INSTRUCTION MANUAL

FOR

ONAN ELECTRIC GENERATING PLANTS

•

HQ *Series*

50 & 60 Cycle

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

921-6 A A A *Price $1.00* A - E


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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 determing 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 TO STATE THE MODEL, SPEC., AND SERIAL NUMBERS OF THE PLANT. THIS INFORMATION IS ABSOLUTELY NECESSARY AND MAY BE OBTAINED FROM THE NAMEPLATE ON THE PLANT.

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 UNIT.

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PLANT RUNNING HOURS COMPARED TO AUTOMOBILE RUNNING MILES

The engine of your generating plant makes as many revolutions in one hour, as the average automobile engine does when the car travels a distance of 41 miles.

100 running hours time on a generating plant engine is equivalent in total RPM to approximately 4100 running miles on an automobile.

Compare the running time of your generating plant engine with the number of miles traveled by an automobile. The oil in an auto is checked every one or two hundred miles (3 to 5 hrs. running time) and changed every 1000 to 1500 miles (28 to 42 hrs.) whereas in a generating plant or stationary power engine, the oil should be checked every 6 to 8 running hours (250 to 350 miles) and changed every 50 to 100 operating hours (2000 to 4000 miles) depending on operating conditions.

About every 5,000 to 10,000 miles (120 to 250 hours), services have to be performed on an auto, such as checking ignition points, replacing spark plugs, condensers, etc. Similarly on your generating plant engine, these same services have to be performed periodically except the change period is reckoned in hours. 10,000 miles on an auto is equivalent to about 250 running hours on your plant engine.

To arrive at an approximate figure of comparative generating plant running hours as against automobile engine running miles, multiply the total number of running hours by 41 to find the equivalent of running miles on an automobile.

Your generating plant engine can "take it" and will give many hours of efficient performance provided it is serviced regularly.

Below is a chart showing the comparison between a generating plant engine running hours and an automobile running miles.

	GENERATING PLANT RUNNING HOURS	AUTOMOBILE RUNNING MILES		GENERATING PLANT RUNNING HOURS	AUTOMOBILE RUNNING MILES
DAILY	1 Hr.	41 Mi.		30 Hrs.	1,230 Miles
AVERAGE	4 Hrs.	164 Mi.	MONTHLY	120 Hrs.	4,920 Miles
	6 Hrs.	246 Mi.	AVERAGE	180 Hrs.	7,380 Miles
	8 Hrs.	328 Mi.		240 Hrs.	9,840 Miles
	7 Hrs.	287 Mi.		365 Hrs.	14,965 Miles
WEEKLY	28 Hrs.	1,148 Mi.	YEARLY	1,460 Hrs.	59,860 Miles
AVERAGE	42 Hrs.	1,722 Mi.	AVERAGE	2,190 Hrs.	89,790 Miles
	56 Hrs.	2,296 Mi.		2,920 Hrs.	119,720 Miles

NOTE: Electric generating plants do not operate economically when used to power electric refrigerators and will add from 4 to 8 operating hours per day in addition to the regular lighting load.

This instruction manual is supplied to assist the operator in the proper installation and operation of the generating plant. Disregarding these instructions may lead to unnecessary trouble and expense. Keep this manual and the wiring diagram accessible for reference.

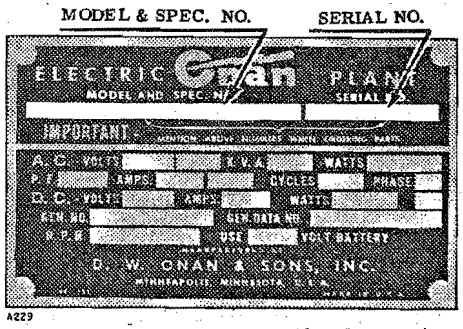
Each electric generating plant is given an actual running test and is carefully checked under various electrical load conditions before leaving the factory, to assure that it is free of defects and will produce its rated output. Inspect the plant for any damage which may have occurred in shipment. Any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

The generating plant consists, basically, of an internal combustion engine and a self excited alternating current generator. The engine is a 4 cylinder gasoline burning type. The generator is a four pole, revolving field type, directly connected to the engine. Accessories and controls suitable for a normal installation and according to the particular model are supplied. Housed models have a sheet metal housing for the plant and include an engine and electrical meter panel. Unhoused models are of the open construction with a box containing the necessary control parts mounted over the generator. See page 63 for information on special purpose plants.

The radiator end of the plant is designated as "Front End" and the carburetor side is designated as "Left Side" of the plant by D. W. Onan & Sons Inc.

ALWAYS REFER TO THIS PLANT BY NAMEPLATE INFORMATION

Take the information stamped on the plant nameplate. (Not the engine nameplate.)



If it ever becomes necessary to contact the factory or an Authorized Service Station in regard to this generating plant, be sure to refer to the nameplate information as shown. This information must be known in order to properly identify the plant and to enable proper advice to be given.

This instruction manual is supplied with all generating plants of the HQ Series. Instructions apply specifically to the standard models. Some details may not apply to special models. Some special installation or operating conditions may require the operator of this plant to modify these instructions. However, by following as closely as possible the recommendations as given in this book and by referring to the plant wiring diagram, the operator should have no difficulty in making a good installation and in properly operating the generating plant.

ENGINE DETAILS

The engine is a Continental Model F 162, specification 966. It has 4 cylinders, L head, 3-7/16" bore, 4-3/8" stroke, 162 cu. inch total piston displacement, 6.8 to 1 compression ratio, 41.0 horse power at 1800 rpm.

The cooling system is approximately 10-1/2 quarts, U.S. standard measure . Full length water jackets surround the cylinder and valve seats. A belt driven, prelubricated, ball bearing water pump maintains circulation of the engine coolant. The temperature of the coolant is controlled by a thermostat and a by-pass. A pusher type fan forces cooling air out through the front of the radiator. The radiator cap is of the pressure type.

