INSTRUCTION MANUAL

FOR

ONAN ELECTRIC GENERATING PLANTS

Series

GO

Spec.

A - H

Models

ALTERNATING CURRENT

DIRECT CURRENT

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

FORM 903-3


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GENERAL INFORMATION

THE PURPOSE OF THIS BOOK. This instruction book is furnished so that the operator may learn of the characteristics of the plant. A thorough study of the book will help the operator to keep the plant in good operating condition so that it will give efficient service. An understanding of the plant will also assist the operator in determining the cause of trouble if it occurs.

KEEP THIS BOOK HANDY. Such simple mistakes as the use of improper oil, improper fuel, or the neglect of routine servicing may result in failure of the plant at a time when it is urgently needed. It is suggested that this book be kept near the plant so that it may be referred to when necessary.

SERVICE. If trouble occurs and the operator is unable to determine the cause after a thorough study of this book, or if he is unable to determine what repair parts are required, needed information will be furnished upon request. When asking for information, be sure to state the Model, Serial, and Generator numbers of the plant. This information is absolutely necessary and may be obtained from name plates on the plant. Give all other available details.

MANUFACTURER'S WARRANTY

The manufacturer warrants each new engine or electric plant to be free from defects in material and workmanship. Under normal use and service our obligation under this warranty is limited to the furnishing of any part without charge which, within ninety (90) days after delivery to the original user shall be returned to us or our authorized service station with transportation charges prepaid, and which our examination shall disclose to have been defective.

Our liability in case of defective workmanship, material or any costs incurred in remedying any claimed defective condition in any unit or such unit having been repaired, altered, or which installation and service recommendations have not been complied with, is limited strictly to the proper adjustment authorized by the factory.

This warranty does not include or cover standard accessories used, such as carburetors, magnetos, fuel pumps, etc., made by other manufacturers. Such accessories have separate warranties made by the respective manufacturers. Repair or exchange of such accessories will be made by us on the basis of such warranties.

This warranty is in lieu of all other warranties expressed or implied.

IMPORTANT--RETURN WARRANTY CARD ATTACHED TO PLANT.

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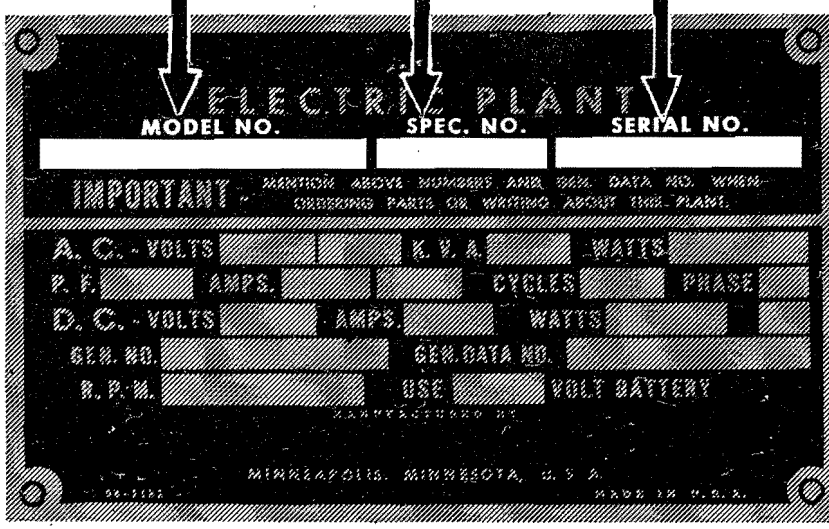
Important !

Always GIVE THESE NUMBERS WHEN ORDERING REPAIR PARTS OR REQUESTING SERVICE INFORMATION FOR YOUR UNIT !

WRITE IN NUMBERS SHOWN ON PLANT NAMEPLATE



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This manual is supplied to assist the operator in the proper installation and operation of the GO series of generating plants. This manual covers both the AC (5GO) and DC (6GO) models. Disregarding the instructions given may lead to unnecessary trouble and expense.

Each generating plant is given an actual running test at the factory and is carefully checked under various electrical load conditions before shipment, to assure that it is free of any defects and will produce its rated output. Inspect the plant carefully for any damage which may have occurred in shipment. Any damaged part must be repaired or replaced before putting the plant into operation.

These instructions apply to the standard models. Some details may not apply to special models. Some special equipment, special installation requirements, or special operating conditions may require the operator of this plant to modify these instructions. However, by using the instructions and recommendations given in this book as a general guide, the operator should be able to make a good installation, and to properly operate the plant. Accessories and controls suitable for a normal installation and according to the particular model are supplied as ordered.

Should it become necessary to contact the factory or an Authorized Service Station in regard to this generating plant, be sure to furnish the nameplate information as shown. This information must be known in order to properly identify the plant and to give proper advice.

ENGINE

A Continental Red Seal engine, spec. No. Y91-273 or Y91-264 powers the plant. The engine is a 4 cylinder, L head, 4 stroke cycle, water cooled internal combustion type. The cylinder bore is 2-7/8", the piston stroke 3-1/2", compression ratio 6.1 to 1, and the maximum horsepower at 1800 r.p.m. is 23. The engine speed is controlled by a centrifugal flyweight type, gear driven governor. 12 volt starting and ignition current is furnished by two 6 volt batteries connected in series. Charging current for the batteries is furnished by the generator on AC plants. A separate automotive type battery charging generator is used on the DC plants. Full length water jackets surround the cylinders and valve seats. Circulation of the engine coolant is maintained by a belt driven, ball bearing pump, and the coolant temperature is thermostat controlled. The cooling system capacity is 11 quarts, U. S. Measure. A pusher type fan forces cooling air out through the front of the radiator. A high water temperature cut-off switch (not on all models) stops the engine if the coolant temperature reaches a dangerously high point. A gear type oil pump supplies pressure lubrication to main, camshaft and connecting rod bearings. The crankcase oil capacity, including the oil filter, is 4 quarts, U. S. Measure. A fuel pump provides for connection to any appropriate gasoline fuel supply tank. Some model plants are equipped with a 5½ gallon fuel tank mounted inside the plant housing. Other special model plants are equipped to burn gaseous fuel.

AC GENERATOR

The alternating current generator is a revolving armature type, directly connected to the rear of the engine. The armature turns at crankshaft speed, being supported at the engine end by the engine rear main bearing. A large ball bearing supports the outer end of the armature. A series field winding is used for electrically cranking the engine. The generator produces a small amount of direct current which is used for exciting the field and for charging the starting batteries. Voltage and frequency are proportional to engine speed, which is regulated by the engine governor. The 60 cycle plants operate at approximately 1800 r.p.m., and the 50 cycle plants at approximately 1500 r.p.m. The inherent design of the generator assures close regulation of voltage between full load and no load conditions.

DC GENERATOR

The direct current generator is of the compound wound type, and uses two interpoles for sparkless commutation. The armature is supported at the engine end by the engine rear main bearing and at the outer end by large ball bearing. The generator is self excited and turns at engine speed. The inherent design of the generator assures exceptionally close voltage regulation between full load and no load conditions.

CONTROL EQUIPMENT

The control equipment varies considerably with differences in individual models. The absence of various meters and automatic control devices on some models does not affect the efficiency of the plant, but does impose upon the operator the responsibility of becoming familiar with the operation and performance of the plant so as to recognize any abnormal condition before damage occurs.

IMPORTANCE OF PROPER INSTALLATION.- Proper installation is essential to satisfactory and dependable performance. Location and ventilation are important factors to consider in installation.

LOCATION.- The plant should be centrally located in relation to the electrical load. If practicable, install the plant in a building or covered vehicle for protection from extremes in weather conditions.

CAUTION

> Exhaust gases are deadly poisonous and must be piped outdoors if the plant is installed indoors. Excessive inhalation of exhaust gases may cause serious illness or death. Some engines have a small hole in the bottom of the exhaust manifold, under the exhaust outlet, for moisture to escape. This hole may be plugged if exhaust gas escape is objectionable.

The muffler outlet is threaded for 1-1/4" standard pipe. If necessary to run an exhaust line upward from the plant, install a suitable condensation trap at the lowest point in the line and drain it regularly. Proper shielding must be provided if the exhaust line passes through an inflammable wall.

If desired, an underground muffler may be constructed. Use a heavy 10 gallon or larger tank or drum, welding suitable pipe fittings to the drum. Use 1-1/4" pipe between the plant muffler and the underground muffler. Bury the underground muffler in loose gravel, and see that the bottom of the drum is perforated to allow condensation to drain out. Extend the muffler outlet at least 24" above ground and fit it with a pipe gooseneck.

The site should be dry, clean, and well ventilated. Either a damp or a dusty condition will require more frequent inspection and servicing of the plant. Allow at least 24" space on all sides for ease in servicing.

If the plant is mounted aboard a truck or trailer, see that it is fastened securely when in transit, and that it sets in a level position when operating. Housed Plant mounting holes are 18" apart lengthwise of the plant and 20-3/4" crosswise of the plant. Unhoused Plant mounting holes are 17¼" apart lengthwise of the plant and 33" apart crosswise of the plant.

VENTILATION.- Proper cooling depends upon correct ventilation to dissipate the heat generated by the engine and generator. Separate air inlet and outlet openings must be provided if the plant is mounted in a small room or compartment.

FUEL SUPPLY, GASOLINE.- The fuel pump inlet has 1/8" pipe threads, into which a fitting for 1/4" flared tubing is installed, Be sure any fitting substituted has 1/8" male pipe threads, to fit the fuel pump inlet. Any tank used must be not more than 8 ft. below the fuel pump. Connections must be air tight to permit the fuel to reach the fuel pump. Observe local fire code specifications in making the installation.

NATURAL GAS OR VAPOR FUEL.- Some special model plants are equipped to burn LPG or natural gas fuel. Any applicable gas codes must be complied with when connecting the plant to a source of gas fuel. In some localities, presence of foreign matter in the gas supply may require installation of a fuel filter in the fuel supply line. The fuel inlet is threaded for 3/4" pipe.

NOTE

On natural gas installations the atmospheric regulator on the plant is designed to operate on a line pressure not to exceed 4.6 ounces. If the line pressure exceeds 4.6 ounces pressure, it will be necessary to install a primary regulator in the line to reduce the pressure before it enters the atmospheric regulator.

BATTERIES.- Two 6-volt batteries (or one 12-volt) are required. Use the short (6 inch) jumper cable to connect the positive (+) post of one battery to the negative (-) post of the second battery, connecting them in series for 12 volts. For housed plants, connect the battery cable which is attached to the start solenoid switch to the remaining positive (+) post of the batteries. Connect the grounded battery cable to the remaining negative (-) post of the batteries. It may be necessary to spread the positive cable clamp slightly to make it fit over the battery positive post. Do not pound on the clamps to force them down on the posts. Coat the clamps lightly with light grease or vaseline and tighten securely to the battery posts.

For unhoused plants, solderless screw type terminals are provided inside the rear of the control box atop the generator. Bring the battery cables in through the grommets at the rear of the control box. Use care to connect the battery cables to the proper terminals as marked on the control box. The negative battery cable must connect to the grounded terminal post inside the control box.

Batteries shipped "dry" must be prepared for use as directed on the tags attached to the batteries. Batteries shipped ready for use were fully charged at time of shipment. Such batteries slowly lose their charge when standing idle, and it may be found necessary to give them a "freshening" charge before putting them in use. Use a hydrometer to determine the charge condition.

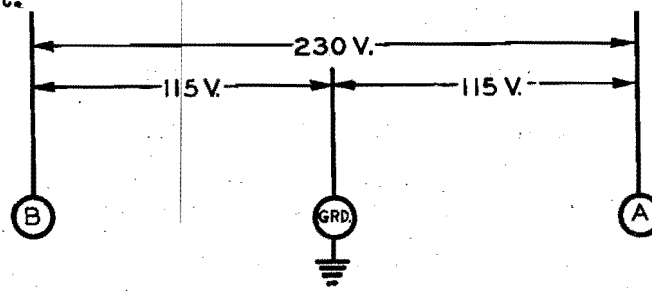
CONNECTING THE LOAD WIRES TO HOUSED PLANTS.- The AC output terminals are located behind the control panel, on the fuel tank support. Run the load wires through the hole in the rear panel, connecting them to the solderless connectors on the output terminals. Be sure to use the proper size insulated wire, taking into consideration the distance between the plant and the load, and the type of load. Consult a competent electrician, and observe applicable electrical codes in making the installation. See that the main line is protected by a fused main switch or a circuit breaker between the load and the generator. Refer to the plant wiring diagram, and follow the applicable directions given below for connecting the load wires.

