛"-14 x 2¾" Spec. .685" Hex. Hd. with Rolled Thrd.	Cyl. Head Screw #1, 2, 3, 4, 8, 13 and 14 holes	638635	WIL
35	6	Nut Hex.—⅛"-20—Special—Hardened & Notched for Identification	Cylinder Head Stud Nut	638539	WIL
36	2	Nut—Hex.—⅛"-20-Plated	Used on Ref. No. 13 & Ref. No. 15 Cyl. Hd. Stud	A-1550	WIL
37	1	Cover Plate for Starting Hole		7403	ON
38	1	Timing Hole Cover		375217	WIL
39	1	Gasket—Cyl. Hd.		638678	WIL
40	1	Intake Manifold		A-8158	WIL
42	2	Stud—⅜" x 3"—⅛" of USS Thd.—¾" of SAE Thd.	Intake Man. to Carb.	1377	ON
43	1	Exhaust Manifold Assembly—Includes Heat Control Shaft Bearing		A-5565	WIL
44	2	Heat Control Valve Shaft Bearing		636438	WIL
45	1	Heat Control Valve		636439	WIL
46	1	Heat Control Valve Shaft		637206	WIL
47	1	Heat Control Valve Bi-Metal Spring		637208	WIL
48	1	Heat Control Valve Bi-Metal Spring Washer		637209	WIL
49	1	Heat Control Valve Counter Weight Lever		637210	WIL
50	1	Heat Control Lever Key		637211	WIL
51	1	Heat Control Valve Bi-Metal Spring Stop		639743	WIL
52	1	Stud—⅜"-16 x 1⅜" Long	Ex. Pipe Flange to Ex. Manifold Flange	332515	WIL
53	1	Gasket—Intake & Exhaust Manifold		638640	WIL
54	2	Manifold Clamp Washer		344732	WIL
55	1	Exhaust Pipe Flange Gasket		634814	WIL
56	1	Muffler		78062	ON
57	1	Exhaust Pipe Adapter		7399	ON
58	1	Exhaust Pipe—1½"-Bent		7400	ON
60	1	Exhaust Muffler Clamp		7311	ON
61	1	Gasket—Intake to Exhaust Manifold		634811	WIL
		(Timing Chain Cover, Flywheel, Bearings and Crank Group—See Fig. 45)			
70	1	Crankshaft Bearing Cap—Front		630285	WIL
71	1	Crankshaft Bearing Cap—Center		630288	WIL
72	1	Crankshaft Bearing Cap—Rear		637236	WIL
73	6	Bearing Caps to Crankcase Screw—Special—Heat treated		381519	WIL
74	1	Drain Pipe	Crankshaft Brg. Cap Drain Tube	630294	WIL
76	2	Stud—¼"-20 x ⅜"	Rear of Cyl. Block	337304	WIL
77	2	Packing—Crankshaft Rear Brg. Cap		637790	WIL
78	1	Flywheel & Ring Gear Assembly		A-1442	WIL
80	2	Flywheel Crankshaft Dowel—Tapered		632156	WIL
	2	Flywheel Dowel Bolt	For Service Only	116295	WIL
81	4	Flywheel Bolt—Special Head		632157	WIL
82	1	Fan & Governor Drive Pulley		A-6414	WIL
	1	Starting Crank Nut Assembly—Includes Nut & Pin #28023		387633	WIL
86	1	Starting Crank		50210	WA
87	1	Starting Crank Clamp Assembly		76726A	ON
88	1	Engine Plate Assembly—Front		A-1463	WIL
89	1	Engine Plate Assembly—Rear		A-8121	WIL
	2	Dowel Bolt—⅜"-24 x 2⅛"	Adapter Ring to Eng. Plate to Cyl. Block	630101	WIL

TABLE OF REPLACEABLE PARTS—Cont.

*Reference numbers are given only when referred to in text or illustrations.
**Function is given only when name and description do not suffice.
***See List of Manufacturers.

* Ref. No.	No. Req.	Name & Description	**Function	Mfgr's. Part No.	*** Mfgr.
		MAIN ENGINE PARTS (Timing Chain Cover, Flywheel, Bearings, and Crank Group—See Fig. 45)			
91	1	Chain Cover Assembly—Complete		A-1189	WIL
92	1	Crankshaft Packing—Front End		637098	WIL
93	1	Crankshaft Packing Retainer		376920	WIL
94	1	Chain Cover Gasket		630368	WIL
95	1	Cylinder Block Gasket—Front		630369	WIL
96	1	Fan Pulley Shield		A-1124	WIL
	6	Fan Pulley Shield Washer—Cloth—¼" hole x ⅝" O.D. x .005" thick		A-6701	WIL
97	4	Stud—⅜"-16 x 1⅛"	Front Plate & Chain Cover to Cyl. Block	384958	WIL
98	2	Stud—⅜"-16 x 1⅝"	Front Plate to Cyl. Block	384958	WIL
		(Camshaft & Valve Group—See Figure 46)			
102	1	Camshaft		637065	WIL
103	1	Camshaft Bushing—Front		639051	WIL
104	1	Camshaft Sprocket		634458	WIL
105	4	Cap Screws—Special—Heat Treated Hex. Hd.—¾"-24 x 1¼"	Sprocket to Camshaft	634850	WIL
106	4	Lockwasher—Special Stamping—Lip Lock	Camshaft Sprocket Bolt	315932	WIL
107	1	Camshaft Thrust Washer		376900	WIL
108	1	Camshaft Drive Chain—½" x 1" Wide—WIL #638467		5-40936	LI
109	1	Camshaft Thrust Plunger		375907	WIL
110	1	Camshaft Thrust Plunger Spring		376908	WIL
111	4	Valve Stem Guide—Exhaust		376511	WIL
112	4	Valve Stem Guide—Intake		637045	WIL
113	4	Valve—Intake		637182	WIL
114	4	Valve—Exhaust		637183	WIL
115	8	Valve Spring		638636	WIL
116	8	Valve Spring Retainer—Lower		637044	WIL
117	16	Valve Spring Retainer Lower Lock		375994	WIL
118	8	Valve Tappet Assembly—includes tappet & adjusting screw		640019	WIL
119	8	Valve Tappet		637047	WIL
120	8	Valve Tappet Self Locking Adjusting Screw—Special—Slotted for Expansion & Spec. Hd.		640020	WIL
		MAIN ENGINE PARTS (Crankshaft & Connecting Rod Group—See Figure 47)			
130	1	Crankshaft Bearing—Front—Upper—.010" undersize	(Std. for PE-95-G)	637724	WIL
130	1	Crankshaft Bearing—Front—Upper—Standard	(Std. for PE-95-H)	634007	WIL
131	1	Crankshaft Bearing—Front—Lower—.010" undersize	(Std. for PE-95-G)	637725	WIL
131	1	Crankshaft Bearing—Front—Lower—Standard	(Std. for PE-95-H)	637008	WIL
132	1	Crankshaft Bearing—Center—Upper—.010" undersize	(Std. for PE-95-G)	639237	WIL
132	1	Crankshaft Bearing—Center—Upper—Standard	(Std. for PE-95-H)	608730	WIL
133	1	Crankshaft Bearing—Center—Lower—.010" undersize	(Std. for PE-95-G)	639238	WIL