The crankcase oil capacity is 4 quarts (U.S. measure) plus approximately 1 pint used in the operation of the oil filter. A gear type oil pump supplies pressure lubrication to main, connecting rod, and camshaft bearings.

Main and connecting rod bearings are precision type replaceable liners. All valves are positive rotator type. Exhaust inserts are used. Valve tappets are adjustable. Firing order is 1-3-4-2. 60 cycle plants run at approximately 1800 rpm. 50 cycle plants run at approximately 1500 rpm. The engine speed is controlled by a flyweight type, gear driven governor.

Some engines have magneto ignition, others have 12 volt battery ignition. Ignition system is radio noise suppressed. Standard models have a 12 V. automotive solenoid shift type starter and a 12 volt charging generator with charging rate automatically regulated.

(Certain special models have 36 volt exciter cranking and consequently have no automotive type starter nor automotive type generator. See the Wiring Diagram.)

The choke is automatic. Standard models burn gasoline fuel and have an up draft carburetor with an adjustable main jet. Special models are equipped to burn gas fuel (natural gas or liquid petroleum gas, depending upon the model).

GENERATOR DETAILS

The air cooled alternating current generator has two main components; the alternator, and the exciter. The alternator is a 4 pole, revolving field type alternating current generator. The exciter generates direct current for exciting the alternator field. The alternator field and the exciter armature is a single rotor assembly which is directly connected to the engine flywheel. Beginning with model specification "C" the exciter armature is keyed to and removable from the rotor shaft of the alternator. The rotor is supported at the engine end by the engine rear main bearing and at the exciter end by a large ball bearing. The larger frame contains stationary armature windings of the alternator, from which the main load is taken, and the smaller frame contains the stationary exciter field.

The generator is specifically designed for high efficiency and excellent motor starting ability. The external voltage regulator gives extremely close voltage regulation. A manually operated field rheostat may be used to control voltage for emergency operation if the automatic regulator should fail. The frequency of the current is determined by the engine speed, and is regulated by the engine governor. The speed is approximately 1800 rpm for the 60 cycle plant, and 1500 rpm for the 50 cycle plant. The KW rating is at 80% power factor for both the 10KW plant and the 15KW plant.

CONTROL DETAILS

The control equipment varies with the plant. Housed plants are equipped with an instrument panel mounting a manual reset circuit breaker, meters, gauges, relays, and switches for greatest convenience in observing the performance and properly operating the plant. Unhoused plants are equipped with a control box mounting equipment necessary for operation of the plant. The absence from the unhoused plant of various instruments included in the housed type plant, does not affect the efficiency of the plant in any way, but does impose upon the operator the responsibility of becoming sufficiently familiar with the performance of the plant to recognize any abnormal condition before damage may be done. Alternating current plants may be connected for remote control of starting and stopping, or connected for automatic equipment such as automatic line transfer controls.

SPECIAL PURPOSE PLANTS

Refer to the separate section near the rear of this book for instructions covering special purpose plants.

IMPORTANCE OF PROPER INSTALLATION. - Satisfactory and dependable performance of the generating plant is dependent to a great extent upon the proper installation. Location and ventilation are important factors to consider in the plant installation.

LOCATION. - Locate the plant centrally in relation to the electrical load. For example, two buildings 500 feet apart are to be supplied with current from the generating plant. If the amount of the electrical load is approximately equal at each building, the ideal location for the generating plant would then be at a point midway between the two buildings. If most of the electrical load will be concentrated in one building, the generating plant should then be located in or near that building. Each installation differs in this respect.

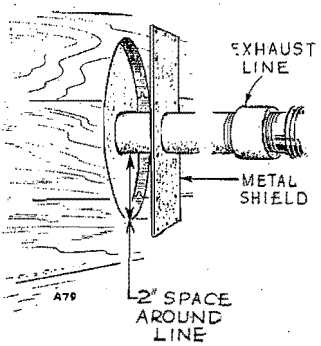
Avoid as much as possible the use of long electric lines. Long lines require larger size wire to avoid excessive voltage drop. Be sure to use large enough wire, taking into consideration distance, electrical load, and permissable voltage drop. Consult a licensed electrican if in doubt.

Select a site for the generating plant which will be dry, clean, and well ventilated. Choice of either a damp or dusty location will require more frequent inspection and servicing of the plant. If practicable, install the plant inside a building or covered vehicle for protection from extremes in weather conditions.

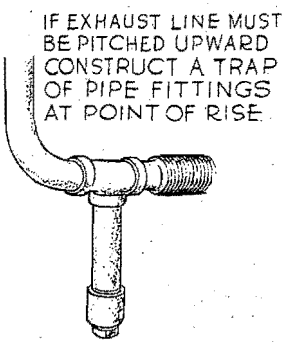
MOUNTING. - For permanent installations, a raised platform of concrete or heavy timber on which to mount the plant will be a convenience in servicing the plant. The plant may be bolted down in position if desired. Allow at least 24 inches of space on all sides of the plant for convenience in servicing.

If the plant is mounted in a mobile vehicle, be sure the plant is bolted securely in place so that it can not shift when in transit. The plant must be set approximately level when in operation.