115 or 230 VOLT, SINGLE PHASE, 2 WIRE PLANT

Connect the white or grounded load wire to the grounded plant terminal. Connect the other (black) load wire to the insulated plant terminal. If the control panel has a receptacle, a load not to exceed 15 amps may be connected to each outlet.

115/230 VOLT, SINGLE PHASE, 3 WIRE PLANT

The center terminal is grounded. For 115 volt current, connect the white or grounded load wire to the center terminal and the other load wire to either of the two outside terminals, A or B. 2500 watts are available on each 115 volt circuit, ground to A, and ground to B. For 230 volt current, connect the load wires to the two outside insulated terminals, A and B, leaving the center terminal unused. If the control panel has a receptacle, a load not to exceed 15 amps, 115 volts may be connected to each outlet.



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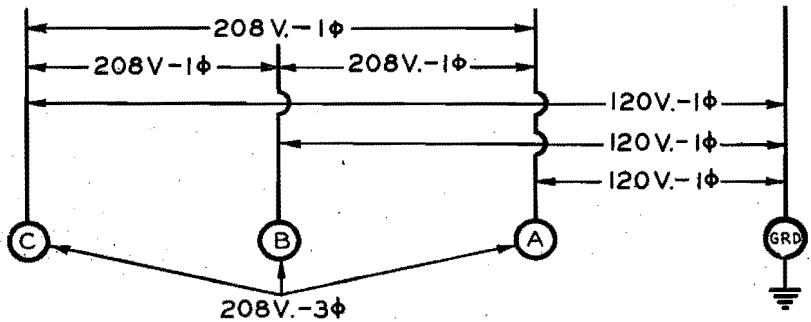
120 VOLT, SINGLE PHASE/208 VOLT, THREE PHASE - 4 WIRE PLANT

The terminal farthest from the generator is grounded. For 120 volt, single phase current connect the grounded load wire to the grounded terminal and the other load wire to any one of the other three insulated terminals, A, B, or C. For 208 volt, 3 phase current, connect a load wire to each of the three insulated terminals A, B, and C, leaving the grounded terminal unused. Reversing the connections between any two insulated terminals will reverse the direction of rotation of three phase motors. Use a phase sequence indicator to assure in-phase connection.

For 208 volt, single phase current, connect one of the two load wires to each of any two insulated terminals. 1666 watts are available on each single phase circuit.

If both single and three phase current is to be used at the same time, use care not to overload any one circuit. Subtract the amount of the 3 phase load from the plant capacity. Divide the remainder by 3, and this is the amount of load that may be taken from any one circuit for single phase current. For example, a 3 phase 2,000 watt load is used.

This leaves 3,000 watts available. Divide the 3,000 watts by 3, giving 1,000 watts, which is the amount that is available from each of the 3 single phase circuits. Do not attempt to take the entire 3,000 watts in this example off one circuit, as overloading the generator will result.



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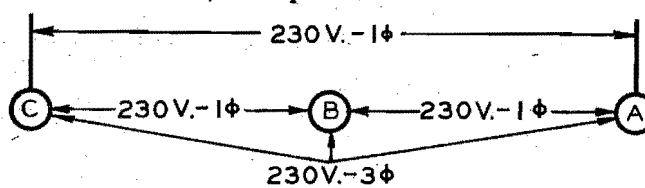
230 VOLT, THREE PHASE, 3 WIRE PLANT

No terminal is grounded. Reversing the connections between any two of terminals A, B, or C will reverse the direction of rotation of three phase motors. Use a phase sequence indicator to assure in-phase connection. 230 volt single phase current may be obtained by connecting one load wire to each of any two terminals. 1666 watts are available on each single phase circuit. If both single and three phase current is to be used at the same time, follow the principles of load balancing as directed above for the 4 wire plant.



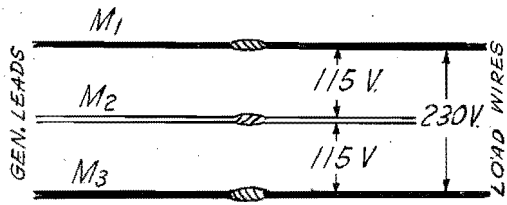
CONNECTING THE LOAD WIRES TO UNHOUSED PLANTS

The generator output leads are within the small outlet box at the rear of the generator. The load wires may be brought in through the desired knock-out hole of the box. Load wires must be of the proper size of insulated wire, taking into consideration the distance involved and the amount of the load. The installation must meet requirements of electrical codes which apply in the locality. Connections must be properly made and insulated. Install an approved switch or other device for disconnecting the plant from the load. Consult a licensed electrician if in doubt.

UNHOUSED 115 VOLT or 230 VOLT, SINGLE PHASE, 2 WIRE PLANT

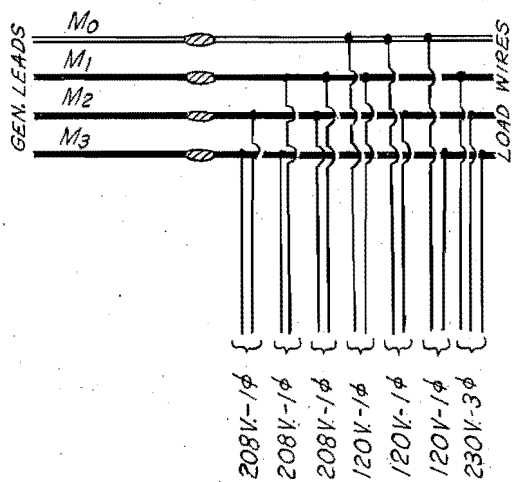
Connect the white or grounded load wire to the grounded generator lead marked M_2. Connect the other (black) load wire to the generator lead marked M1.

UNHOUSED 115/230 VOLT, SINGLE PHASE, 3 WIRE PLANT



The generator lead marked M2 is grounded. For 115 volt current, connect the white or grounded load wire to the M2 lead and the other (black) load wire to either the M1 or the M3 generator lead. 2500 watts are available on each 115 volt circuit, M2 to M1, or M2 to M3. For 230 volt current, connect one load wire to the M1 lead and the other load wire to the M3 lead, leaving the M2 lead unused. Thus 5000 watts of 230 volt current are available.

UNHOUSED 120 VOLT, SINGLE PHASE/208 VOLT, THREE PHASE - 4 WIRE PLANT



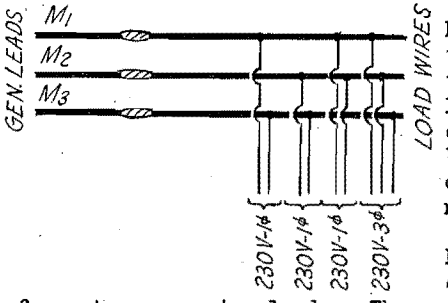
The generator lead marked M0 is grounded. For 120 volt, single phase current connect the white or grounded load wire to the generator lead marked M0 and the other (black) load wire to any one of the other three generator leads marked M1, M2, or M3. Three separate 120 volt circuits are thus available: M0 to M1, M0 to M2, and M0 to M3. When using single phase current, not more than one third of the capacity of the generator is available on each of the three single phase circuits. Divide the load as equally as possible between the three single phase circuits.

For 208 volt, single phase current, the M0 generator lead is not used. Connect separate load wires to any two of the M1, M2 or M3 generator leads. Three separate single phase circuits are available: M1 to M2, M1 to M3, and M2 to M3. As when connected for 120 volts, the load should be divided between the three single phase circuits. For 208 volt, three phase current, the M0 generator lead is not used. Connect the three load wires to the generator leads M1, M2, and M3, one load wire to each generator "hot" lead. Reversing the connections between any two leads will reverse the direction of rotation of 3 phase motors. A phase sequence indicator may be used to assure in-phase connection when necessary. If both single phase and three phase current is used at the same time, use care not to overload or unbalance the generator. Subtract the amount of the three phase load from the total capacity of the generator. Divide the remainder by three to determine the amount of load which may be connected to each single phase circuit. Refer to the "housed plant" load connections for an example.

UNHOUSED 220/380 VOLT, THREE PHASE - 4 WIRE PLANT

The load wires are connected to this plant the same as to the preceding 120/208 volt plant. For a 220 volt circuit use the connections for the 120 volt circuit. For a 380 volt circuit use the connections shown for the 208 volt circuit.

UNHOUSED 230 VOLT, THREE PHASE, 3 WIRE PLANT



No generator lead is grounded. For three phase current, connect the three load wires to the generator leads M1, M2, and M3, one wire to each lead. Reversing the connections between any two leads will reverse the direction of rotation of 3 phase motors.

For 230 volt, single phase current, connect a separate load wire to each of any two generator leads. Three separate single phase circuits are thus available: M1 to M2, M1 to M3, and M2 to M3. Not more than one third of the generator capacity is available on each single phase circuit.

If both single and three phase current is used at the same time, follow the principles of load distribution as directed for the 4 wire plant.

REMOTE CONTROL CONNECTIONS

A small, four place terminal block is mounted in the unhoused plant control box, or on the housed plant fuel tank support. To provide for remote control of starting and stopping the generating plant, connect one or more remote control switches to this terminal block. If installed within 250 feet of the plant, use #18 or #19 wire. Use #16 wire up to 500 feet, or #14 wire up to 1000 feet. Connect the switch terminals #1,

2, and 3 to the corresponding terminals marked 1, 2, and 3 on the terminal block. Be sure to connect switch terminal #1 to the #1 terminal on the terminal block. Any additional switches must be connected in parallel, all #1's together, all #2's together, etc.

If automatic or line failure controls are to be connected, follow the directions for connections as supplied with the control equipment.

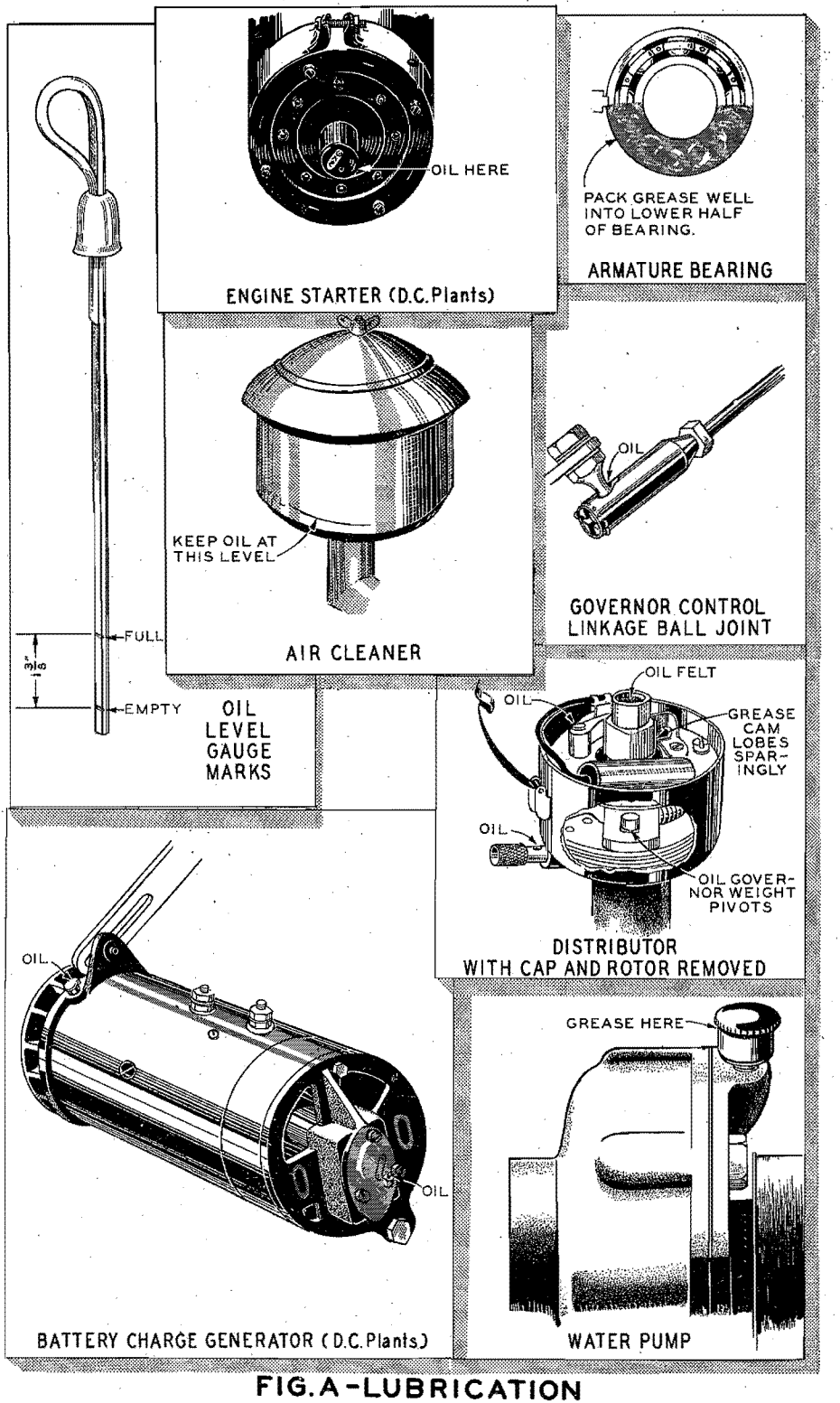


FIG. A - LUBRICATION

PREPARATION FOR OPERATION.- Before putting the plant in operation, it must be supplied with fuel, oil, and water (or antifreeze liquid). Comply with the following instructions.