133	1	Crankshaft Bearing—Center—Lower—Standard	(Std. for PE-95-H)	638731	WIL
134	1	Crankshaft Bearing—Rear—Upper—.010" undersize	(Std. for PE-95-G)	639239	WIL
134	1	Crankshaft Bearing—Rear—Upper—Standard	(Std. for PE-95-H)	638732	WIL
135	1	Crankshaft Bearing—Rear—Lower—.010" undersize	(Std. for PE-95-G)	639240	WIL
135	1	Crankshaft Bearing—Rear—Lower—Standard	(Std. for PE-95-H)	638733	WIL
136	6	Crankshaft Bearing Dowel		635377	WIL
137	1	Crankshaft Packing—Rear		637237	WIL
138	1	Crankshaft—.010" undersize	(Std. for PE-95-G)	637733	WIL
138	1	Crankshaft—Standard	(Std. for PE-95-H)	638121	WIL
139	1	Crankshaft Thrust Washer		634796	WIL
140	as req'd	Crankshaft Shim .002" Thick		630262	WIL
141	1	Crankshaft Sprocket		638459	WIL
142	1	Crankshaft Sprocket Spacer		630727	WIL
143	1	Crankshaft Oil Slinger		375877	WIL
144	1	Gasket—Crankshaft Oil Slinger		334103	WIL
145	2	Connecting Rod & Piston Assy.—Grade A	For #1 and #3 Cyl.	640050	WIL
146	2	Connecting Rod & Piston Assy.—Grade A	For #2 and #4 Cyl.	640054	WIL
147	4	Piston & Pin Assembly—Grade A		637038	WIL
148	4	Piston—Grade A		636954	WIL
149	4	Piston Pin		636961	WIL
150	4	Piston Ring—Compression—Upper—3⅛" x $\frac{1}{32}$"		639864	WIL
151	4	Piston Ring—Compression—Lower—3⅛" x $\frac{1}{16}$"—Taper Faced		637042	WIL
152	4	Piston Ring—Oil Regulating		638242	WIL
153	2	Connecting Rod Assy.—with Bearings—#1 & #3		640036	WIL
154	8	Connecting Rod Cap Bolt—Dowel Bolt $\frac{11}{32}$"		637020	WIL
155	8	Connecting Rod Cap Bolt Nut—Heat Treated		636962	WIL
156	8	Connecting Rod Bearing—.010" undersize	(Std. for PE-95-G)	116534	WIL
156	8	Connecting Rod Bearing—Standard	(Std. for PE-95-H)	639862	WIL
158	2	Connecting Rod Assy.—with Bearings—#2 & #4		640000	WIL
160	1	Crankshaft Identification Tag—.010" Crankshaft		A-7694	WIL
	4	Piston Pin Lock Screw—$\frac{5}{8}$"-24 x 1$\frac{1}{32}$"		632157	WIL

OILING SYSTEM PARTS
(Oil Filter Group - See Figure 48)

170	1	Oil Filter Onan #7466		27078	PUR
	1	Oil Filter Element - Purolator--Onan #7467		26637	PUR
171	1	Oil Filter Bracket Assembly		A-1247	WIL
172	1	Rubber Grommet $\frac{11}{32}$"	Protects Filter Inlet Tube	345961	WIL
173	1	Oil Filter Tube Assembly Inlet		A-1197	WIL
174	1	Oil Filter Tube Assembly Outlet		A-1198	WIL
175	2	Connector $\frac{1}{4}$" Inv. Flared Tube	One on Filter Inlet One on Filter Outlet to Chain Cover	200X4	WE
176	1	Clip $\frac{11}{32}$"-$\frac{13}{16}$" Hole	Oil Filter Tube to Chain Cover	75686	ON
177	1	Ell $\frac{1}{4}$" Inverted Flared Tube	Inlet Oil Filter Tube to Cyl. Block	384569	WIL
178	1	Tee	Bottom Filter Fitting	580X4	WE
	1	Oil Filter Cover Bolt		25765	PUR
	1	Oil Filter Cover Bolt Gasket Onan #7837		25756	PUR
	1	Oil Filter Cover Bolt Spring		25757	PUR
	1	Oil Filter Cover Gasket		25802	PUR
	1	Oil Filter Clamp Assy.		27081	PUR
	1	Oil Filter Drain Plug		27695	PUR

TABLE OF REPLACEABLE PARTS—Cont.

*Reference numbers are given only when referred to in text or illustrations.
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***See List of Manufacturers.