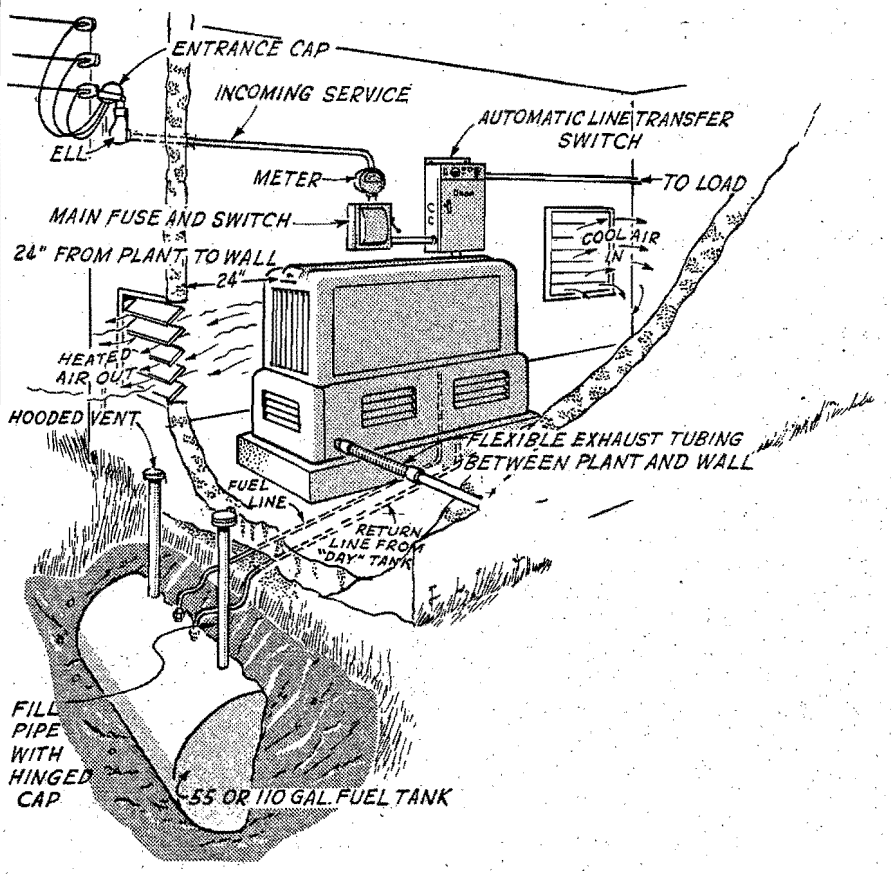
VENTILATION. - The plant generates a considerable amount of heat which must be dissipated by proper ventilation. Engine heat is removed by a pusher type fan which blows cooling air out through the front of the radiator. For room or compartment installations, provide an opening at least as large as the radiator area for exit of the heated air. This opening should be directly in front of the radiator, and as close to the radiator as practicable. It may be necessary to construct a duct from the front of the radiator to the outdoors. In cold weather, some method of controlling the air flow should be provided, so that the temperature of the room can be kept at a normal point. Generator cooling air is discharged from an air duct near the left rear of the engine. Provide an outlet for this heated air. See that the air heated by the plant will not be recirculated to the plant. Provide for the free entry of fresh air. Consult the dealer or factory if special ventilation problems arise. The plant can be adapted to piping fresh cooling water through the engine.



EXHAUST LINE PASSING THROUGH WALL OR PARTITION



CONDENSATION TRAP



Typical Onan Standby Installation

THIS INSTALLATION IS A TYPICAL ONE.
BEFORE INSTALLING CHECK REGULATIONS.

EXHAUST. - Exhaust gases are deadly poisonous and must be piped outside if the plant is installed indoors. Excessive inhalation of exhaust gases may cause serious illness or death. The exhaust outlet for unhoused plants is 1-1/2" standard pipe size. The muffler outlet for housed plants is 1-1/4" standard pipe threads. Use pipe at least as large as the outlet size for the first 10 feet and increase pipe diameter one size for each additional 10 feet in length. Avoid sharp turns as much as possible. If the line passes through an inflammable wall, shield the wall by passing the line through properly insulated metal collars. If the exhaust line is lengthy or rises from the plant muffler, provide a means of draining condensation periodically.

UNDERGROUND MUFFLER. - If exhaust noise from the standard muffler will be objectionable, an underground muffler may be constructed. Use a heavy 10 gallon or larger tank or drum. If the tank contained any inflammable material, be sure all fumes are exhausted before starting to work on it. Weld suitable pipe fittings to the tank, for inlet and outlet pipes. Perforate the bottom of the tank, for condensation to drain out. Bury the underground muffler in loose gravel. Extend the outlet pipe at least 24 inches above the ground and fit it with a gooseneck fitting to avoid entrance of rain or snow. If there is any possibility of an underground muffler filling with water at any time, the underground muffler can not be used.

FUEL SUPPLY, GASOLINE. - When installing a separate gasoline tank, the lift of the fuel to the fuel pump on the plant must not be more than 6 feet. The horizontal distance between the tank and the plant should not exceed 50 feet. If the fuel outlet of the tank is at the top of the tank, a drop or suction pipe must extend down to within an inch or two of the tank bottom. All connections between the fuel tank and the fuel pump must be tight. An air leak will prevent pumping of fuel to the plant.

Tanks of 55 gallon or 110 gallon capacity, and 25 or 50 ft. fuel lines for underground installation are available through the dealer from whom the generating plant was purchased. Observe local underwriters codes regarding the installation of any fuel tank.

The fuel pump inlet on the plant is for 1/4 inch inverted flare tubing connection. For some installations, it will be necessary to remove the inverted connection from the fuel pump elbow, which is threaded with standard 1/8 inch pipe thread.

NATURAL GAS OR VAPOR FUEL. - Some special model plants are equipped to burn LPG or natural gas fuel, and some are fitted with heat exchanger equipment. 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.

REGULATOR. - The Ensign atmospheric type regulator is designed to operate on a line pressure not to exceed 8 inches water column. If the line pressure exceeds 8 inches water column, it will be necessary to install a primary regulator in the line to reduce the pressure before it enters the atmospheric regulator.

The Garretson atmospheric type regulator is designed to operate on a line pressure of from 4 to 8 ounces. If the pressure exceeds 8 ounces a primary regulator must be installed and adjusted to reduce the pressure to 8 ounces before it enters the atmospheric regulator.

ASSEMBLING THE GARRETSON REGULATOR.