LUBRICATION.- Refer to Fig. A. Use approximately 3 quarts (U. S. Measure) of a good quality heavy duty (detergent) type oil to fill the crankcase to the high level mark on the bayonet type gauge. Approximately 1 quart of oil remained in the oil filter when the crankcase was drained at the factory. Do not use an oil heavier than SAE number 20 in a plant being put into service the first time. After the first oil change, use an oil of the proper SAE number as indicated in the following table, according to the lowest temperature to which the plant will be exposed when not running. Temperatures indicated are for conditions where the plant will be standing idle long enough to cool to the surrounding temperature.

LOWEST TEMPERATURE	SAE NUMBER OF OIL
100° F. (38° C.)	40
32° F. (0° C.)	30
0° F. (-18° C.)	20
Below 0° F. (-18° C.)	5W

See ABNORMAL OPERATING CONDITIONS

The crankcase oil capacity is 3 quarts (U. S. Measure), plus approximately 1 quart used in the operation of the oil filter. When a new oil filter element is installed, it will be found that the element will absorb approximately 1 quart of oil.

The use of a heavy duty (detergent) type oil will greatly increase the life of pistons and rings. If a change to a heavy duty type oil is made after using non-detergent oil in this plant, allow not more than one third the usual operating hours between the next two oil changes. Thereafter change the crankcase oil at the regular periods, as recommended under PERIODIC SERVICE.

CAUTION

When using a detergent type oil, always use oil of the same brand when adding oil between changes. When mixed together, detergent oils of different manufacturers sometimes form chemical compounds that are harmful to internal engine parts.

Keep the crankcase oil level at or near the upper level mark on the oil level gauge, but not above it. If the crankcase is overfilled, the connecting rods may strike the oil, causing improper lubrication and excessive oil consumption. Never allow the oil level to fall below the low level mark on the oil level gauge.

Remove the air cleaner top and fill the cup to the level indicated with oil of the same SAE number as that used in the crankcase, except as instructed under ABNORMAL OPERATING CONDITIONS - COLD TEMPERATURES.

Fill the oil cup on the side of the distributor.

Place a drop of oil on each of the governor to carburetor link ball joints.

It is unnecessary to lubricate the generator bearing and water pump until time to do so as noted under PERIODIC SERVICE.

FUEL, GASOLINE.- Use only a good grade, clean, fresh, regular automotive type gasoline of 68 to 74 octane rating. Do not use any highly leaded premium type of gasoline. The use of any gasoline which has a high lead content will necessitate more frequent carbon removal, spark plug, and valve servicing. However, do not use a low octane gasoline, such as "stove" gas, as its use will cause excessive detonation or "spark knock", and damage to engine bearings, valves, rings, etc.

If the plant has the mounted fuel tank, do not fill the tank entirely full of cold gasoline, as the fuel may expand as the plant warms up, causing the gasoline to overflow. Observe the usual precautions when handling gasoline. Do not fill the tank when the plant is running.

On plants equipped with the mounted fuel tank, note that the electric fuel gauge on the control panel registers the amount of fuel in the tank only when the plant is running. If it is desired to check the fuel when the plant is stopped, throw the ignition switch to the HAND START position while making the observation. Be sure to return the switch to the ELECT. START position.

If an auxiliary fuel tank is used, connection may be made to the two way fuel shut-off valve at the bottom of the tank mounted on the plant.

FUEL, NATURAL GAS OR LPG.- Make sure that fuel supply lines (and tanks, if used) have been properly installed and connected.

RADIATOR.- The capacity of the cooling system is approximately 11 quarts (U. S. Measure). See that the radiator and cylinder block drain cocks are closed. Fill the radiator with clean, alkali-free water such as clean rainwater. The use of a rust and scale inhibitor is recommended. If the plant will be exposed to freezing temperatures, use a standard anti-freeze in the proper proportion. To avoid loss of anti-freeze through the overflow pipe due to expansion, fill only to approximately 2 inches below the bottom of the filler neck. Check the cooling system to see that there are no leaks.

If the foregoing instructions have been carefully complied with, the plant should be ready for operation. However, before starting the plant, carefully study the paragraphs under the headings OPERATION and ABNORMAL OPERATING CONDITION immediately following.

PRELIMINARY.- Be sure that the plant has been properly installed and prepared for operation before starting it. Turn on the fuel supply and check for leaks, correcting any that may be found. See that the circuit breaker handle is in the OFF position, so that no load is connected.

CAUTION

> If the preparation has been made for extremely cold weather, using diluted No. 10W oil, the initial filling of the crankcase with diluted oil should have been left to be done immediately before starting the plant. Be sure the crankcase is filled with the proper oil to the high level mark on the bayonet gauge.

Oil was sprayed into the cylinders before the plant was shipped, and it may be necessary to remove and clean the spark plugs in gasoline before the engine will start the first time. Dry the plugs before reinstalling them.

STARTING THE PLANT ELECTRICALLY.- See that the ignition switch is set at the ELEC. START position. If the plant is to be operated on gasoline fuel, press the START button firmly for several seconds to allow the fuel pump to become full and to pump gasoline into the carburetor. The carburetor is automatically choked, and the engine should start after a few seconds of cranking. Hold the start button in until the plant has reached running speed. If it does not start, do not press the START button continuously, but for periods of not more than five seconds at a time, with equivalent stops between. If the plant fails to start after a few attempts, check the fuel and ignition systems and repeat the procedure after correcting the trouble.

If the plant is equipped for natural or Liquid Petroleum Gas operation, see that the arm of the choke control mounted upon the exhaust manifold is locked down so as to make the choke inoperative. No choking is necessary when operating on gas, and the carburetor choke valve should be wide open. See that the gasoline supply is turned off, and that there is no gasoline in the carburetor bowl. Turn on the fuel supply and press the START button. The regulator primer button, at the center of the regulator, may have to be pushed to start the engine the first time. Do not overprime. Unless the fuel to be used is of approximately the same BTU rating as that used by the manufacturer (1000 BTU) it will be necessary to readjust the carburetor gas adjustment valve to insure smooth and economical operation. See the section headed ADJUSTMENTS.

STARTING THE PLANT MANUALLY.- If gasoline fuel is used, use the hand crank to turn the engine over enough times to fill the fuel pump and carburetor. Throw the ignition switch to the HAND START position. Crank the engine with a quick upward pull. If the plant is equipped with the Sisson automatic choke, have some one pull up on the automatic choke arm while cranking. Some plants are specially equipped with a low oil pressure ignition cut-off switch. These special plants have a momentary contact, toggle type switch located at the front of the plant. This

switch by-passes the low oil pressure cut-off when in contact. Hold this toggle switch in contact while manually cranking the engine, and hold in contact until the plant has reached running speed. If the plant is equipped with a manually operated choke, operate the choke as required by temperature conditions. Do not spin the crank or press down on it. If gas fuel is being used, it may be necessary to press the regulator priming button, at the center of the regulator, to start the engine the first time. Do not overprime. For manually starting a plant equipped for gas fuel, the gas should have a BTU rating above 800 BTU per cu. ft. The temperature should be above 30° F. (-1° C.). See that the automatic choke arm is locked down. After the carburetor gas adjustment valve has been properly adjusted, it should be unnecessary to use the priming button. After the plant starts, be sure to return the ignition switch to the ELECT. START position.

CAUTION

KEEP THE IGNITION SWITCH AT THE ELECT. START POSITION AT ALL TIMES EXCEPT WHEN ACTUALLY STARTING THE PLANT MANUALLY. THROW THE SWITCH TO THE HAND START POSITION WHILE CRANKING THE PLANT MANUALLY, BUT RETURN IT TO THE ELECT. START POSITION AS SOON AS THE PLANT STARTS. WHILE THIS SWITCH IS AT THE HAND START POSITION THE HIGH WATER TEMPERATURE CUT-OFF SWITCH (AND LOW OIL PRESSURE SWITCH, IF THE PLANT IS SO EQUIPPED) IS CUT OUT OF THE CIRCUIT AND THE PLANT IS NOT PROTECTED AGAINST OVERHEATING. IF THE SWITCH IS LEFT AT THE HAND START POSITION WHEN THE PLANT IS NOT RUNNING, THE BATTERY MAY BECOME DISCHARGED AND THE IGNITION COIL DAMAGED.

If the plant will start but does not continue to run, when electrically cranked, possibly the start button is being released too soon. If not, try starting the plant manually. If the plant starts and continues to run with the ignition switch at the HAND START position, but stops when thrown to the ELECT. START position, trouble is indicated in one of the relays, the high water temperature switch, or a loose connection.

CHECKING THE OPERATION.- After the plant starts, allow the engine to reach operating temperature. Check the level of the coolant in the radiator, as the thermostat may have allowed an air pocket to form, thus preventing complete filling. Add coolant to bring the level to the proper point, if necessary. The oil pressure should be between 20 and 40 pounds, the coolant temperature approximately 150° to 180° F. (65° to 82° C.), and the battery charge rate between 2 and 7 amperes, depending upon the charge condition of the batteries.

When the plant is not in operation, the water temperature gauge will register 212° F. The fuel gauge, oil pressure gauge, and charge ammeter will register zero. If it is desired to check the water temperature or fuel supply when the plant is not running, throw the ignition switch to the HAND START position while making the observation. Be sure to return the switch to the ELECT. START position after making the observation. While the plant is running, the various gauges are automatically in operation when the ignition switch is at the ELECT. START position.

Connect a load to the plant by throwing the main line switch, or control panel circuit breaker if the plant is so equipped, to the ON position. The no load voltage is approximately 125 volts for the 115 volt plant, after the plant has reached operating temperature. The full load voltage is approximately 108 volts, for a 115 volt plant. Voltage will be correspondingly higher for plants of other voltages. If the plant tends to surge, or the voltage tends to fluctuate, it is usually an indication the engine needs additional warm-up before connecting a heavy load. Those plants which are equipped with the electrical meter panel have a circuit breaker which will automatically disconnect the load if the plant is severely overloaded. If the plant is not equipped with the circuit breaker, keep the correct size fuse in the load line switch. Those plants equipped with an output receptacle on the panel will not register on the meters any load which may be connected to the receptacle. This receptacle is provided for a trouble light or similar light load up to 15 amps., 115 volts for each outlet.

Continuous overloading of the generator will cause the generator temperature to rise to a dangerous point and lead to early failure of the windings. If the main line fuse should blow out or the plant circuit breaker open, remove the cause of overloading before again connecting the load to the plant. On the three phase plant, if part of the load is single phase, the total load on any one "leg" should not exceed one third the total capacity of the generator. On the 115/230 volt plant, divide the load as closely as possible between the two circuits when using 115 volt current. Confine the load on each 115 volt circuit to not more than 2500 watts.

HIGH WATER TEMP. SWITCH.- The high water temperature switch is standard equipment on the housed type of plant. This switch is optional equipment on other models. If the engine water temperature rises to a dangerous point, the cut-off switch operates to automatically close the stop circuit, having the same effect as pressing the stop button on the plant. The engine must cool off approximately 10° F. before it can be restarted, after the cut-off switch has operated. Before attempting to start the plant after the cut-off switch has operated, determine and correct the cause of the high temperature.

LOW OIL PRESSURE SWITCH.- Some plants are equipped with a low oil pressure cut-off switch. On these plants, if the engine oil pressure falls to approximately 6 pounds, the cut-off switch operates to close the stop circuit, stopping the plant. Determine and correct the cause of the low oil pressure before attempting to again start the plant.