* Ref. No.	No. Req.	Name & Description	**Function	Mfgr's. Part No.	*** Mfgr.
		OILING SYSTEM PARTS			
		(Oil Pump Group - See Figure 49)			
	1	Oil Pump Assembly - Complete		637636	WIL
188	1	Oil Pump Body		630384	WIL
189	1	Oil Pump Shaft Assembly - Includes shaft, Rotor & Pin		636599	WIL
193	1	Oil Pump Shaft Gasket		375927	WIL
194	1	Oil Pump Rotor Disc		636600	WIL
195	1	Oil Pump Pinion		343306	WIL
196	1	Oil Pump Cover Assembly		730387	WIL
197	1	Oil Pump Pinion Pin		343309	WIL
199	1	Oil Relief Plunger		630518	WIL
200	1	Oil Relief Plunger Spring		384156	WIL
201	as req'd	Oil Pump Oil Relief Spring Shim		630389	WIL
202	1	Oil Pump Oil Relief Spring Retainer		630390	WIL
203	1	Oil Pump Oil Relief Spring Retainer Gskt.		634813	WIL
204	as req'd	Oil Pump Cover Gasket—Paper		630392	WIL
205	1	Oil Pump Cover Gasket—Vellumoid		639870	WIL
206	1	Copper Gasket—Pump Cover to Body Screw		380197	WIL
207	1	Oil Pump Gear—Driven		637425	WIL
209	1	Gasket	Oil pump body to Cyl. Block	630394	WIL
210	3	Stud—⅜"-18 x 2¾"	Holds Pump to cyl. block	376981	WIL
		(Oil Pan and Filler Tube Group—See Figure 50)			
220	1	Oil Filler Tube Assembly		A-6915	WIL
221	1	Oil Filler Tube Support Bracket		A-5105	WIL
		(Oil Pan and Filler Tube Group—See Figure 50)			
222	2	Clamp, Hose—¾"	Oil Filler to Air Cleaner Tube	53108	WIL
223	1	Hose—8½" Long x ½" I.D.	Oil Filler to Air Cleaner Tube	7436	ON
224	1	Oil Filler Cap & Bayonet Gauge Assy.		A-6525	WIL
225	1	Oil Filler Cap Gasket		A-7280	WIL
226	1	Adapter for Oil Drain		78234	ON
228	1	Gasket	For Oil Drain Fitting	314338	WIL
232	1	Drain Valve—½"—Onan #76513		189A	AMCO
233	1	Oil Pan Assembly		A-7238	WIL
234	1	Oil Pan Gasket		639980	WIL
235	1	Oil Float Assembly—Taylor Sales Corp. #215-B		630396	WIL
236	1	Oil Float Support		630397	WIL
238	1	Oil Float Support Gasket		630398	WIL
	1	Oil Float to Crankcase Bolt—Heat Treated		636796	WIL
	1	Bracket, Oil Drain		7464	ON
		COOLING SYSTEM PARTS			
		(Radiator, Fan and Idler Pulley Group—See Figure 51)			
245	1	Drain Valve—Radiator		145	WE
246	1	Reducer Bushing	Drain Valve Bushing	3226X4	WE

247	1	Radiator Water Outlet Hose—Lower		A-592	WIL
248	1	Radiator Water Outlet Tube Elbow—Lower		7314	WIL
249	1	Water Pump Inlet Hose		630512	WIL
250	8	Radiator Hose Clamp		7329	ON
251	1	Radiator Inlet Hose—Upper		A-6373	WIL
252	1	Radiator Inlet to Water Outlet Tube		A-6374	WIL
253	1	Water Outlet Elbow Hose		A-6373	WIL
254	1	Radiator—Onan #7287		R-2378	PER
		Radiator Cap—4 lbs. pressure		7452	ON
255	1	Fan Assembly—Schwitzer Cummins—Onan #7345		AF-07589	SC
256	1	Spacer for Fan		7349	ON
257	1	Fan & Water Pump Drive Belt—V Belt—42" V—44¼" O.D.—1⅛" Max. Width—Onan #7440		8429	IND
258	1	Fan Guard		7373	ON
	1	Fan Idler Pulley & Bracket Assembly		AE-7937	WIL
259	1	Bracket Assembly	Fan Idler Pulley Assembly Bracket	AE-7938	WIL
260	1	Fan Idler Pulley & Bearing Assembly—Includes Bearing Snap Ring		A-7396	WIL
	1	Fan Idler Pulley (not illustrated)		A-7348	WIL
	1	Fan Idler Pulley Bearing (not illustrated)		A-7362	WIL
	1	Fan Idler Pulley Snap Ring (not illustrated)		A-7369	WIL
	1	Fan Idler Pulley Bracket Support Assembly—Includes bushing		A-1392	WIL
261	1	Fan Idler Pulley Bracket Support		A-1393	WIL
262	2	Bushing—Front Engine Plate (1)—Fan Idler Pulley Bracket Support (1)		A-1394	WIL
	2	Cap Screw—Hex. Hd. ⅜-16 x ¾" Special—Heat Treated	Support to Cyl. Block	633949	WIL
264	1	Bushing—Idler Assembly Brace Lock		A-1470	WIL
265	1	Bolt—Hex. Hd. ⅜"-16 x 1¼"—Large Head	Bushing to Front Bracket	5157	WIL
266	2	Bolt (insulator)	Idler Brkt. to Eng. Plate (1)—Idler Brkt. to Support (1)	A-1397	WIL
267	1	Idler Brace & Handle Assembly		A-1491	WIL
268	1	Idler Brace Adjusting Guide		A-1400	WIL
269	1	Idler Brace Pivot Screw—1⅛"—Special Shoulder under head		A-1468	WIL
270	1	Idler Brace Spring		A-1469	WIL
		(Water Pump Group—See Figure 52)			
	1	Water Pump Assembly		639992	WIL
280	1	Water Pump Body		637052	WIL
281	1	Water Pump Impeller		639993	WIL
282	1	Water Pump Bearing & Shaft Assembly—Optional in place of #D2-13567		885141	ND
283	1	Water Pump Bearing & Shaft Assembly—Optional in place of #885141		D2-13667	MA
284	1	Water Pump Bearing Retaining Wire		636298	WIL
285	1	Water Pump Seal Washer		640034	WIL
286		Water Pump Seal Assembly		640031	WIL
287	1	Fan & Water Pump Pulley		636299	WIL
288	1	Gasket	Water Pump to Cyl. Block	637053	WIL
	1	Water Pump Repair Kit		A-6839	WIL

TABLE OF REPLACEABLE PARTS—Cont.

*Reference numbers are given only when referred to in text or illustrations.
**Function is given only when name and description do not suffice.
***See List of Manufacturers.