1. Assemble the 3/4" (B) and 1/8" (C) plugs to the regulator.
2. Assemble the pipe nipple (K), elbow (D), and half nipple (E) as shown.
3. Install the regulator to the 3/4" incoming fuel supply line. Turn the regulator to an upright position and support the supply line so as to serve as a mounting for the regulator.

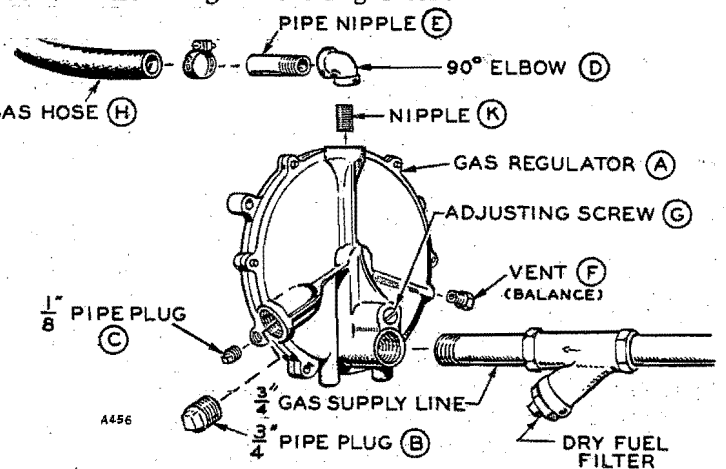


FIG. 00 - REGULATOR

ADJUSTING THE REGULATOR TO THE INCOMING LINE PRESSURE

Open the fuel shut-off valve in the gas supply line. Blow into the open vent or balance hole in the regulator to allow fuel to flow past the regulator valve.

Place a soap bubble over the open end of the pipe nipple located on top of the regulator.

Turn the adjusting screw out or counterclockwise making the soap bubble grow larger. Then turn the screw in until the soap bubble will hold. Assemble the vent to the vent hole in the regulator then connect the rubber hose between the carburetor and the regulator.

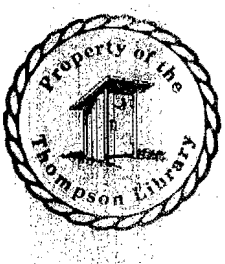
BATTERIES. - Two 6 volt (or one 12 volt) batteries are required. Use the short (6-3/4 inch) jumper cable to connect the positive post of one 6 volt battery to the negative post of the second 6 volt battery. For housed plants, connect the battery cable attached to the start solenoid switch to the remaining positive (+) post of the batteries. Connect the battery cable which is grounded, 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 post. Do not pound on the clamps to force them down on the posts. Tighten the clamps securely and coat lightly with light grease or vaseline to minimize corrosion deposits. Consult the wiring diagram for requirements on special models.

For unhoused plants, the battery cables are shipped loose rather than attached to the plant, otherwise battery connections apply as given for housed plants.

"Wet" (ready for use) starting batteries are sometimes supplied with the plant. These batteries are in a well charged condition when shipped from the factory. However, if they are not placed in service within 30 to 40 days, they may have become partly discharged. If such is the case, they should be given a freshening charge before being placed in service. If "dry" batteries are supplied, they must be prepared for use according to the instructions given on the tag attached to the batteries.

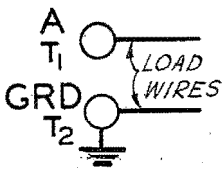
CONNECTING THE LOAD WIRES - HOUSED PLANTS

GENERAL. - The AC output terminal studs, to which the load wires are to be connected, are located below the control panel, on the chassis. Remove the smaller grille from the right side of the plant (facing the radiator end). A good installation might include entry of the load wires through conduit from underneath the plant or through the hole in the chassis after removing the dot button near the right rear grille. Solderless screw type connectors are provided for connecting the load wires to the output terminal studs. Be sure to use sufficiently large insulated wire. The connections must be made to conform to applicable electrical codes. Follow the instructions for connecting to the plant terminal as given, according to the type of plant. A small ac output nameplate attached beside the load terminals designates the terminals for load wire connections. Most nameplates show the respective generator lead "T" designation in addition to the "A, B, C, or GRD" designation. These terminal designations agree with the wiring diagram.



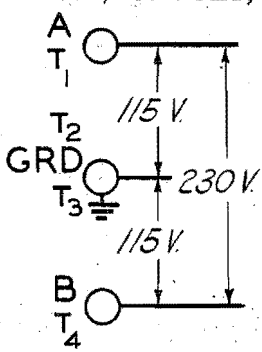
On 3 phase, 4 wire plants the (line to neutral) single phase voltage will always be the lower voltage as specified on the nameplate, when the voltmeter (connected line to line) reads the higher voltage as specified on the nameplate.

115 VOLT OR 230 VOLT, SINGLE PHASE, 2 WIRE PLANT. -



One terminal post is grounded. The insulated "A" terminal post is "hot". Connect the neutral load wire to the plant terminal post marked "GRD". Connect the "hot" load wire to the plant terminal post marked "A".

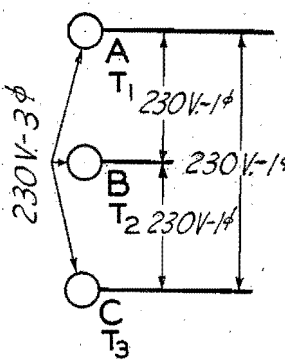
115/230 VOLT, SINGLE PHASE, 3 WIRE PLANT. -



The center terminal is grounded. Terminals "A" and "B" are "hot". For 115 volt current connect the neutral load wire to the plant terminal post marked "GRD". Connect the "hot" load wire to either of the two outside terminals A or B. Two separate 115 volt circuits are thus available with not more than 1/2 the total plant rating available on each circuit. Balance the load as closely as possible between the two circuits.