EMERGENCY OPERATION

If a burned out relay, switch, or other temporary difficulty prevents normal operation of the plant with the ignition switch at the ELECT. START position, the plant may be run temporarily with the switch at the HAND START position. This is purely an emergency measure and should be resorted to only if necessary. The starting batteries will not receive any charging current, and all relays, etc. are cut out of the engine control circuit. Keep a careful check on the plant while operating under these conditions.

STOPPING THE PLANT.- To stop the plant, press the STOP switch momentarily. The stop circuit will not work if the ignition switch is at the HAND START position. In an emergency, if the stop circuit fails to work, stop the plant by turning off the fuel supply.

LOW TEMPERATURES

Lubrication, fuel, and the cooling system require special attention at temperatures below 32° F. (0° C.).

CRANKCASE OIL.- If the plant must be started after standing unused in temperatures between 32° F. (0° C.) and 0° F. (-18° C.) use a good quality oil of SAE number 20W in the crankcase. For temperatures below 0° F. (-18° C.) use SAE number 5W oil. The oil should be the detergent, or heavy duty type.

If number 5W oil is not obtainable, dilute number 10W oil with approximately 1 part of kerosene to 4 parts of oil. Thoroughly mix the oil and kerosene just before pouring into the engine. Immediately start the plant and run for at least 10 minutes to thoroughly circulate the mixture through the engine. Do not put diluted oil into the engine until ready to start the plant. Mix the oil well just before pouring it into the engine. Always use a mixture of the same proportions when adding oil between changes. When using diluted oil, change the oil every 25 operating hours and check the oil level frequently. Use undiluted oil again as soon as temperature conditions permit.

CAUTION

Always drain the oil only when the engine is warm.
Drain the oil filter when changing to a lighter oil.
Add sufficient oil to compensate for that used to fill the oil filter.

AIR CLEANER.- If congealed oil or frost formation within the air cleaner restricts the air flow, remove and clean the air cleaner. Reassemble and use the air cleaner without oil until conditions permit the use of oil in the normal manner.

COOLING SYSTEM.- The coolant must be protected if there is any possibility of its freezing. Use any good antifreeze, in the proportion recommended by the manufacturer for the lowest temperature to which the plant will be exposed. The capacity of the cooling system is approximately 11 quarts.

If the plant is to be stored in freezing temperatures, without adding anti-freeze solution, be sure to open the cylinder block drain cock to thoroughly drain all water from the block, after draining the radiator.

If the water temperature gauge shows the engine to be operating too cool, a portion of the radiator surface may be covered to raise the coolant temperature to normal. Avoid overheating. Set the high water temperature cut-off switch to operate at a temperature several degrees below the boiling point of the coolant, taking into consideration the altitude at which the plant is operating, and the type of anti-freeze solution used. Check the antifreeze solution frequently.

FUEL, GASOLINE.- Use fresh, clean, high test (not highly leaded, premium) gasoline for easy starting in cold weather. Keep the fuel tank nearly full in order to prevent moisture condensation within the tank, which can cause considerable trouble from ice formation in the fuel system. Do not fill the fuel tank entirely full of gasoline, for expansion as the plant warms up may cause it to overflow.

FUEL, GAS OR VAPOR.- Some types of Liquid Petroleum Gas will not vaporize readily at low temperatures. Heat exchanger equipment is available, at extra cost, and should be installed at the factory if temperature conditions require it.

BATTERIES.- Check the charge condition of the batteries frequently, to be sure that they are kept in a fully charged condition. A discharged battery will freeze at approximately 20°F. (-7°C.) and be permanently damaged. A fully charged battery will not freeze at -90°F. (-67°C.). Run the plant for at least 20 minutes after adding water, to assure mixing the water with the electrolyte.

HIGH TEMPERATURES

If the plant is to be operated in abnormally high temperatures (above 100°F., or 38°C.), provide sufficient air circulation for proper cooling. Keep the cooling system clean and free of rust and scale. See that the high water temperature cut-off switch is correctly set, and that the ignition switch is at the ELECT. START position. Keep the ignition timed correctly. Keep the radiator well filled, the fan belt tension properly adjusted, and the crankcase oil level at, but not above, the upper level mark on the oil level gauge.

CAUTION

For best cooling effects, keep the door panels in place on the plant when it is in operation.

Use SAE number 30 oil for temperatures up to 100°F. (38°C.) and SAE number 40 for higher temperatures. Check the oil level frequently, and change the crankcase oil at least every 50 hours. Keep the electrolyte level in the batteries up to normal.

DUST AND DIRT

Keep the plant as clean as practicable. Service the air cleaner as frequently as conditions require. Keep the radiator fins clean and free of obstructions. Keep the generator commutator and slip rings and brushes clean. See that all brushes ride freely in their holders. Keep oil and gasoline supplies in air tight containers. Install a new oil filter element as often as necessary to keep the oil clean. Change the crankcase oil more frequently if it becomes discolored before the normal time has elapsed between changes.

PERIODIC SERVICE

GENERAL.- Follow a definite schedule of inspection and servicing to assure better performance and longer life of the plant at minimum expense. Service periods outlined below are for normal service and average operating conditions. For extreme load conditions, or abnormal operating conditions, service more frequently. Keep a record of the hours of operation each day to assure servicing at the proper periods.

DAILY SERVICE

If the plant is operated more than 8 hours daily, perform the DAILY SERVICE operations every 8 hours.

FUEL.- If the plant is operated on gasoline fuel, check the fuel gauge often enough to assure a continuous fuel supply. Do not fill the tank while the plant is running.

RADIATOR.- Check the level of the coolant and, if necessary, add sufficient liquid to bring the level up to within one or two inches of the bottom of the filler neck. In freezing weather, if a nonpermanent type antifreeze is used, check the protective strength of the coolant.

AIR CLEANER.- Check the oil level in the air cleaner cup and add sufficient oil to bring it to the indicated level. Clean out and refill the oil cup if dusty conditions prevail.

CRANKCASE OIL LEVEL.- Check the oil level as indicated on the bayonet type oil level gauge. Do not allow the engine to operate with the oil level close to the low level mark on the gauge. Add sufficient oil of the proper SAE number to bring the level to the upper level mark, but do not overfill the crankcase.

CLEANING.- Keep the plant as clean as possible. A clean plant will give longer and more satisfactory service.

WEEKLY SERVICE

If the plant is operated more than 50 hours a week, perform the WEEKLY SERVICE operations every 50 hours.

CRANKCASE OIL.- Add crankcase oil as necessary, or change the oil after 50 operating hours. If the plant has been operating with diluted oil, change the oil after 25 hours operation.

GENERAL LUBRICATION.- Put a drop of light lubricating oil on each of the governor to carburetor link ball joints, and fill the distributor oil cup. Put several drops of oil in the oil holes at each end of the battery charging generator, and in the oil hole at the forward end of the starting motor of the direct current, battery ignition plant.

AIR CLEANER.- Clean the air cleaner filter element and cup thoroughly in gasoline or other suitable solvent. Allow to dry, or use compressed air to dry. Refill the cup to the indicated level with clean oil of the same SAE number as that used in the crankcase, except as noted under ABNORMAL OPERATING CONDITIONS.

FAN BELT.- Check the fan belt tension. Adjust to permit about 3/4" play when pressure is applied midway between the fan and crankshaft pulleys. See ADJUSTMENTS section. Install a new belt if the old one is badly worn.

BATTERIES.- See that battery connections are clean and tight. Keep the electrolyte level at the proper level above the plates by adding only clean water which has been approved for use in batteries. In freezing weather, run the plant at least 20 minutes after adding water, to mix the water with the electrolyte.

SPARK PLUGS.- Clean the spark plugs and check the electrodes gap. Keep the gap adjusted to 0.025". More frequent spark plug service may be necessary if leaded gasoline is used.

WATER PUMP LUBRICATION.- Use a good grade of water pump grease in the water pump grease cup. Turn the grease cup cap down 1 turn each 50 hours of operation. If grease appears in the coolant, the water pump is being overlubricated. To correct, turn the cap down less than 1 turn.

DISTRIBUTOR.- Check the distributor contact points. If they are only slightly burned or pitted, remove and resurface them on a fine stone. Install new contact points if the old ones are badly burned. Keep the gap adjusted to 0.020". Excessive burning or pitting of the points indicates a faulty condenser, which should be replaced with a new one.

MONTHLY SERVICE

If the plant is operated more than 200 hours a month, perform the MONTHLY SERVICE operations every 200 hours.

FUEL SYSTEM.- Remove the pipe plug at the bottom of the carburetor and drain the carburetor of any sediment which may have accumulated.

Remove the cover and filter screen from the fuel pump. Clean the screen thoroughly. Reassemble the screen and cover. Be sure the cover gasket is in good condition. Be sure there are no leaks at any point in the fuel system.

DISTRIBUTOR.- Place one drop of light oil on the distributor breaker arm pivot pin, several drops on the felt pad under the rotor, and three or four drops on the flyweight mechanism, distributed where it will reach friction points. Place a light coating of grease on each cam lobe, where the breaker arm block rubs.

EXHAUST SYSTEM.- Inspect all exhaust connections carefully. Make any necessary repairs.

COOLING SYSTEM.- In some localities, presence of lime or mineral deposits in the water may necessitate frequent flushing of the plant cooling system. Remove the top and bottom radiator hoses. If available, connect a source of water under pressure to the bottom of the radiator and reverse flush until the water runs clear from the top radiator connection. Repeat the operation on the engine, reversing the usual flow by running the water in at the outlet elbow. Make sure hose connections are tight when refilling the cooling system.

OIL FILTER.- If the crankcase oil is becoming discolored, remove and discard the oil filter element. Clean out the oil filter and install a new element. The new filter element will absorb approximately one quart of oil when the plant is started up. After a short running period, stop the plant and check the crankcase oil level. Add oil as necessary to bring the oil up to the proper level.

ENGINE COMPRESSION.- Check the compression of each cylinder, using a compression gauge. Compression of a new engine when hand cranked is approximately 70 pounds. A difference of more than 10 pounds pressure between cylinders indicates a compression loss which should be corrected. High compression is an indication of excessive carbon or lead deposits in the combustion chambers.

CARBON REMOVAL.- The frequency of necessary carbon and lead removal servicing will vary with the type of fuel used. When a highly leaded gasoline is used, it may be necessary to remove lead deposits more frequently than every 200 operating hours. Remove the cylinder head and clean all carbon and lead deposits from the tops of pistons, valves, and top surface of the cylinder block. Clean the deposits from the cylinder head. If necessary, grind the valves to a good seat.

GENERATOR.- Check the condition of the commutator, collector rings, and brushes. In service, the commutator and collector rings acquire a glossy brown color, which is a normal condition. Do not attempt to maintain a bright, metallic, newly machined finish. If the commutator or collector rings become heavily coated, clean with a lint free cloth. Slight roughness may be remedied by lightly sanding with #00 sandpaper. Clean out all carbon and sandpaper dust.

When brushes are worn so that the top of the brush is below a point midway between the top and bottom of the brush holder, replace the brushes with new ones. Brushes must ride freely in their holders, and spring tension should be uniform. Commutator brush spring tension is approximately 30 oz. and collector ring brush spring tension is approximately 16 oz. Tension should be measured with the free end of the spring level with the top edge of the brush holder.

Check the brush rig for proper alignment of the reference marks on the brush rig and its support. See Maintenance and Repair, Brush Rig.

GENERAL.- Thoroughly inspect the plant for oil or water leaks, loose electrical connections, and loose bolts or nuts. Make any necessary repairs.

SEMI-YEARLY SERVICE

Every 6 months or 1200 operating hours, whichever occurs first, service the generator ball bearing.

Remove the plate from the housing rear end. Thoroughly clean all dirt from around the generator bearing cover and remove the cover and gasket. Remove the old lubricant from the bearing with a clean finger. Work about one tablespoon of new ball bearing lubricant into the bearing and again remove the lubricant. Refill the bearing housing about one half full of bearing lubricant, packing it well into the lower half of the bearing. Be sure that no dirt gets into the bearing. Reinstall the bearing cover, using a new gasket if necessary.

CARBURETOR, GASOLINE.- The carburetor should require no servicing other than keeping it clean and free of sediment. When cleaning jets and passages, use compressed air or a fine, soft copper wire. Be sure that all gaskets are in their proper place when reassembling.

Changes in the type of fuel used, or in operating conditions may necessitate a readjustment of the carburetor. The main jet is not adjustable and its size has been selected to give the best performance. The idle adjustment needle should be adjusted to give the smoothest operation at no load. Turn the idle adjustment needle out, counterclockwise, until the engine begins to misfire, then turn the needle in, clockwise, until the engine runs smoothly. Adjust the throttle lever stop screw so that there is 1/32" space between the screw end and the throttle stop when the plant is operating at no load.