* Ref. No.	No. Req.	Name & Description	**Function	Mfgr's. Part No.	*** Mfgr.
		FUEL SYSTEM PARTS			
		(Fuel Pump Parts Group—See Figure 53)			
300	1	Fuel Strainer Bail Assembly		1523231	AC
301	1	Fuel Pump Bowl Gasket		1523096	AC
302	2	Fuel Pump Outlet & Inlet Valve Assembly		1523106	AC
303	1	Fuel Pump Diaphragm & Pull Rod Assembly		1522199	AC
304	1	Fuel Pump Rocker Arm Link		1521708	AC
305	1	Fuel Pump Rocker Arm Pin		1521578	AC
	1	Fuel Pump Rocker Arm Pin Washer		1521288	AC
306	1	Fuel Pump Rocker Arm Assembly		1521960	AC
307	1	Fuel Pump Rocker Arm Spring		1522046	AC
308	1	Fuel Pump Diaphragm Spring		1523744	AC
309	1	Fuel Pump Bowl		1537065	AC
310	1	Fuel Pump Filtering Screen Assembly		1523099	AC
312	1	Fuel Pump Body & Priming Lever Assembly		1537812	AC
313	1	Top Cover	Holds Bowl in position	1523084	AC
314	2	Valve Gasket		1521953	AC
315	1	Valve Clamp		1521956	AC
316	1	Fuel Strainer Thumb Nut		855763	AC
317	1	Fuel Strainer Bowl Seat		854005	AC
318	1	Pull Rod Seal Washer		1521985	AC
319	1	Pull Rod Seal		1521880	AC
		(Carburetor Parts Group—See Figure 54)			
330	1	Body Flange Assembly		1-429S	CA
331	1	Throttle Valve		2-116	CA
	2	Throttle Valve Attaching Screw		39-11	CA
332	1	Throttle Shaft & Lever Assembly		3-497S	CA
	1	Throttle Lever Adj. Screw Hex. Nut		105A-34	CA
333	1	Choker Valve Assembly		7-116S	CA
	2	Choke Valve Attaching Screw		39-10	CA
334	1	Low Speed Jet Assembly		11-180S	CA
	1	Rivet Plug		11B-35	CA
	1	Rivet Plug		11B-41	CA
	5	Rivet Plug		11B-79	CA
335	1	Idler Port Rivet Plug		11B-108	CA
336	1	Strainer Plug & Gasket Assembly		11B-125S	CA
337	2	Nozzle & Pump Passage Plug & Gasket Assembly		11B-127S	CA
338	2	Low Speed Jet & Idle Passage Plug & Gasket Assembly		11B-129S	CA
339	1	Nozzle Retainer Plug		11B-171	CA
340	1	Nozzle		12-255	CA
341	1	Choker Shaft		13-85	CA

342	3	Needle Seat & Plug Gasket		20-22	3CA
343	1	Metering Rod Jet & Plug Gasket		20-26	CA
344	1	Strainer Plug Gasket		20-61	CA
345	1	Nozzle Gasket		20-72	CA
346	1	Float & Lever Assembly		21-74S	CA
347	1	Float Lever Pin		24-23	CA
348	1	Needle Spring & Seat Assembly		25-93S	CA
	1	Strainer	Pump Check Strainer	30-20	CA
349	1	Idle Adjustment Screw		30A-39	CA
350	1	Idle Well Jet		43-67	CA
351	1	Pump Jet		48-84	CA
352	1	Pump Arm & Collar Assembly		53A-168S	CA
353	1	Pump Operating Lever Assembly		53A-170S	CA
354	1	Idle Adjustment Screw Spring		61-57	CA
	1	Idle Adj. Screw		30A-39	CA
	1	Connector Rod Spring		61-128	CA
355	1	Plunger Spring		61-143	CA
356	1	Pump Arm Spring		61-169	CA
357	1	Metering Rod Spring		61-201	CA
	1	Intake Needle Spring		61-207	CA
	1	Spring Retainer		63-35	CA
358	1	Plunger & Rod Assembly		64-62S	CA
359	1	Metering Rod—Standard		75-570	CA
	1	Metering Rod Pin Hex. Nut		105A-19	CA
	1	Metering Rod Pin Washer		136-39	CA
	1	Throttle Lever Adjustment Screw Hex. Nut		105A-34	CA
	1	Throttle Lever Idle Adjustment Screw		101-120	CA
	1	Throttle Shaft Arm & Screw Assembly		114-21S	CA
	1	Throttle Shaft Arm Clamp Screw		101-28	CA
	1	Throttle Connector Rod		115-59	CA
	1	Connector Rod Washer		136-37	CA
	1	Connector Link		117-58	CA
	1	Metering Rod Jet & Gasket Assembly		120-136S	CA
	4	Bowl Cover Attaching Screw		101-82	CA
360	1	Bowl Cover Gasket		121-73	CA
	4	Bowl Cover Lock Washer		86-10	CA
361	1	Discharge Disc Check Plug Assembly		122-47S	CA
362	1	Intake Ball Check Plug Assembly		122-64S	CA
363	1	Metering Rod Disc		129-15	CA
364	1	Bowl Cover & Pin Assembly		146-95S	CA
365	1	Metering Rod Pin		150-97	CA
	1	Metering Rod Pin Hex. Nut		105A-19	CA
366	1	Intake Needle Pin		150-98	CA
	1	Pin Spring		150A-10	CA
367	1	Insulator		183-19	CA
368	2	Carburetor Body Flange Gasket		121-56	CA
	2	Body Flange Lockwasher		86-11	CA
	2	Flange Stud Lockwasher		86-15	CA
	2	Body Flange Attaching Screw		101-122	CA
	2	Air Horn Screw and Washer Ass'y		101-150S	CA

TABLE OF REPLACEABLE PARTS—Cont.

*Reference numbers are given only when referred to in text or illustrations.
**Function is given only when name and description do not suffice.
***See List of Manufacturers.