For 230 volt current, connect the load wires to the plant terminals A and B, leaving the center "GRD" terminal unused.

230 VOLT, THREE PHASE, 3 WIRE PLANT. -

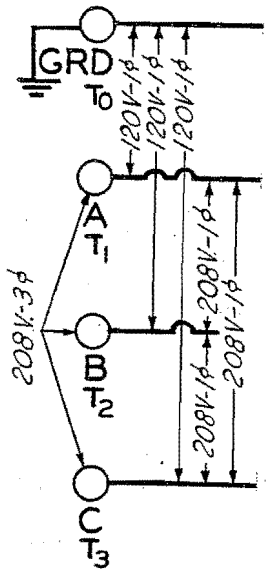


No terminal is grounded. For three phase current, connect a separate load wire to each plant terminal A, B, and C, one wire to each terminal. Reversing the connections between any two terminals will reverse the direction of rotation of 3 phase motors. Use a phase sequence indicator to assure in-phase connection.

To obtain 230 volt, single phase current, connect separate load wires to each of any two plant terminals, one wire to each terminal. Three 230 volt, single phase circuits are thus available, with 1/3 the plant rating to each circuit. Balance the load as closely as possible between the circuits.

If both single and 3 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 load that may be taken from any one circuit for single phase current. For example, a 3 phase 4,000 watt load is used. This leaves 6,000 watts available for single phase, if the plant capacity is 10,000 watts. One third of this 6,000 watts is 2,000 watts, which is the amount that may be taken from each of the 3 single phase circuits. Do not attempt to take all 6,000 in this example off one circuit, as overloading of generator will result.

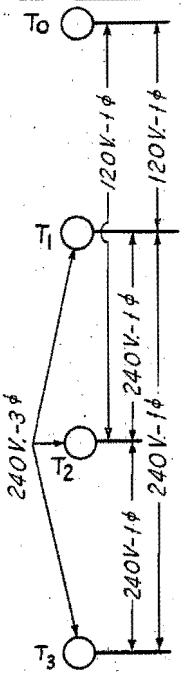


120/208-VOLT, 3 PHASE, 4 WIRE WYE CONNECTED PLANT. -

The topmost terminal is grounded. For 120 volt, single phase current, connect the grounded load wire to the grounded (top) plant terminal, and the other load wire to any one of the other three terminals A, B, or C. Three 120 volt, single phase circuits are thus available, with 1/3 the plant rating to each circuit. Balance the load as closely as possible between the circuits.

For 208 volt, three phase current, connect a load wire to each of the three insulated plant terminals A, B, and C, leaving the grounded (topmost) terminal unused. Reversing the connections between any two insulated terminals will reverse the direction of rotation of 3 phase motors. Use a phase sequence indicator to assure in-phase connections.

For 208 volt, single phase current, connect separate load wires to each of any two insulated(three lower) terminals, one wire to each terminal. Three circuits are thus available, with 1/3 the plant rating to each circuit. Balance the load as closely as possible between the circuits. If both single and three phase current is used at the same time, see the directions for the three phase, three wire plant.



120/240 VOLT 3 PHASE, 4 WIRE DELTA-CONNECTED GENERATOR PLANT. - This type of generating plant is specially designed so that two types of loading can be applied to the generator; regular 240 volt, 3 phase, 3 wire operation; or, combination 240 volt, 3 phase, 3 wire and 120/240 volt, 1 phase 3 wire operation.

The load terminals are marked T0, T1, T2 and T3 from top to bottom. The T0 terminal is the center tap between T1, and T2. The T0 terminal of the generator is not grounded.

For 240 volt 3 phase 3 wire operation connect the three load wires to the three terminals T1, T2, T3, one wire to each terminal post. For 3 phase 3 wire operation the T0 terminal is not used and is normally not grounded.

If it is desired to use combination single phase and three phase loads simultaneously connect such single phase loads as follows:

For 120/240 volt, 1 phase, 3 wire operation, terminals T1 and T2 are the "Hot" terminals: the T0 terminal is the neutral (which can be grounded if desired). For 120 volt service, connect the "Hot" (Black) load wires to the T1 and T2 terminals, and the neutral (White) wire to the T0 terminal. Two 120 volt circuits are thus obtained. The two black wires connected to T1 and T2 will give one 240 volt circuit.

Any combination of single phase and three phase loading can be applied to the generator sinultaneously as specified above as long as no terminal current exceeds the rated NAMEPLATE current of the generator.

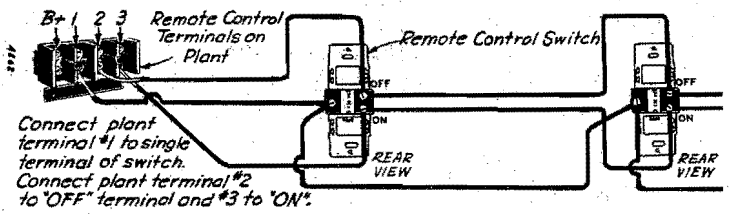
Combination single phase and three phase loads applied to a three phase generator are unbalanced loads which cause the phase voltages to be unequal. These unbalanced loads will not create voltage unbalance of the phase voltages of greater than 5 per cent so long as no terminal current exceeds the rated current of the generator.

This generating plant may be used with an ONAN automatic line transfer control, for standby plant operation. The T0 terminal of the ONAN automatic line transfer control is always grounded. Connecting the generating plant T0 lead to the line transfer T0 terminal grounds the generator. If used in conjunction with an ONAN Automatic line transfer control on a 3 phase 3 wire circuit, the line transfer T0 terminal should be left open and not used.