CARBURETOR, GAS OR VAPOR.- A change in the BTU rating of the fuel used will probably necessitate readjusting the knurled head gas adjustment valve at the bottom of the carburetor. With a full load on the plant, turn the adjusting valve in (clockwise) until the voltage as shown on the AC voltmeter drops noticeably, or the engine begins to lose speed. Turn the screw slowly out (counterclockwise) until the voltage rises to normal and the engine runs smoothly. If it is necessary to open the adjustment much beyond the point where normal voltage is attained in order to obtain smooth operation, a readjustment of the governor may be necessary. Check the operation at various loads. There is no idle adjustment necessary for gas or Butane-Propane vapor operation except to see that the throttle lever stop screw is adjusted to 1/32" clearance between the screw end and the throttle stop with the plant operating at no load.

ELECTRIC CHOKE.- The choke was adjusted at the factory to operate at a temperature of 70°F. or 21°C. In extremely cold temperatures, the choke may close so tightly that it will cause overchoking. In extremely high temperatures a reverse situation may occur. To readjust this type of choke to function properly in very cold temperatures, loosen the choke thermostat housing lockscrew and turn the thermostat housing slightly to the left (counterclockwise). To readjust the choke for very high temperatures turn the thermostat housing to the right (clockwise). Be sure to tighten the lockscrew after making the adjustment.

SISSON CHOKE.- Some plants are equipped with the Sisson choke control mounted on the exhaust manifold. This type choke control should not require seasonal adjustments, but may be readjusted in the following manner. Turn the shaft of the control to the position where a 3/32" diameter rod or nail may be passed down through the hole in the end of the shaft opposite the lever. Engage the rod or nail in the notch in the mounting flange of the control. Loosen the lever clamp screw just enough to allow the lever to be turned slightly. To adjust the choke for a leaner mixture, push the lever downward. To adjust the choke for a richer mixture, pull the lever upward. Retighten the lever clamp screw, and remove the rod from the hole in the shaft. Check to see that there is no binding or sticking action.

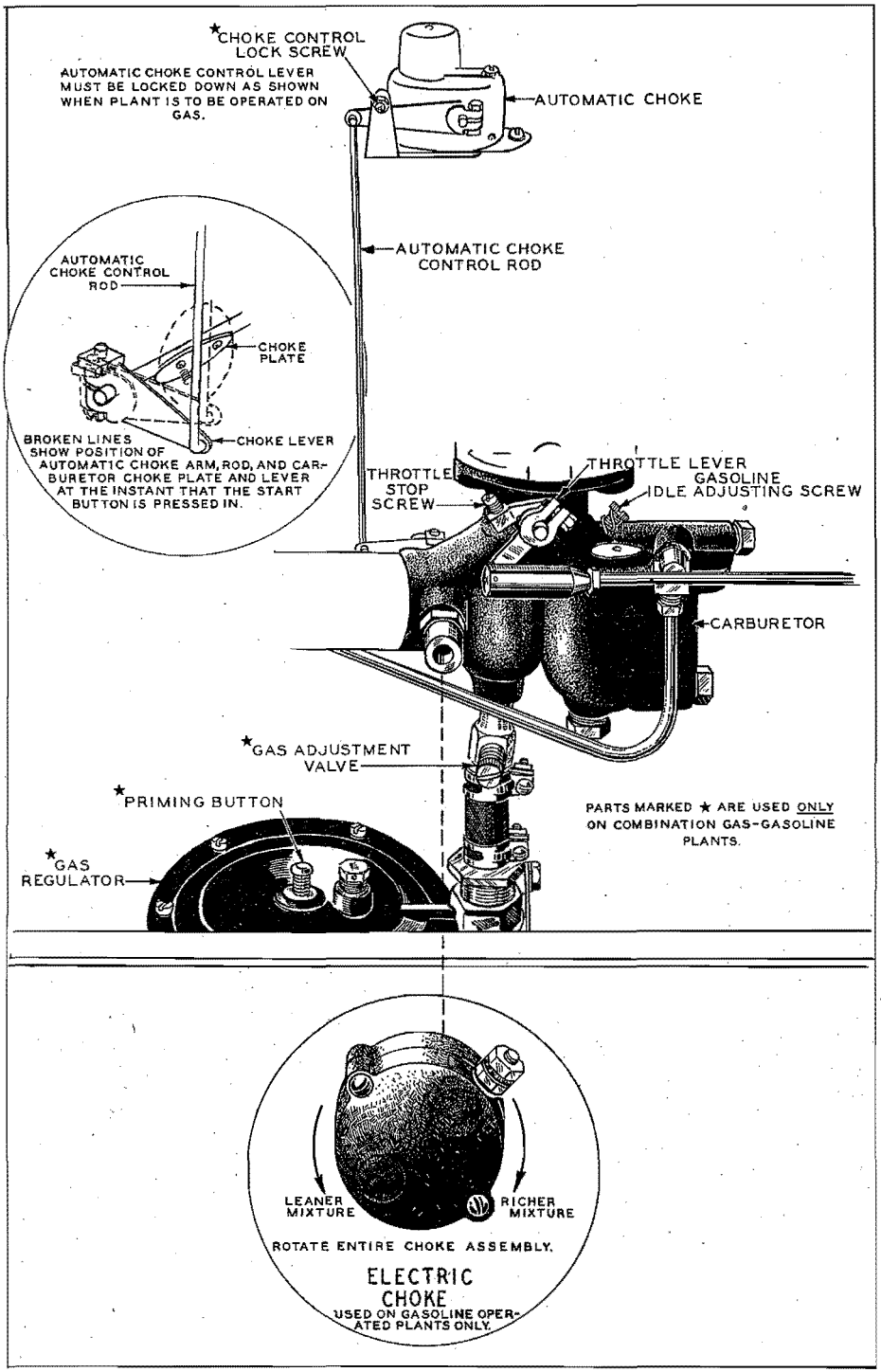


FIG.B–CARBURETOR AND CHOKE ADJUSTMENT

GOVERNOR.- The governor controls the speed of the engine, and therefore the voltage and frequency of the current. Proper governor adjustment may be made as follows, referring to Fig. C. Use a voltmeter while making the adjustments.

1. With the engine stopped, and tension on the governor spring, adjust the governor linkage length so that the carburetor throttle stop lever clears the stop pin by not less than 1/64" as shown.

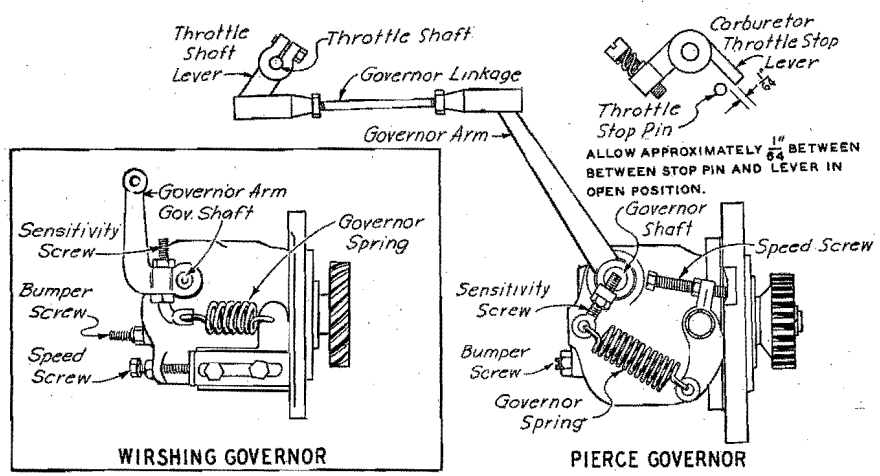
2. Start the plant and allow it to reach operating temperature.

3. With no electrical load connected, adjust the speed screw to the point where the voltage is approximately 126 volts for a 115 volt AC plant, or 121 volts for a DC plant. Apply a full load to the plant and check the voltage. It should be approximately 108 volts for a 115 volt AC plant, or 110 volts for a DC plant. Voltages will be proportionally higher for 230 volt plants, or lower for 208 volt plants. Engine speed, as checked with a tachometer should be within the limits of 1890 r.p.m. at no load to 1745 r.p.m. at full load for an AC plant. The DC plant engine speed should be within 1800 r.p.m. and 2000 r.p.m., with a spread between no load and full load of not more than 100 r.p.m.

4. If the plant tends to hunt (alternately increase and decrease speed) under load conditions, increase very slightly the distance between the eye of the sensitivity screw and its support. For best regulation keep the screw in as close as possible without causing hunting. ANY CHANGE IN THE SETTING OF THE SENSITIVITY SCREW WILL REQUIRE CORRECTING THE SPEED SCREW ADJUSTMENT.

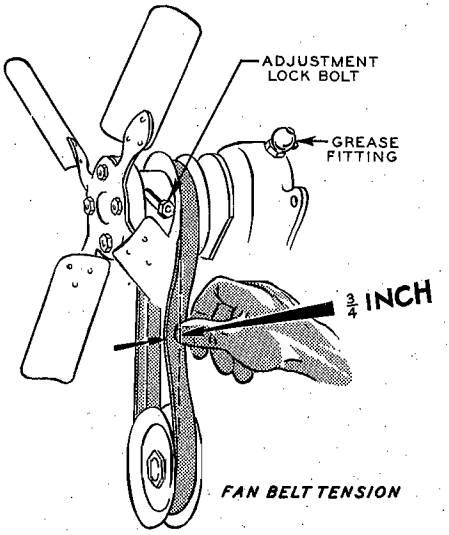
5. If hunting occurs at NO LOAD, screw the small bumper screw in until the hunt is stopped, but not far enough to increase the engine speed. CAUTION: Be sure all load is removed when adjusting the bumper screw.

Be sure that all lock nuts are tightened as adjustments are completed. The governor can not operate properly if there is any binding, sticking, or excessive looseness in the connecting linkage or carburetor throttle assembly. A lean fuel mixture, or a cold engine may cause hunting. If the voltage drop is excessive when a full load is applied, and adjustments are correctly made, it is probable that the engine is low on power and should be repaired as necessary.

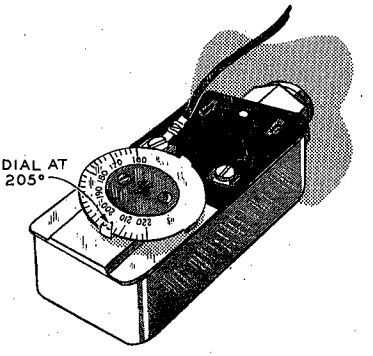


HIGH WATER TEMPERATURE SWITCH.- The high water temperature switch operates to stop the engine if the coolant temperature rises too high. This prevents overheating, which could cause serious damage to the engine parts. The engine may be started again when the coolant temperature drops approximately 10°F. The dial adjustment should be set to operate at a temperature several degrees below the boiling point of the coolant, taking into consideration the altitude at which the plant is operating. Lower the setting 3°F. for each 1000 feet above sea level. The dial was set at 205°F. at the factory. Do not set the switch to operate at too low a temperature, or the engine may be stopped before it reaches normal operating temperature. The switch will not operate if the ignition switch is at the HAND START POSITION.

FAN BELT TENSION.- The fan belt tension is regulated by the width of the fan pulley groove. The front half of the pulley turns on the hub. By loosening the two lock bolts and turning the front half of the pulley clockwise, the pulley groove is narrowed and the belt tightened. Turn the pulley counterclockwise to widen the pulley groove and lessen the belt tension. Allow 3/4" play in the belt as shown in the illustration, Fig. D. Too tight a belt will have a short life and cause excessive strain and wear on the water pump bearings. A belt too loose will slip, wear out rapidly, and will result in inefficient cooling. Be sure that the adjustment lock screws are properly tightened. Check these screws frequently, even when no adjustment is necessary.



FAN BELT TENSION



HIGH WATER TEMPERATURE CUT-OFF SWITCH

FIG.D

GENERAL.- Refer to the SERVICE DIAGNOSIS section for assistance in locating and correcting troubles which may occur. The information in this section is intended to assist in properly maintaining the equipment and in making repairs. Should a major overhaul become necessary, it is recommended that the plant be carefully checked and all necessary repairs made by a competent mechanic who is thoroughly familiar with modern internal combustion engines and revolving armature type generators.

ENGINE

TIMING GEARS.- The crankshaft and camshaft timing gears are keyed to their respective shafts. The camshaft gear is fastened with a large hexagon nut and locking washer. The gears may be removed with a gear puller. Always install both gears new when either needs replacing, never one only. The crankshaft gear has one tooth punch-marked, which must mesh with the two teeth punch-marked on the camshaft gear. See the illustration, TIMING GEARS, Fig. E.