* Ref. No.	No. Req.	Name & Description	**Function	Mfgr's. Part No.	*** Mfgr.
		FUEL SYSTEM PARTS			
		(Air Cleaner Parts Group See Figure 55)			
380	1	Air Cleaner Body		613455	OA
381	1	Cleaner Element & Wing Bolt		613387	OA
382	1	Cleaner Cup Oil		613306	OA
383	1	Body Gasket Upper		613313	OA
384	1	Oil Cup Gasket Lower		613314	OA
	2	Toggle Spring		613380	OA
		(Fuel System Miscellaneous Group See Figure 56)			
395	2	Connector—Inverted Male - Fuel Line Pump to Fuel Filter		200X4	WE
396	1	Ins. Gasket & Manifold Baffle Assembly		1A-558	CA
397	1	Air Horn Assembly		6-4968	CA
		(Fuel System—Miscellaneous Group See Figure 56)			
398	1	Ell—Inverted Male Fuel Pump		400X4	WE
399	2	Ell ⅛"—Inverted Flared Tube Fuel Pump to Carburetor Line		384549	WIL
400	1	Carburetor Flange Gasket		630889	WIL
401	1	Carburetor Insulator Gasket		A-923	WIL
402	1	Intake Manifold Shield		A-8169	WIL
403	1	Fuel Filter Assembly—Onan #1097		OW418	TI
	1	Fuel Filter Bowl Gasket		1099	ON
	1	Fuel Filter Bowl Screen		OW-362	TI
	1	Bowl, Fuel Filter—Onan #1098		OW-363	TI
404	1	Fuel Tan—Cap with Chin & Retaining Wire		5729R	ON
405	1	Fuel Tank		7356	ON
406	1	Manual Choke Rod		7377	ON
407	1	Clip, Fuel Line	Fuel Line to Distributor Mtg.	75686R	ON
408	1	Fuel Line Clip	Fuel Line to Gen. Adapter Ring Stud	7415	ON
409	2	Fuel Line Clip	Fuel Line to Idler Assembly	75686	ON
410	2	Wire Harness Clip	Auto Choke Rod	7482	ON
411	1	Fuel Line—52"—Inv. Nut Each End		76881	ON
	1	Auxiliary Fuel Line—20 Ft.—Flex.		76887	ON
412	1	Street Ell—Fuel Line		3400X2	WE
413	1	Shut Off Valve—Fuel Line—2 Way		6737	WE
414	1	Close Nipple		3326X2	WE
415	1	Automatic Choke Rod—14⅛" x ⅛"		7374	ON
417	1	Air Cleaner Bracket		7358	ON
418	1	Air Horn Clamp		A-281	WIL
419	2	Air Cleaner Hose Clamp		7830	ON
420	1	Air Cleaner Hose—2⅛" Wire Inserted—1 Ply—13"		7448	ON
421	1	Fuel Line	Carburetor to Pump	A-6616	WIL

422	1	Overspeed Gov. Handy Vel. Gov.—Onan #7411		235-740A	KI
423	1	Carburetor—Onan #7012		572S	CA
424	1	Carburetor Air Cleaner Assembly—WILA #5621		613300	OA
425	1	Choke Arm—Manual		7375	ON
426	1	Fuel Pump Assembly—Complete—Onan #7910		1537766	AC
427	1	Fuel Pump Flange Gasket		638737	WIL
428	1	Automatic Choke—Onan #7451		MC211	PI
	1	Arm, Throttle Assy.		7435	ON
	1	Clip—Onan #7466	Water Temperature Line	3043-4	TIN
	1	Clip—Onan #7446	Water Temperature Cut-off Switch to Fuel Line	3043-4	TIN
	1	Clip—Onan #7446	Choke Wire to Governor Line	3043-4	TIN
	1	Lever, Idle Set		7430	ON
		(Governor Parts Group—See Figure 57)			
435	1	Governor Assembly—Onan #7433		26710-326	KI
436	1	Governor Support Bracket Assembly		A-6419	WIL
437	2	Governor Mounting Bracket Spacer		A-6824	WIL
438	1	Governor to Carburetor Link—¼" Rod x 4½"		7432	ON
439	2	Governor Ball Joint—¼"-28		75863	ON
440	1	Governor Oil Line—⅛" Copper Tube — 21" Long with Inv. Nut on Each End		7402	ON
441	1	Governor Drive Belt—Onan #7429		1470	IND
442	1	Elbow--Inverted Male		400X3	WF
443	1	Oil Line—9"--Flexible	Governor Oil Return Line	19468	ON
	1	Body Assembly		26616	KI
444	1	Governor Body		26617-1	KI
445	1	Spring Slide		26618	KI
446	1	Shoulder Screw		26619	KI
447	1	Adjusting Screw		21535	KI
448	1	Lock Nut		H6202	KI
449	1	Operating Shaft		26621	KI
450	2	Ball Bearing		26622	KI
451	1	Thrust Washer		26623	KI
452	1	Snap Ring		24335	KI
453	1	Oil Seal		26624	KI
454	1	Bearing Retainer		26625	KI
455	1	Spring Washer		26662	KI
456	1	Riser Fork Assembly		26629	KI
457	1	Clip		23231	KI
458	1	Oil Level Plug		25368	KI
	1	Operating Lever & Eye Bolt Assembly		26626	KI
459	1	Operating Lever		26627	KI
460	1	Spring Eyebolt		26628	KI
461	1	Locknut		H-7434	KI
462	1	Governor Flange		26633-1	KI
463	2	Ball Bearing		25464	KI
464	1	Oil Seal		25380	KI
	1	Shaft & Weight Assembly		26634	KI
465	1	Shaft & Weight Carrier		26635	KI
466	2	Governor Weight Assembly		26636	KI

TABLE OF REPLACEABLE PARTS—Cont.

*Reference numbers are given only when referred to in text or illustrations.
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***See List of Manufacturers.

* Ref. No.	No. Req.	Name & Description	**Function	Mfgr's. Part No.	*** Mfgr.
		FUEL SYSTEM PARTS (Governor Parts Group - See Figure 57)			
467	1	Washer		26640	KI
468	2	Weight Pin		H-7548	KI
469	1	Weight Pin Clip		22110	KI
470	1	Fork Riser		26643	KI
471	1	Ball Bearing		26645	KI
472	1	Gasket		26646	KI
473	6	Gasket		25230	KI
474	6	Body Screw		26648	KI
475	1	Governor Spring		23491-10	KI
476	1	Bumper Spring		H-9367	KI
477	1	Bumper Spring Screw		26649	KI
478	1	Bumper Screw Locknut		26706	KI
479	1	Taper Pin		H-8167	KI
480	1	Gasket		26773	KI
481	1	Pulley		26641	KI
482	1	Taper Pin		20251	KI
		IGNITION SYSTEM (Ignition Unit Parts Group—See Figure 58)			
485	1	Contact Plunger	High Tension Cable Brush	IG-514	AU
486	1	Distributor Cap Assembly		IG-1324	AU
487	2	Governor Weight Assembly	Governor Flyweights	IG-2456	AU
489	1	Governor Weight Spring Set		IGB-202S	AU
490	1	Press-in Sleeve Oiler		X-490	AU
491	1	Anti-Rattle Spring		IGT-69	AU
492	1	Cam Sleeve Felt Wick		IGH-28	AU
493	1	Cam and Stop Plate	Opens Breaker Points	IGC-1132LB	AU
494	1	Drive Shaft & Governor Assembly		IGS-2134L	AU
495	1	Thrust Washer		IG-816C	AU
496	1	Thrust Washer		IG-90	AU
497	1	Timing Control Arm Assembly	Adjusts Timing	IGS-1080	AU
498	1	Distributor Shaft Collar		IGB-199	AU
499	1	Distributor Drive Rivet		SW-213	AU
500	1	Contact Plunger Spring		IG-515	AU
501	1	Rotor		IG-1657	AU
502	1	Lock Spring Ring		IG-680	AU
503	1	Washer	Spacer	IGS-99	AU
504	2	Thrust Washer		IGS-104	AU
505	1	Absorbent Bronze Bearing		IG-579A	AU
506	1	Distributor Base Assembly		IGS-2135	AU
507	1	Drive Shaft Assembly		IGS-1134L	AU