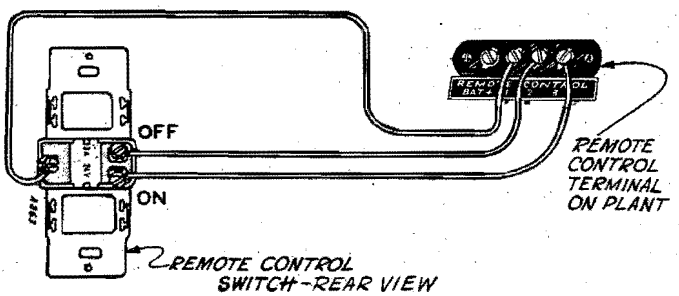
REMOTE CONTROL CONNECTIONS

A small, four place terminal block marked "REMOTE-DC OUTPUT" on the wiring diagram, is provided for connecting start-stop stations. On housed plants the terminal block is located to the left of the ac output terminals. On unhoused plants the terminal block is located inside the control box. One or more remote control switches may be connected to this block for remote starting and stopping. Connect the switch terminals as illustrated, to the terminals No. 1, 2, and 3 on the terminal block. Terminal number 1 is used as a common ground, terminal number 2 connects to the stopping circuit of the plant and terminal number 3 connects to the starting circuit of the plant. The terminal marked B+, is to be used only with an automatic control installation. The wire length from the plant to the switch determines the wire size necessary. Use #18 wire up to 135 feet, #16 wire up to 215 feet, #14 wire up to 340 feet, and #12 up to 550 feet. If automatic line transfer equipment is to be connected, follow the directions supplied with the equipment.

The "Pennsylvania Approved" standby plants are 36-volt-series-field-cranking, and since the stopping circuit differs from the standard type HQ plant, the separate list of permissible remote distances apply as follows: Use #18 wire up to 260 feet; #16 wire up to 420 feet; #14 wire up to 670 feet; #12 wire up to 1060 feet.



REMOTE CONTROL CONNECTIONS - HOUSED PLANTS



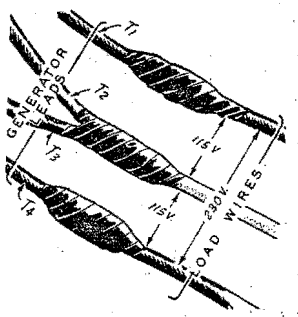
REMOTE CONTROL CONNECTIONS - UNHOUSED PLANTS

CONNECTING THE LOAD WIRES - UNHOUSED PLANTS

GENERAL. - The generator output leads extend out of the generator and have terminals to which the load wires may be bolted. Installing similar terminals on the load wires or using solderless connectors will facilitate making connections. The connections must meet specifications of electrical codes which apply in the locality. Install an approved switch or other device for disconnecting the plant from the load. Connect load wires to generator leads as directed below, according to the type of plant.

On 3 phase, 4 wire plants the (line to neutral) single phase voltage will always be the lower voltage as specified on the nameplate, when the voltmeter (connected line to line) reads the higher voltage as specified on the nameplate.

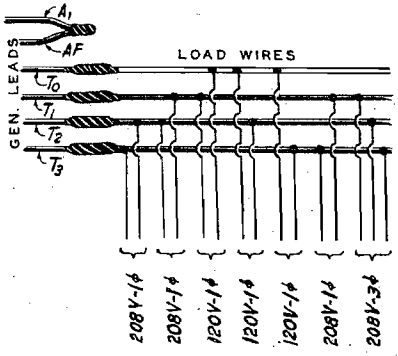
115/230 VOLT, 1 PHASE, 3 WIRE PLANT. - Connect generator leads marked T2 and T3 together. This will be the "neutral" load connection lead. For 115 volt 3 wire service, connect the neutral (white) load wire to the T2, T3 leads. Connect two separate black (hot) load wires, one to each of T1 and T4 generator leads. Two 115 volt circuits are thus available, one between T1 and T2, T3 and the other between T4 and T2, T3. One half the capacity of the generator is available on each circuit. Do not attempt to take the entire generator capacity from one 115 volt circuit, as the generator will be unbalanced and overloaded. Divide the loads as equally as possible between the two circuits.



For 230 volt service, do not connect a load wire to generator leads T2, T3 which must be connected together. Connect one load wire to the generator lead T1, and the other load wire to the generator lead T4.

Note: (3 PHASE PLANTS) If no switchboard (meter box) is to be used, generator leads marked A1 and AF must be connected together. If a switchboard is used, connect all generator leads to the proper points as shown on the switchboard wiring diagram.

120/208-VOLT, 3 PHASE, 4 WIRE WYE CONNECTED PLANT. - For 120 volt, 1 phase current, connect the neutral (white) load wire to the generator lead marked T0. Connect a "hot" (black) load wire to either T1, T2, or T3. Three separate 120 volt circuits are thus available: T0 - T1, T0 - T2, and T0 - T3. 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.

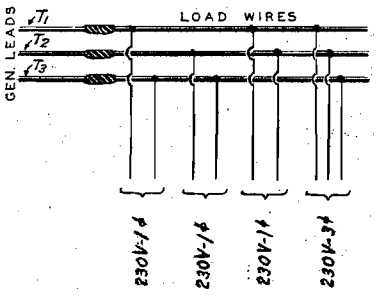


For 208 volt, 1 phase current, the T0 generator lead is not used. Connect separate load wires to any two of the T1, T2 or T3 generator leads. Three separate single phase circuits are available T1 - T2, T1 - T3 and T2 - T3. As when connected for 120 volts, the load should be divided between the three single phase circuits.

For 3 phase current, the T0 generator lead is not used. Connect the three load line wires to the generator leads T1, T2, and T3, one load wire to each generator lead. Reversing the connections between any two leads will reverse the direction of rotation of 3 phase motors.

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. Do not attempt to take the entire single phase load off one circuit, unless the load is a small one. See the example for the housed type of plant.