TAPPET ADJUSTMENT.- The tappet adjustments may be reached by removing the valve chamber cover. The tappets are the adjustable screw type, requiring three wrenches to adjust. See the illustration, TAPPET ADJUSTMENT, Fig. F.

Adjust the valves for each cylinder as follows. Crank the engine by hand until the intake valve opens and closes. Both valves for that cylinder will then be closed. Intake valves are numbers 2, 3, 6 and 7. The adjusting screw clearance should be set to 0.012" for both the intake and exhaust valves. On engines which have the "Roto" type exhaust valves, set the exhaust valve tappet clearance to 0.010". Make sure the lock nut on each adjusting screw is securely tightened after the adjustment is made. Tappets set too close may cause burned or warped valves, seats, and scored tappets or camshaft lobes. Make a final check with the engine running at idle speed.

VALVE SERVICE.- The proper seating of the valves is essential to good engine performance. If any one valve is leaking, service all valves. Each valve, its guide, piston top, the cylinder head, and the top surface of the cylinder block should be thoroughly cleaned of all carbon deposits. Replace with a new one any valve of which the stem is worn or the head is warped or badly burned. The intake valve face angle is 30° and the exhaust valve face angle is 45°.

All old valves to be reused should be ground and assembled to their original seats. Grind only enough to assure a perfect seal. Be sure to remove all traces of grinding compound from valves and seats. Lightly oil the valves and guides before reassembly.

On some engines the exhaust valves are of the "Roto" type, each valve having a cap under the end of the valve stem which pushes up against the valve spring retaining washer, permitting the valve to rotate slightly as it opens and closes. When reassembling, install the cap on the end of the valve stem before installing the spring retainer locks. Note that the exhaust valve retainer locks have a slight taper. The thinner edge of the lock must face upward. Be sure two locks are installed on each valve stem. The intake valve locks are the single pin type. If the "Roto" exhaust valves are properly installed, it will be possible to turn them in their guides when fully open which is not possible with the conventional type valves.

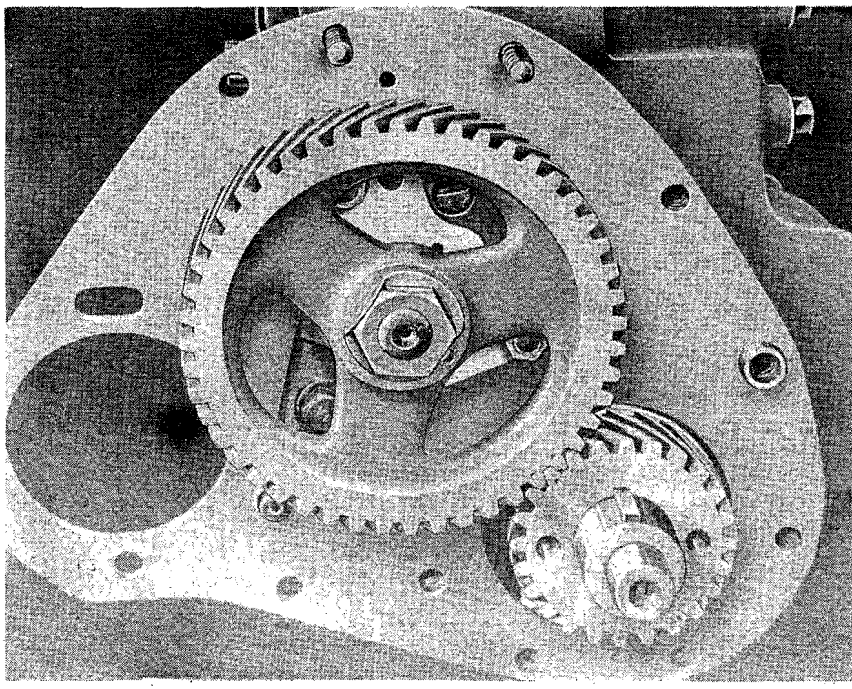


FIG. E-TIMING GEARS

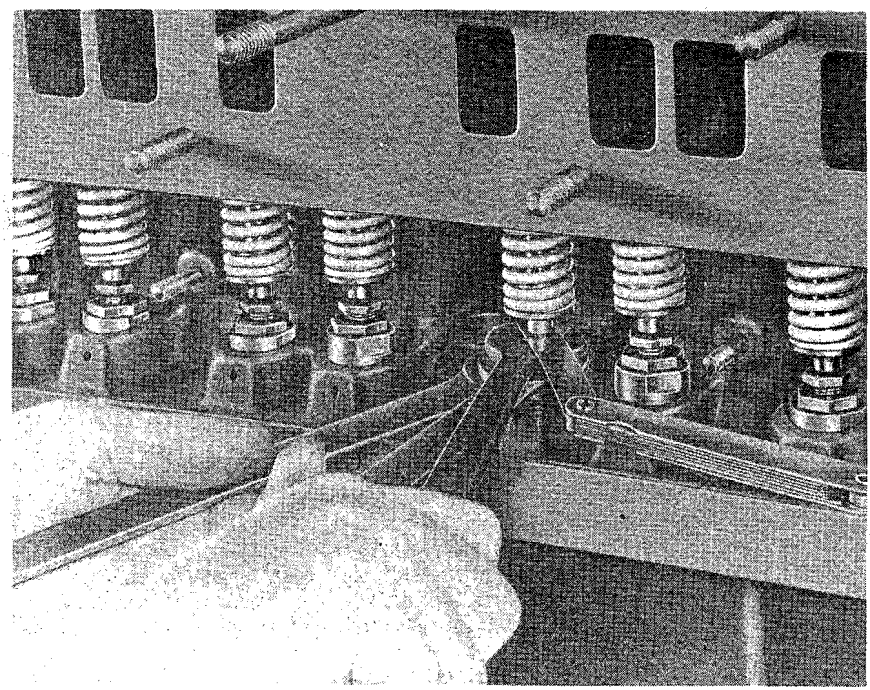


FIG. F-TAPPET ADJUSTMENT

Set the tappet clearances after the valves have been reassembled in the engine. When tightening the cylinder head nuts, start at the center of the head and work outward and towards the ends. After approximately 10 hours of operation, again check the tappet clearnaces, making any necessary adjustments.

IGNITION TIMING.- See Fig. G. Set the distributor contact points to 0.020" gap at full separation. There are stamped markings on the flywheel which can be seen by removing the small flywheel inspection hole cover on the right side of the engine. Turn the engine over with the hand crank until the No. 1 piston is coming up on the compression stroke. Slowly crank the engine until the flywheel mark IGN centers in the inspection hole. At this point, the distributor rotor should point to the distributor cap tower for the No. 1 spark plug wire, and the distributor points should just separate. If the rotor points to the tower for the No. 4 spark plug wire, it will be necessary to remove the distributor, lift the drive shaft in the cylinder head and turn it one half turn. Start the plant and allow it to reach operating temperature. Test the spark advance by applying a full electrical load. Slow the engine by pulling on the governor arm, then release and allow the engine to suddenly accelerate. There should be one or two "pings" or detonation knocks. If no ping is heard, advance the timing. If a continuous ping is present, retard the timing. Advance or retard the spark timing as necessary by loosening the distributor clamp and turning the distributor body slightly clockwise to advance, or counterclockwise to retard. Retighten the clamp screw. Keep the spark advanced as far as possible without causing a "ping", or detonation under normal running conditions.

PISTON RING REPLACEMENT.- The piston and connecting rod assemblies are removed from the tops of the cylinders. Check the cylinders for out of round, tapered or scored condition. Rebore for oversize pistons if necessary. Any ridge worn at the top of the cylinder should be removed if not reboring.

Two compression rings and one oil control ring are used on each piston. Fit each ring to its individual cylinder, checking the gap between the ring ends by placing the ring squarely in the cylinder in a position corresponding to the bottom of its travel. See Fig. H. The correct gap is from 0.008 to 0.013". Do not use rings which require too much filing to obtain the correct gap. If using the old pistons, clean all ring grooves of carbon deposits and see that oil return holes are open. See that each ring fits its groove properly, with 0.0015" to 0.002" clearance. Rings of the tapered type will be marked "TOP" or may be otherwise easily identified, and this taper must be installed with the smaller diameter toward the closed end of the piston. Fit the proper ring in each ring groove on the piston, spacing the gaps equally around the circumference of the piston, and no gap directly in line with the piston pin.

PISTON REPLACEMENT.- If cylinders become badly worn, tapered or scored, rebore and hone to fit one of the available oversizes in pistons. Pistons are available in .010", .020", .030", .040", .050" and .060" oversizes. The pistons should be fitted to the cylinders to a clearance of .0015" measured with a 1/2" wide feeler gauge inserted between the piston and cylinder at a point half way between piston pin holes. A pull of 5 to 10 pounds should be required to pull the feeler gauge past the piston. See Fig. I. Piston and connecting rod assemblies must be properly aligned before installation in the engine.

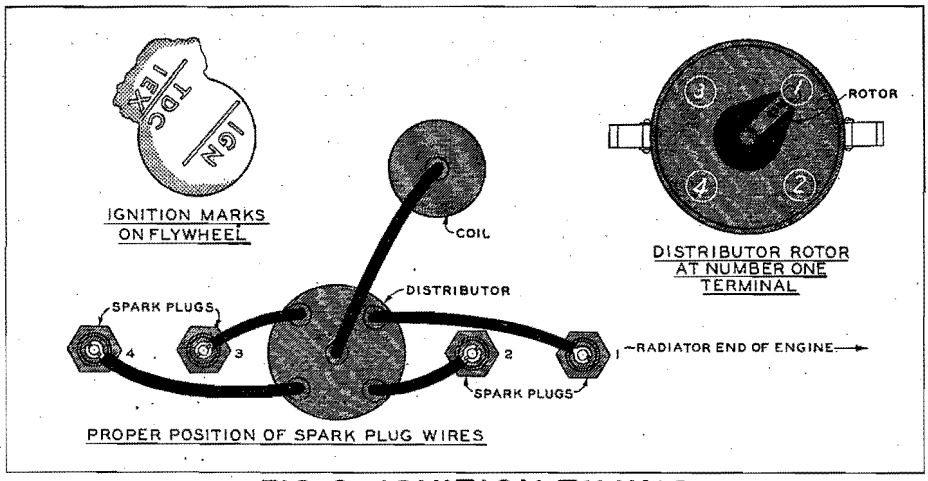


FIG. G - IGNITION TIMING

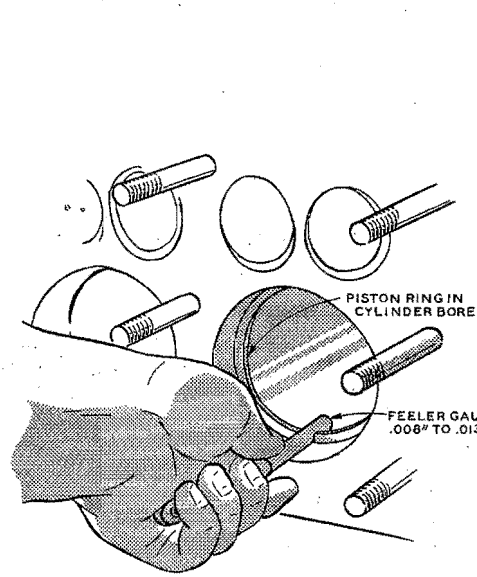


FIG. H - PISTON RING GAP

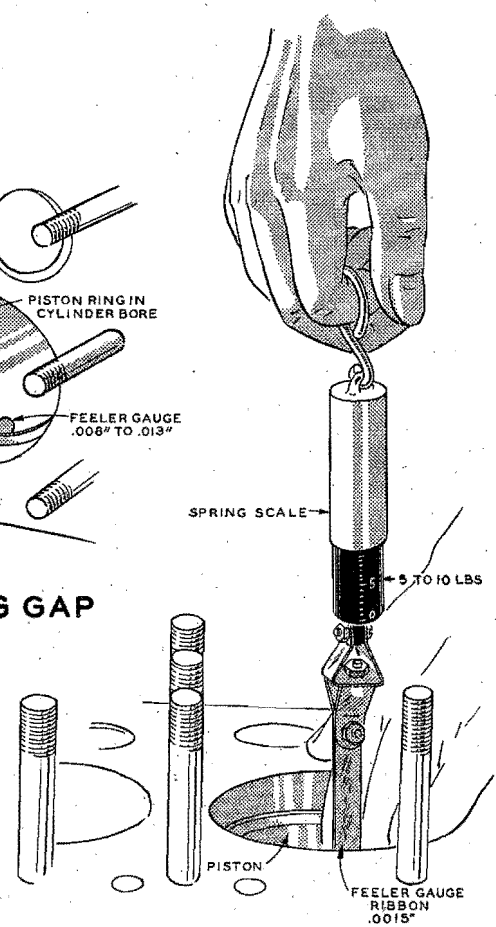


FIG. I - PISTON FITTING

CONNECTING RODS.- The connecting rod lower end bearings are steel backed and readily replaceable. When removing the connecting rods, be sure to note the numbers on the rods and bearing caps, and reassemble with the numbers toward the camshaft. Connecting rods 1 and 3 are not interchangeable with reds 2 and 4, nor are the bearings. Notches machined in the connecting rod halves act as retainers for matching ears stamped into the steel back of the bearing shells, or inserts. This design locks the shells and prevents their turning in the rod. If a shell becomes worn, both shells for that rod should be discarded, and new ones installed. The shells are designed to give a clearance of .0015" to .002" without any scraping or other fitting. Under no condition should fitting ever be attempted by scraping or filing of the cap or upper half of the rod, as this would permanently ruin the rod. Be sure that rods and caps, as well as bearing shells are perfectly clean and free of oil when inserting the shells. Oil on the back of the shell will prevent proper seating of the shell in the rod or cap. Oil the crankshaft journal after the bearing shell has been firmly seated.