508	1	Breaker Plate Assembly—includes Contacts & Condenser		IGC-2148C	AU
509	1	Breaker Plate Assembly—less Contacts & Condenser		IGC-1148	AU
510	2	Distributor Cap Spring		IG-694	AU
511	2	Hinge Pin—Special Split Pin		X-1448	AU
512	1	Service Contact Set	Breaker Contact Set	IGP-3028FS	AU
513	1	Terminal Slot Cover		IGC-117	AU
514	1	Condenser	Ignition	IGW-3139N	AU
515	1	Breaker Arm Spring Clip		IG-676	AU
516	1	Breaker Arm Spring		IGP-30	AU
		(Ignition System—Miscellaneous Group—See Figure 59)			
529	1	Ignition Unit		IGC-4705	AU
531	1	Spark Plug Cable Assemlby #1—Consists of Wire, Spark Plug Radio Suppressor and End Terminal		A-1412	WIL
532	1	Spark Plug Cable Assembly #2—Consists of Wire, Spark Plug Radio Suppressor and End Terminal		A-1414	WIL
533	1	Spark Plug Cable Assembly #3—Consists of Wire, Spark Plug Radio Suppressor and End Terminal		A-1416	WIL
534	1	Spark Plug Cable Assembly #4—Consists of Wire, Spark Plug Radio Suppressor and End Terminal		A-1418	WIL
535	1	Ignition Coil Secondary Cable Assembly—Consists of Wire, Terminal, Radio Suppressor and Cable Insulator		A-1420	WIL
536	4	Radio Suppressor	For Spark Plug Cables and Coil to Dist. Cable	A-6320	WIL
537	4	Spark Plug Apron—Rubber		A-1096	WIL
538	5	Distributor & Spark Coil Tower Apron—Rubber		327257	WIL
539	1	Center Distributor Tower Apron		A-6321	WIL
540	1	Rubber Grommet—$1\frac{1}{16}$" I.D.	Holds Spark Plug Wires together	301435	WIL
541	4	Spark Plug—Onan #7908		J-9	CH
542	4	Spark Plug Gasket		N-672	CH
543	1	Ignition Coil & Bracket Assembly		IG-4070L	AU
544	2	Stud—Ignition Coil to Cyl. Block—$\frac{1}{4}$"-20 x 1" Condenser		635886	WIL
545	1	Condenser	For Ignition Coil Term. .1 MFD.	10289	EU
546	1	Bond Strap—$\frac{1}{4}$" x 3"-$\frac{3}{16}$" & $\frac{1}{4}$" Holes	Temp. Gauge Capillary Tube to Cyl. Block	7382	ON
547	1	Ignition Coil Primary Cable	Ignition Coil to Ignition Unit	A-5083	WIL
548	1	Wire—Ignition Resistor to Ign. Coil—#16 Black Motor Lead—#77026 Terminal on Both Ends—$6\frac{1}{2}$" Long			ON
	1	Wire—Ignition Resistor to Control Panel—#16Black Motor Lead—#77026 Terminal on One End—$\frac{3}{8}$" Striped Other End—61" Long			ON
550	1	Ignition Resistor—1 ohm—50 watt—Adj.		7434	ON
	1	Ignition Resistor Angle Bracket—16 Ga.		7460	ON
551	2	Battery—6-Volt Onan #76850		17K2R	GRA
552	1	Battery Cable—5" C. to C.		1747	ON
553	1	Battery Cable—14" C. to C.		7918	ON
554	1	Battery Cable—17" C. to C.		7919	ON
	2	Electrolyte for one 6-Volt Battery—Specific Gravity 1.265—Onan #76144		1265-ACID	GRA
	2	Resistor Bracket		7460	ON

TABLE OF REPLACEABLE PARTS—Cont.

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* Ref. No.	No. Req.	Name & Description	**Function	Mfgr's. Part No.	*** Mfgr.
		GENERATOR PARTS (Generator Group—See Figure 60)			
560	1	Generator Bearing		7306	HO
561	1	Generator Ball Bearing Cover Gasket—Onan #5156		5156	AR
562	1	Generator Bearing Stop Clip		5160	ON
563	4	Brush Spring—D.C.		5190	ON
564	4	Brush—D.C.—M-46	Exciter	5195	ON
565	1	Generator Baffle Ring		7002	ON
566	1	Generator Adapter		7013	ON
567	1	Generator Frame Bracket—R.H.		7014	ON
568	1	Generator Frame Bracket—L.H.		7015	ON
569	1	Generator Ball Bearing Cover		7155	ON
570	1	Blower Wheel		7503	ON
	1	Generator Bearing Oil Shield		7513	ON
572	4	Exciter Pole Shoe		12508	ON
573	3	Condenser—.01 MFD	1 used on Brush Rig 1 used on Pos. Slip Ring 1 used on Neg. Slip Ring	76811	ON
574	4	Brush Spring—Slip Ring		19653	ON
575	4	Brush—L51—Slip Ring	Alternator	75361	IL
576	1	Generator Frame		75526D	ON
577	1	Generator Wire Outlet Cover		75538	ON
578	1	Exciter Frame Bell Housing		75580	ON
579	1	Exciter Frame—Rolled Steel		75582	ON
580	1	End Bell Cover Band		75592	ON
581	1	Exciter Armature & Rotor Assembly		7514	ON
582	1	Brush Rig Assembly—includes insulation disc, brushes, springs and guides		76579A	ON
583	1	Stator Winding Assembly		76659B	ON
584	1	Connector Wire	Ground Jumper	75787	ON
585	1	Connector Wire	Brush Jumper	75785	ON
586	1	Exciter Field Coil Set	D.C. Field	75645C	ON
587	6	Stud—Generator Frame to Adapter Ring		7332	ON
	4	Exciter Field Coil		75645D	ON
		CONTROL PARTS (Control Group—See Figure 61)			
607	2	Batt. Charging Resistor—2-Ohm—75 Watt—6" x ¾" Fixed		7463	PR
608	1	Batt. Charging Resistor—2.5 Ohm—50 Watt—4" x ¾"—Fixed		7445	PR
609	1	Batt. Charging Regulator—Onan #75866		TCA-4001	AU
610	1	Ammeter—D.C.—20-0-20—2"		1412L	US
611	1	Toggle Switch—Onan #7238	Manual and Remote Start	21350-AL	AH