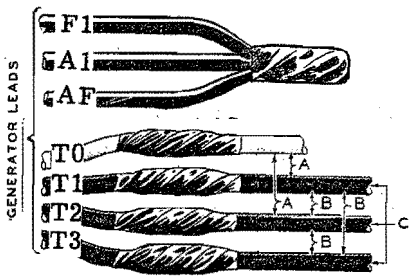
3 PHASE, 3 WIRE PLANT. - For 3 phase current, connect the three load wires to the generator leads T1, T2, and T3, one wire to each lead. Reversing the connections between any two leads will reverse the direction of rotation of 3 phase motors.



For single phase current, connect a separate load wire to each of any two generator leads. Three separate single phase circuits are thus available T1 - T2, T1 - T3, and T2 - T3. Not more than on 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.

120/240 VOLT 3 PHASE, 4 WIRE DELTA-CONNECTED GENERATOR PLANT. - This type of generating plant is specially designed so that two types of loading can be applied to the generator; regular 240 volt, 3 phase, 3 wire operation; or, combination 240 volt, 3 phase, 3 wire and 120/240 volt, 1 phase 3 wire operation.



CIRCUIT	VOLTAGE
A →	120V., 1 PHASE
B →	240V., 1 PHASE
C →	240V., 3 PHASE

The output leads which extend from the generator, are marked T0, T1, T2, and T3, and have "eye" terminals attached. The T0 generator lead is not grounded. Join leads F1, A1, and AF if no automatic control is used.

For 240 volt 3 phase 3 wire operation connect the three load wires to the three output leads T1, T2, T3, one wire to each lead terminal. For 3 phase 3 wire operation the T0 terminal is not used and is normally not grounded. Tape the lead end.

If it is desired to use combination single phase and three phase loads simultaneously connect such single phase loads as follows:

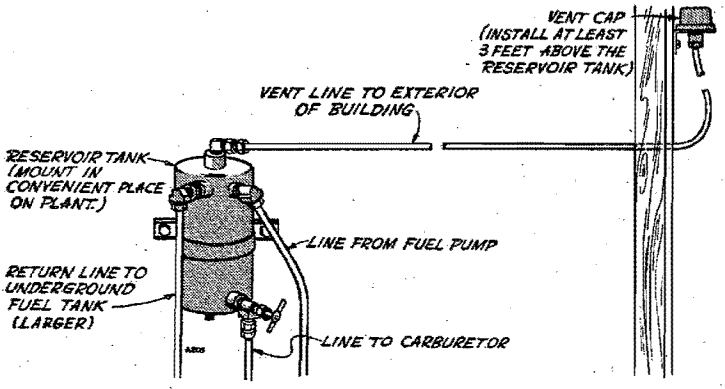
For 120/240 volt, 1 phase, 3 wire operation, output leads T1 and T2 are "Hot". The T0 lead is the neutral (which can be grounded if desired). For 120 volt service, connect the "Hot" (Black) load wires to the T1 and T2 leads, and the neutral (White) load wire to the T0 output lead. Two 120 volt circuits are thus obtained. The two black wires connted to T1 and T2 will give one 240 volt circuit.

Any combination of single phase and three phase loading can be applied to the generator simultaneously as specified above as long as no terminal current exceeds the rated NAMEPLATE current of the generator.

Combination single phase and three phase loads applied to a three phase generator are unbalanced loads which cause the phase voltages to be unequal. These unbalanced loads will not create voltage unbalance of the phase voltages of greater than 5 per cent so long as no terminal current exceeds the rated current of the generator.

This generating plant may be used with an ONAN automatic line transfer control, for standby plant operation. The T0 terminal of the ONAN automatic line transfer control is always grounded. Connecting the generating plant T0 lead to the line transfer T0 terminal grounds the generator. If used in conjunction with an ONAN Automatic line transfer control on a 3 phase 3 wire circuit, the line transfer T0 terminal should be left open and not used and the end of the T0 generator lead should be taped.

RESERVOIR TANK (OPTIONAL). - A reservoir fuel tank, commonly called a "DAY" tank, may be installed, as illustrated. Fuel from this tank flows by gravity to the carburetor to replace any fuel lost by evaporation and insures quick starting after an idle period.

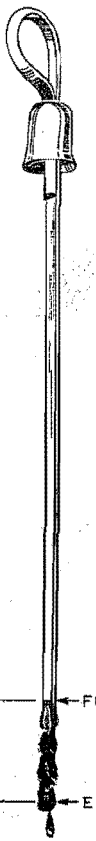


RESERVOIR FUEL TANK

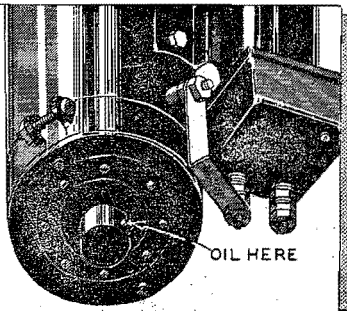
GROUNDING THE PLANT. - Most local electrical codes require that a generating plant be grounded. Observe National and exsisting local codes when grounding the plant.

CITY WATER COOLED PLANTS. - The engines powering these special model plants are cooled by passing a controlled flow of fresh cool water through the engine cooling system. The plumbing requirements will vary according to the particular installation. If water impurities exist (such as calcium, alkali, iron, etc.) in a ratio great enough to eventually restrict the cooling system, install a filtering device to purify the water before entering the engine.

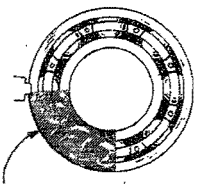
A chemical process, which protects from rust and mineral caking, is available. Details concerning this Model A "Aqua-Clear" process may be obtained from Sudbury Laboratory Inc, Box 487, South Sudbury, Massachusetts, U.S.A.