The sides of the connecting rod crank ends are not babbitt lined in this engine. The faces are steel and, being exposed to the steel crankshaft, it is of vital importance that the side play clearance of .006" to .010" be maintained. When installing new pistons, pins, or connecting rods, be sure pistons and connecting rod assemblies are first properly aligned on an accurate aligning gauge.

MAIN BEARINGS.- The crankshaft main bearings are of the same type as the connecting rod bearings. The upper and lower shells are made in pairs for each individual bearing, but front, center and rear bearings are not interchangeable as pairs. The same general directions given for fitting the connecting rod bearings should be observed in fitting the main bearings. The clearance, when installed, should be .0015" to .002". The rear face of the front main bearing takes the end thrust of the crankshaft. The crankshaft end play should be .004" to .006" and is regulated by a removable thrust collar just to the rear of the crankshaft gear, together with a shim pack to the rear of this collar. When servicing the crankshaft or any parts in connection with the shaft, especially connecting rod and main bearings, always be sure that all oil holes in the shaft are open and clean. Note that one center main bearing cap screw is shorter than the other bearing cap screws. This shorter screw must be installed on the camshaft side of the bearing cap. Use of one of the longer screws at this point will block the oil passage.

PISTON PINS.- The hardened piston pins are selected in production to obtain a 0.0003" loose fit in connecting rod pin bushing, and light push fit in piston boss. By heating the piston in hot water, the piston pin can be pushed in by hand. Maintain these clearances if necessary to fit oversize piston pins. Pins are available in .003", .005", and .010" oversizes. When reinstalling old pistons, be sure that they are installed in their original cylinder, and in the same position relative to the numbered side of the connecting rod. When reassembling, make sure that the snap ring at either end of the pin is tightly in place.

CAMSHAFT.- The camshaft is an alloy steel forging. Provided that proper lubrication is supplied, the camshaft and its bearings should never require servicing. The cams, if cut by too close adjustment of the tappet clearance, can be reconditioned by careful honing if not too badly damaged.

The camshaft bearings are bronze bushings which are line reamed after installation in the crankcase, to a clearance of .0015" to .002". The installation of new camshaft bearings is not practicable without the proper line reaming equipment.

WATER PUMP.- The water pump on this engine is a centrifugal, ball bearing, self sealing type. To dismantle the pump proceed as follows:

1. Remove the nut and lockwasher from the front of the water pump shaft and, using a suitable puller, pull the pulley off the shaft.

2. Remove the three nuts mounting the shaft support to the body and remove the support assembly.

3. To remove the impeller, remove the set screw and pull or press the impeller from the shaft. Note that if the set screw is loosened only a few turns it will not be free from the hole in the shaft.

4. To remove the shaft and bearings from the support, remove the set screw from the top of the support and press the assembly out through the front.

5. The seal will be found assembled in the impeller hub. Care must be taken in removing this assembly, as the carbon seal is fragile and easily broken. To reassemble, reverse the procedure used in disassembly. When reassembling the pump make sure that the set screw projects far enough to line up the impeller on the shaft. Press the impeller on flush with the end of the shaft. Pack the space between bearings with a good grade of waterpump grease.

CRANKCASE VENTILATION.- The crankcase oil fill cap permits entry of air to the crankcase which is drawn out through the valve chamber cover tube to the intake manifold. If the oil fill cap becomes clogged with dust and dirt, excessive crankcase vacuum may build up, causing oil to be drawn from the valve chamber into the intake manifold. The baffle plate on the inner side of the valve cover must be in place and undamaged for proper ventilation.

LUBRICATION SYSTEM.- A gear type oil pump supplies oil under pressure through drilled passageways to the crankshaft main bearings, lower connecting rod bearings, camshaft bearings and valve tappets. Whenever the engine is disassembled for servicing, make sure that all oil passages are unobstructed. Thoroughly clean the engine oil pan and the oil pump strainer screen. An oil pressure relief adjustment is adjusted at the factory to give a pressure of 20-40 pounds at the governed speed, with the engine oil hot. The oil pressure relief adjustment is reached by removing a large hexagon shaped plug in the side of the crankcase just below the oil filter, and adjusted by adding or removing spacer washers.

TABLE OF CLEARANCES

NOTE

The clearances given below are for settings at 72° F. (22.2° C.).

	MINIMUM	MAXIMUM
Valve Tappets - Roto Exhaust	.010"	
Valve Tappets - Intake and Exhaust (Conventional)	.012"	
Valve Seat Width - Intake and Exhaust	1/16"	3/32"
Crankshaft Main Bearings	.0015"	.002"
Crankshaft End Play	.004"	.006"
Connecting Rod Bearing	.0015"	.002"
Connecting Rod End Play	.006"	.010"
Piston in Cylinder	.0015"	
Camshaft Bearings	.0015"	.002"
Distributor Breaker Points Gap	.020"	
Spark Plug Electrode Gap	.025"	
Piston Ring Gap	.008"	.013"

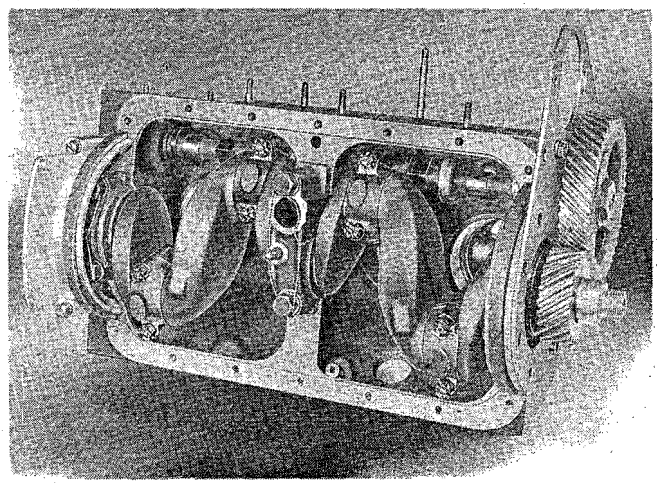


FIG.J-BOTTOM VIEW OF ENGINE

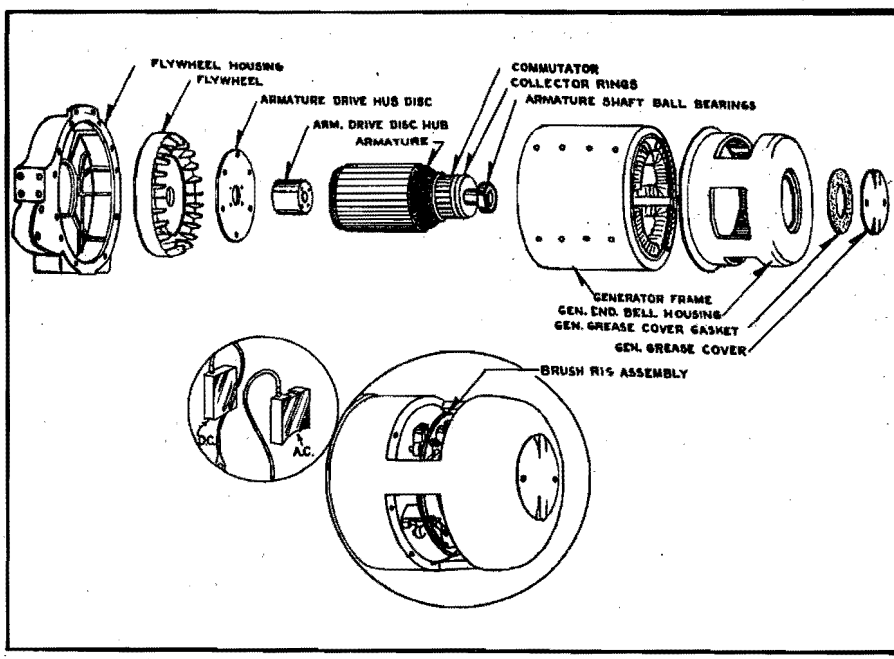


FIG. K-ALTERNATING CURRENT GENERATOR ASSEMBLY

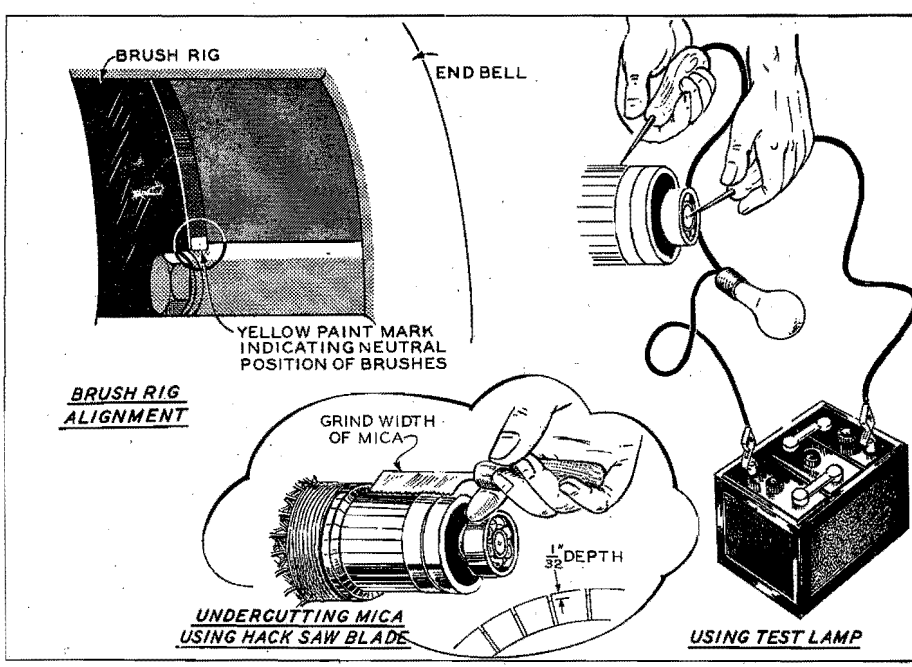


FIG. L-CARE OF COMMUTATOR AND BRUSHES

GENERATOR

GENERAL.- The generator normally requires little maintenance other than the PERIODIC SERVICE.

COMMUTATOR AND COLLECTOR RINGS.- After a long period of service, the surface of the commutator may become worn to such an extent as to cause the mica insulation between the commutator bars to extend above the level of the bars. This condition would cause noisy brushes and would soon lead to excessive brush sparking and pitting of the commutator bars. High mica should be undercut to a depth equal to the distance between bars, or approximately 1/32". Lift each brush high in its guide so that its spring will press against its side, and remove the end bell. Tag leads to insure correct replacement. With a tool fashioned from a hack saw blade, carefully undercut the mica. Be sure to remove any burrs which may have been formed when undercutting, and see that spaces between bars are completely free of any metallic particles.

Should dusty operating conditions cause the surface of the commutator or collector rings to become grooved, out of round, pitted or rough, it will be necessary to remove the armature and turn the commutator or collector rings down in a lathe. It will be necessary to remove the generator field frame before the armature can be removed. Remove the ball bearing from the armature shaft before turning down to prevent any foreign material getting into it. After the commutator is turned down, the mica between bars must be undercut as described above. When the armature is reinstalled, align it as carefully as possible before installing the frame and end bell.