612	1	Batt. Charging Relay		76560B	ON
613	1	Batt. Charging Relay Coil		1616	ON
614	1	Batt. Charging Relay Armature & Contact Assy.		1547A	ON
615	1	Batt. Charging Relay Armature Return Spring		1630	ON
616	1	Batt. Charging Relay Stationary Contact Panel with Contacts		1553-A	ON
617	1	Start Stop Switch—Onan #1740		617-393	CU
618		Wire Clamp—Fuel Gauge Wire to Control Panel Cabinet—Onan #1814		21776	EI
620	1	Stop Relay—Type 60—12 V.—1 Pole—Onan #7241		60-211001	RBM
621	1	Hi-Water-Temperature Cut-off Switch—1 Pole-1 Thro—Set to break at 209° F. Onan #7428		1186-2EI	WHI
623	1	Low Oil Pressure Switch—Onan #7276		7013A	AU
624	1	Shock Mounting—1" Dia.—Onan #7279.		40	GO
625	1	Terminal Block—Molded		7222	ON
626	8	Remote Control Terminal Stud Adapter—Molded		7389	ON
627	4	A.C. Terminal Stud Adapter		7390	ON
628	1	Voltage Selector Switch—Onan #78237		162C	MA
631	1	Start Relay—12 V.—2 Pole—Series 165—Low Current		7410	ON
632	8	Wire Clip—Tinnerman—Onan #7422	Control Panel Wires	30435	TIN
633	1	Wire Clip—Tinnerman—Onan #7423	Wire Harness to Battery Rack	30445	TIN
635	1	Fuel Gauge—#6675A Hd.—4181 Gasket—10364A—Elec. Hd., 3663 Lock, 7336A Gskt., 6232 Flange—3696 Mach. Screw—Onan #7421			AU
636	1	Fuel Gauge Resistor—Onan #76868		7336A	AU
637	1	Oil Pressure Gauge—2" with U Clamp—Onan #15168		15168	US
638	4	Condenser—.1 MFD—Remote Control Stop Terminal (1), Remote Control Start Terminal (1), Solenoid Batt. Contact Terminal (1), Solenoid Switch Exciter Side (1)—Onan #5928		10289	EU
639	1	Solenoid Starting Switch—Onan #78802		SS-4023	AU
640	1	Ignition Relay—Onan #78707		HRK-4001	AU
641	2	Condenser—.01 MFD—AC Load Terminal		76811	ON
643	1	Water Temperature Gauge		76667	US
644	1	Ammeter—A.C.—Simpson 0-50—Model 57		76702	SI
645	1	Circuit Breaker—35 Amp.—3 Pole		78619	SQ
646	7	Terminal Block—Molded Bakelite		7378	ON
647	1	Voltmeter—Simpson 0-300 A.C.—Moeld 57		78256	SI
648	1	Terminal Block—8 Term.—Onan #76826		1008	BU
649	1	A.C. Terminal Mounting Bracket		7392	ON
650	1	Remote Control Terminal Mounting Bracket		7393	ON
651	4	Bond Strap—1" x 6"—2 $\frac{3}{8}$" Holes—Control Panel to Generator Frame		7323	ON
652	1	Bond Strap 1" x 10-$\frac{1}{16}$" Hole & $\frac{1}{16}$" Hole—Control Panel to Generator Frame		7320	ON
653	4	A.C. Terminal Stud Assembly—$\frac{3}{8}$"-16 x 3" Brass		7388	ON
654	1	Remote Terminal Stud Assembly—$\frac{1}{4}$"-20 x 2$\frac{1}{8}$"		7391	ON
655	1	Tee—Lo Oil Pressure Cut-off Switch		550X4	WE
657	8	A.C. Terminal Block Connector Strips		7225	ON
658	1	Instrument Panel		7478	ON

TABLE OF REPLACEABLE PARTS—Cont.

*Reference numbers are given only when referred to in text or illustrations.
**Function is given only when name and description do not suffice.
***See List of Manufacturers.

* Ref. No.	No. Req.	Name & Description	**Function	Mfgr's. Part No.	*** Mfgr.
		CONTROL PARTS (Control Group—See Figure 61)			
	2	Stud—Resistor Mtg. 10-32 x 7⅛" long	Use with Resistor Ref. #607	75868	ON
	2	Resistor Mounting Bracket	Use with Resistor Ref. #607	75869	ON
	1	Wiring Harness	Contains 10-#16 wires and 2-#14 wires	338C5	ON
663	1	Oil Pressure Gauge Line		76881	ON
	1	Clip, Oil Gauge Line	Line to Battery Rack	7458	ON
	1	Clip, Wire—Onan #7472	Wire Harness to Frame	3044-4	TIN
	1	Elbow, Inverted Female	Oil Gauge	7447	ON
	1	Clip	Wire Harness	7416	ON
	1	Clip, Wire—Onan #7446	Wires to Solenoid	3043-4	TIN

HOUSING PARTS
(Housing Group—See Figure 62)