BRUSH RIG.- It is unnecessary to remove the brush rig from the end bell when servicing the generator. If it has been removed mistakenly, line up the paint mark on the outer edge of the brush rig with the mark on the brush rig support in the end bell. A deviation from the proper positioning of the brush rig will lead to excessive arcing of the brushes, burning of the commutator, low generator output, and possible irreparable damage to the generator windings due to overheating. Any defective condenser should be replaced with a new one of the same capacity.

BRUSHES.- Install new brushes when the old ones are worn so that the top of the brush is below a point midway between the top and bottom of the brush guide. Do not continue to use brushes that are worn too short, because the spring tension lessens as the brush becomes shorter, and weak spring tension leads to excessive brush sparking and pitting of the commutator or collector rings. It is recommended that only a moderate load be applied to the generator until the new brushes have been "run in", to eliminate excessive sparking. See that brushes ride freely in their guides and that spring tension is uniform. The correct tension is 30 oz. for the commutator brush springs and 16 oz. for the collector ring brush springs, measured with the contact point of the spring level with the top of the guide.

GENERATOR WINDINGS.- Use a continuity type test lamp set to test for grounded or open circuits in the generator windings. Be sure that all brushes are lifted away from contact with the commutator and collector rings and that generator leads to the control panel are disconnected. When disconnecting leads, tag them to facilitate correct replacement. Disconnect condenser leads from brush terminals to avoid mistaking a defective condenser for a grounded lead.

Use an armature growler to test the armature for an internal short circuit. Field coil windings may be tested for an internal short circuit by comparative ohmeter readings.

If one or more field coils test defective, install a new set of field coils. If an armature winding tests defective, install a new armature assembly. Leads may be repaired as necessary.

CONTROLS

CONTROL PANEL EQUIPMENT.- If any of the control panel equipment fails to function properly, the defective part should be replaced with a corresponding new unit rather than to attempt repairs on the old part. Disconnect the battery whenever servicing any control panel equipment. Keep all connections tight and clean.

If the plant will start but does not continue to run, start the plant manually. If it continues to run with the ignition switch at the HAND START position, trouble is indicated in one of the relays, the high water temperature switch, or a loose connection. An open circuit between the generator and the stop relay will also prevent the plant from running with the ignition switch at the ELECT. START position.

DO NOT LEAVE THE IGNITION SWITCH AT THE HAND START POSTTION LONGER THAN NECESSARY TO MAKE TESTS.

The plant is equipped with a start disconnect relay which serves to open the start circuit when the plant is started with automatic or line transfer equipment. Failure of the start disconnect relay to operate will cause the start circuit to remain closed after the plant starts and will allow an excessively high voltage to reach the batteries.

Failure of the reverse current relay (charge relay) may cause the charge ammeter to show a discharge of approximately 7 amps when the plant is stopped. Replace the relay with a new one if cleaning the contact points with a hard finish paper does not remedy the situation. The correct adjustment is obtained by setting the spring tension to allow the relay points to open at 12.6 volts and close at 15.4 volts when tested on a test bench.

The voltage regulator relay should allow a charge rate of approximately 6 amps when the batteries are less than 3/4 fully charged. As the batteries approach a fully charged condition the charge rate should drop to approximately 2 amps or less. The spring tension may be increased to advance the high charge rate cut in point, or decreased to retard the point at which the high charge rate becomes effective.

SERVICE DIAGNOSIS

POSSIBLE CAUSE	REMEDY
GENERATOR OVERHEATING	
Overloaded.	Reduce load.
Brush rig out of position.	Be sure to line up marks. See Brush Rig.
VOLTAGE DROPS UNDER HEAVY LOAD	
Engine lacks power.	See remedies for engine missing under heavy load.
Poor compression.	Tighten cylinder head and spark plugs. If still not corrected, grind the valves. Replace piston rings, if necessary. Refer to MAINTENANCE AND REPAIR.
Faulty carburetion.	Check the fuel system. Clean, adjust or replace parts necessary.
Restricted air cleaner.	Clean and refill.
Excessive choking.	See that choke opens properly.
Carbon in cylinder.	Remove carbon.
Restricted exhaust line.	Clean or increase the size.
ENGINE MISFIRES AT LIGHT LOAD	
Carburetor idle adjustment set wrong or clogged.	Adjust, clean if needed.
Spark plug gaps too narrow.	Adjust to correct gap, 0.025".
Intake air leak.	Tighten or replace gaskets.
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, coil, etc., or retime ignition.
Uneven compression.	Tighten cylinder head and spark plugs. If still not corrected, grind valves. Replace piston rings, if necessary.
Worn intake valve stems or guides.	Replace valves or guides.

POSSIBLE CAUSE	REMEDY
ENGINE MISFIRES AT HEAVY LOAD	
Spark plugs defective.	Replace.
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, coil, etc., or retime ignition.
Clogged carburetor.	Clean jets.
Clogged fuel screen.	Clean.
Defective spark plug cables.	Replace.
ENGINE MISFIRES AT ALL LOADS	
Fouled spark plug.	Clean and adjust.
Defective or wrong spark plug.	Replace.
Sticking valves.	Clean stems and guides.
Broken valve spring.	Replace.
Defective ignition wires.	Replace.
Defective or improperly adjusted points.	Adjust or replace breaker points. See Periodic Service - Weekly.
LOW OIL PRESSURE	
Too long screw on center main bearing.	See MAIN BEARINGS.
Oil too light.	Drain refill with proper oil. See PREPARATION.
Oil badly diluted.	Drain, refill with proper oil.
Oil too low.	Add oil.
Oil relief valve not seating.	Remove and clean, or replace. See LUBRICATION SYSTEM.
Badly worn bearings.	Replace. See MAINTENANCE AND REPAIR.
Sludge on oil pump screen.	Remove and clean.
Badly worn oil pump.	Replace.
Defective oil pressure gauge.	Replace.

POSSIBLE CAUSE	REMEDY
HIGH OIL PRESSURE	
Oil too heavy.	Drain, refill with proper oil. See PREPARATION.
Clogged oil passage.	Clean all lines and passages.
Oil relief valve stuck.	Remove and clean. See LUBRICATION SYSTEM.
Defective oil pressure gauge.	Replace.
PLANT STARTS BUT DOES NOT CONTINUE TO RUN	
START button released too soon.	Hold in contact longer.
Defective panel equipment.	See Controls.
ENGINE BACKFIRES AT CARBURETOR	
Lean fuel mixture.	Clean carburetor.
Clogged fuel screen.	Clean screen.
Intake air leak.	Replace flange gaskets, tighten carburetor.
Poor fuel.	Refill with good, fresh fuel.
Spark too late.	Retime ignition. See IGNITION TIMING.
Spark plug wires crossed.	Install wires correctly. See IGNITION TIMING.
Intake valves leaking.	Grind or replace. See VALVE SERVICE.
EXCESSIVE OIL CONSUMPTION, LIGHT BLUE SMOKY EXHAUST	
Worn piston rings.	Install new piston rings. See PISTON RING REPLACEMENT.
Oil leaks from engine or connections. This does not cause smoky exhaust.	Replace gaskets or leaking tubing. Tighten screws and connections.
Oil too light or diluted.	Drain, refill with correct oil. See PREPARATION.
Too large bearing clearance.	Replace bearings. See MAINTENANCE AND REPAIR.
Oil pressure too high.	Refer to symptoms of high oil pressure for remedies.

POSSIBLE CAUSE	REMEDY
EXCESSIVE OIL CONSUMPTION, LIGHT BLUE SMOKY EXHAUST (CONT.)	
Breather Cap Clogged.	Clean - See CRANKCASE VENTILATION.
Engine misfires.	Refer to symptoms of engine misfires.
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, coil, etc., or retime ignition.
Unit operated at light or no load for long periods.	No remedy needed.
Too much oil.	Drain excess oil.
BLACK, SMOKY EXHAUST, EXCESSIVE FUEL CONSUMPTION, FOULING OF SPARK PLUGS WITH BLACK SOOT, POSSIBLE LACK OF POWER UNDER HEAVY LOAD	
Fuel mixture too rich.	Adjust choke. Install needed carburetor parts, adjust float level.
Choke not open.	See that choke opens properly. See ADJUSTMENTS.
Dirty air cleaner.	Clean, refill to proper level.
LIGHT POUNDING KNOCK	
Loose connecting rod bearing.	Replace. See MAINTENANCE AND REPAIR.
Low oil supply.	Add oil.
Low oil pressure.	Refer to symptom of low oil pressure for remedies.
Oil badly diluted.	Change oil.
ENGINE STOPS UNEXPECTEDLY	
Fuel tank empty.	Refill.
High water temperature.	See symptoms for engine overheating.
Defective ignition.	Check the ignition system. Repair or replace parts necessary.
DULL METALLIC THUD. IF NOT BAD, MAY DISAPPEAR AFTER FEW MINUTES OPERATION. IF BAD, INCREASES WITH LOAD	
Loose crankshaft.	Replace bearings, unless one of the next three remedies permanently corrects the trouble.

POSSIBLE CAUSE	REMEDY
SHARP METALLIC THUD, ESPECIALLY WHEN COLD ENGINE FIRST STARTED	
Low oil supply.	Add oil.
Low oil pressure.	Refer to symptom of low pressure for remedies.
Oil badly diluted.	Change oil.
PINGING SOUND WHEN ENGINE IS RAPIDLY ACCELERATED OR HEAVILY LOADED	
Carbon in cylinders.	Remove carbon.
Spark too early.	Retime ignition. See IGNITION TIMING.
Wrong spark plugs.	Install Champion J8 plugs.
Spark plugs burned or carboned.	Install new plugs.
Valves hot.	Adjust tappet clearance. See TAPPET ADJUSTMENT.
Fuel stale or low octane.	Use good fresh fuel.
Lean fuel mixture.	Clean carburetor.
ENGINE CRANKS TOO STIFFLY	
Too heavy oil in crankcase.	Drain, refill with lighter oil.
Engine stuck.	Disassemble and repair.
ENGINE WILL NOT START WHEN CRANKED	
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, coil, etc., or retime ignition.
Lack of fuel or faulty carburetion.	Refill the tank. Check the fuel system. Clean, adjust, or replace parts necessary.
Clogged fuel screen.	Clean.
Cylinders flooded.	Crank few times with spark plugs removed.
Poor fuel.	Drain, refill with good fuel.
Poor compression.	Tighten cylinder head and spark plugs. If still not corrected, grind the valves. Replace piston rings, if necessary. See MAINTENANCE AND REPAIR.
Wrong timing.	Retime ignition. See IGNITION TIMING.

POSSIBLE CAUSE	REMEDY
ENGINE RUNS BUT CURRENT DOES NOT BUILD UP	
Poor brush contact or dirty commutator or slip rings.	See that brushes seat well, are free in holders, are not worn too short, and have good spring tension.
Open circuit, short circuit, or ground in generator.	See GENERATOR, replace part necessary.
CURRENT UNSTEADY BUT ENGINE NOT MISFIRING	
Speed too low.	Adjust governor to correct speed.
Poor commutation or brush contact.	See that brushes seat well on commutator and slip rings, are free in holders, are not worn too short, and have good spring tension.
Loose connections.	Tighten connections.
Fluctuating load.	Correct any abnormal load condition causing trouble.
TAPPING SOUND	
Tappet clearance too great.	Adjust or replace tappets.
Broken valve spring.	Install new spring.
HOLLOW CLICKING SOUND WITH COOL ENGINE UNDER LOAD	
Loose pistons.	If noise only slight and disappears when engine warms up, no immediate attention needed. Otherwise replace worn parts.
VOLTAGE LOW AT FAR END OF LINE BUT NORMAL NEAR POWER UNIT	
Too small line wire for load and distance.	Install larger or extra wires or reduce load.
MOTORS RUN TO SLOWLY AND OVERHEAT AT FAR END OF LINE BUT OK NEAR POWER UNIT	
Too small line wire for load and distance.	Install larger or extra wires, or reduce load.
NOISY BRUSHES	
High mica between bars of commutator.	Undercut mica. See GENERATOR.

POSSIBLE CAUSE	REMEDY
EXCESSIVE ARCING OF BRUSHES	
Rough commutator or rings.	Turn down.
Dirty commutator or rings.	Clean. See GENERATOR.
High mica.	Undercut mica.
Brush rig out of position.	Line up marks on brush rig and support.
ENGINE OVERHEATING	
Low water in radiator.	Refill radiator.
Overloaded.	Remove part of load.
Improper lubrication.	See Low Oil Pressure.
Radiator obstructed.	Clean radiator.
Ignition timing late.	Adjust. See IGNITION TIMING.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