665	24	Shoulder Pin	7331	ON
666	24	Spring for Shoulder Pin	7372	ON
667	2	Panel to Radiator Bracket	7260	ON
668	2	Tool Box Support Stud	7298	ON
669	1	Skid Base	7300	ON
670	1	Front Engine Mounting	7301	ON
671	1	Center Housing Support	7302	ON
673	1	Front End Panel	7305	ON
674	1	Exhaust Compartment Top Plate	7310	ON
676	1	Front Engine Support Bracket—R.H.	7336	ON
677	1	Front Engine Support Bracket—L.H.	7337	ON
678	1	Lifting Yoke	7338	ON
679	1	U-Bolt	7339	ON
680	1	Instrument Panel Frame	7350	ON
683	2	Fuel Tank U Clamp	7353	ON
684	1	Tray for Battery Box	7354	ON
685	1	Battery Top Frame	7355	ON
686	1	Rear Top Housing Plate	7357	ON
687	1	Front Top Housing Plate	7358	ON
688	1	Right Rear Housing Panel	7359	ON
689	1	Right Front Housing Panel	7360	ON
690	1	Left Rear Housing Panel	7361	ON
691	1	Left Front Housing Panel	7362	ON
692	1	Support for Fuel Tank & Batteries	7364	ON
693	1	Instrument Panel Door	7365	ON
694	1	Rear End Panel	7366	ON
695	1	Tool & Parts Box	7367	ON
696	2	Track for Sliding Top Plate	7369B	ON
697	4	Stud for Battery Rack—⅛" x 9¾"	7370	ON
698	2	Spare Parts Box	7384	ON
699	2	Battery Spacer Block—End	7386	ON
700	1	Battery Spacer Block—Center	7387	ON
701	2	Support for Spare Parts Box	7395	ON
703	2	Top Plate Chain	7412	ON
704	1	Bottom Dust Pan	7405	ON
705	1	Front Dust Plate	7406	ON
	4	Hood Clamp—Onan #7449	C2052	BAS
	2	Anti-Squeak Webbing—2" x 8½" x ⅛"	7959	ON

Radiator Mounting

FACTURERS NAMES AND ADDRESSES

iation	Name and Address
	A.C. Spark Plug Company General Motors Division General Motors Corp. Flint, Michigan
I	Arrow-Hart & Hegeman Elec. Co. Hartford, Connecticut
O	American Radiator Co. Sanitation Building Pittsburg, Pennsylvania
	Armstrong Cork Company 515 Plymouth Building Minneapolis, Minnesota
	Electric Autolite Company 4900 Chrysler Building New York, N.Y.
	Barcol Mfg. Co. 225 Louisiana St. Buffalo, New York
S	V. Bassick Co. Bridgeport, Conn.
	Bonney Forge & Tool Wks. Allentown, Pa.
	Burke Electric Co. Erie, Pennsylvania
	Carter Carburetor Corp. 2850-56 North Spring Ave. St. Louis, Mo.
	Champion Spark Plug Co. Toledo, Ohio
	R. W. Cramer Company Centerbrook, Connecticut
	Cutler Hammer, Inc. 315 N. 12th Street Milwaukee, Wisconsin
	P. R. Mallory & Co. 3029 East Washington St. Indianapolis, Ind.
	New Departure Division General Motors Corp. Bristol, Conn.
	Durkee Atwood Co. 215 N.E. 7th Street Minneapolis, Minnesota

Abbreviation	Name and Address
EI	Eizemann Magneto Corp. New York, N.Y.
EU	Electric Utilities Co. 2900 S. Mich. Blvd. Chicago, Ill.
GA	Gamble Stores—No. 102 111 S. 6th St. Minneapolis, Minnesota
GO	B. F. Goodrich Co. 2800 Tennyson Road Cleveland, Ohio
GRA	Grant Battery Co. 226 N. Second St. Minneapolis, Minnesota
HO	Hoover Ball & Bearing Co. Ann Arbor, Michigan
HU	Hubbel Manufacturing Co. Bridgeport, Connecticut
IL	Illinois Coil Spring Co. 2100 North Major Avenue Chicago, Illinois
IND	Independence Rubber Co. 665 W. Washington Blvd. Chicago, Illinois
JBT	J. B. T. Instrument Co. New Haven, Connecticut
KI	King Seely Corp. Ann Arbor, Michigan
LI	Link Belt Co., Indianapolis, Ind., Chicago, Illinois, Philadelphia, Pa., Dallas, Texas, Atlanta, Georgia, San Francisco, Calif., Toronto, Ont., Canada.
MA	Marlin Rockwell Corp. Jamestown, N.Y.
MI	Minn. Mining & Mfg. Co. 900 Fauqier Ave. St. Paul Minnesota

MANUFACTURER'S NAMES AND ADDRESSES

Abbreviation	Name and Address
OA	Oakes Products Div. Houdaille Hershey Corp. Detroit Mich.
OH	Ohmite Mfg. Co. 4835 W. Flournoy St. Chicago, Illinois
ON	D. W. Onan & Sons 43 Royalston Ave. No. Minneapolis, Minn.
PER	Perfex Corporation Milwaukee, Wisconsin
PI	Pierce Gov. Co. Anderson, Indiana
POC	Pure Oil Company 1306 S. 1st Street Minneapolis, Minn.
PR	Precision Machine Works, Inc. 14 S. 9th Street Minneapolis, Minnesota
PU-CA	Pure Carbon Co., Inc. St. Marys, Penna.
PUR	Purolator Products, Inc. Frelinghuysen Ave. & Empire St. Newark, New Jersey
RBM	RBM Mfg. Co. 1601 Wall Street Fort Wayne, Ind.
SC	Schwitzer Cummins Company Indianapolis, Indiana
SI	Simpson Electric Co. 5216-18 W. Kinzie St. Chicago, Illinois
SM	S & M Tire & Auto Suppl 1301 Hennepin Avenue Minneapolis, Minnesota
SQ	Square D Mfg. Co. 6060 Rivard Street Detroit, Michigan
TI	Tilotson Mfg. Co. Toledo, Ohio
TIN	Tinnerman Products 2429 University Ave. St. Paul, Minnesota
US	U. S. Gauge Company 44 Beaver Street New York, N.Y.
VL	Vlcheck Tool Co. 15 N. Jefferson St. Chicago, Illinois
WA	Walker Mfg. Co. Michigan Div. Jackson, Michigan
WE	The Weatherhead Co. 300 East 131st St. Cleveland, Ohio
WHI	White Rogers St. Louis, Missouri
WIL	Willys-Overland Motors, I Toledo, Ohio