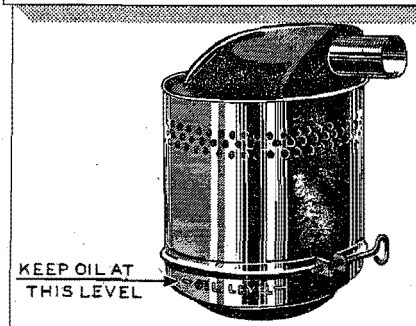
OIL LEVEL GAUGE MARKS



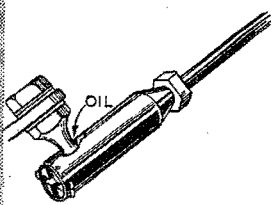
ENGINE STARTER



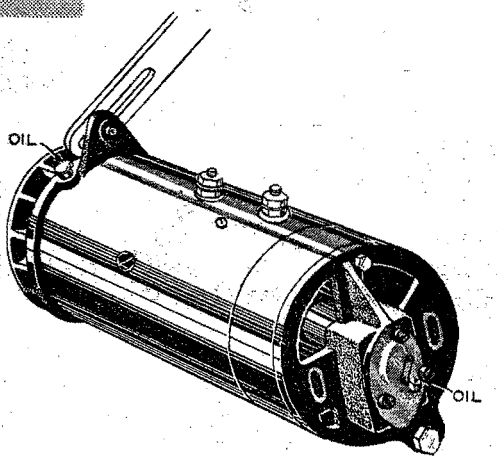
ARMATURE BEARING



AIR CLEANER



GOVERNOR CONTROL LINKAGE BALL JOINT



BATTERY CHARGE GENERATOR

LUBRICATION

PREPARATION FOR OPERATION. - Before putting the plant in operation, supply it with fuel, oil, and water (or anti-freeze liquid). Comply with the following instructions.

LUBRICATION. - Fill the crankcase with 4 quarts (U.S. Measure) of a good quality heavy duty (detergent) type oil. Approximately 1 pint 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, according to the lowest temperature to which the plant will be exposed, as indicated in the following table. The temperatures indicated are for conditions where the plant will be standing idle long enough to cool off to the surrounding temperature.

TEMPERATURE	SAE NUMBER OF OIL
Above 32° F. (0° C.)	30
32° F. to 0° F. (0° C. to -18° C.)	10
Below 0° F. (-18° C.)	5W or 10W (As required for engine starting.)

If SAE number 5W oil is not obtainable for use in temperatures below 0°F., use diluted number 10W oil as directed under ABNORMAL OPERATING CONDITIONS - LOW TEMPERATURES.

The use of a heavy duty (detergent) type of oil will help to increase the life of pistons and rings. If a change to a detergent 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.

Keep the crankcase oil level at or near the upper level mark on the oil level gauge, but never above it. Do not attempt to check the oil level while the plant is running. 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 to the low level mark on the oil level gauge.

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

AIR CLEANER. - Remove the bottom cup of the air cleaner and fill to the "OIL LEVEL" mark with oil of the same SAE number as that used in the crankcase. Be sure the bottom cup is properly re-installed.

FUEL, GASOLINE. - The fuel pump inlet is provided with a fitting for 1/4" inverted flared tubing. If necessary to replace the inlet fitting with another type, be sure the replacement fitting has 1/8" pipe threads to fit the fuel pump inlet.

If the plant is equipped with a fuel tank mounted inside the plant housing, the tank capacity is 15 gallons, U.S. Measure. Do not fill the tank completely full of cold gasoline. Expansion of the gasoline as the plant warms up, may cause the gasoline to overflow, creating a fire hazard. The fuel gauge on the control panel registers the amount of fuel in the mounted tank only when the plant is running, or if the ignition switch is thrown to the HAND START position. Do not fill the tank when the plant is running.

Use fresh, clean "regular" grade gasoline. Do not use premium grade gasoline. If highly leaded gasoline is used, more frequent carbon and lead removal, valve grinding and spark plug servicing will be necessary. However, do not use a low octane fuel, such as "stove gas".

FUEL, GAS. - If the plant is equipped to burn gas fuel, observe provisions of local gas codes in connecting to a source of gas fuel. There were two types of atmospheric regulators furnished with the HQ series units. See the paragraph "Natural Gas Fuel"in the "Installation Section" for the recommended line pressure for the type of regulator that was furnished with the unit.

RADIATOR. - The capacity of the cooling system is 10-1/2 quarts U.S. Measure. Be sure both drain cocks are closed. Use clean, alkali free (soft) water. Clean rain water may be used. The use of a rust and scale preventative in the cooling system is recommended.

If the plant will be exposed to freezing temperatures, use a standard anti-freeze solution. Use the correct proportion of antifreeze as recommended by the anti-freeze manufacturer, depending upon the lowest temperature to which the plant may be exposed. To avoid loss of antifreeze through the radiator overflow pipe, due to expansion of the coolant as the plant warms up, fill only to between 1 or 2 inches below the bottom of the filler neck.

After the instructions under INSTALLATION and PREPARATION have been carefully complied with, the plant should be ready for operation. However, before starting the plant, carefully study the sections headed OPERATION and ABNORMAL OPERATING CONDITIONS immediately following.

PRELIMINARY. - Before starting the plant, be sure that it has been properly installed and prepared for operation. Turn on the fuel supply and check for leaks, correcting any that may be found. Be sure that no electrical load is connected to the generating plant.

STARTING THE PLANT ELECTRICALLY. - Set the ignition toggle switch at the ELECT. START position. Press the START switch to electrically crank the engine. On a plant being started for the first time, or one which has run out of gasoline, it will be necessary to allow the engine to crank long enough to allow the fuel pump to become full and to pump gasoline to the carburetor. Do not crank steadily, but in periods of approximately five seconds each, with five seconds intervals between crankings.

When the carburetor receives sufficient fuel, the plant should start. Carburetor choking is automatic. As the engine starts to fire, hold the START switch in contact until the plant has picked up running speed.

After the first start, the plant should start within a few seconds of cranking. Failure to start promptly is usually an indication of trouble in the fuel or ignition systems, and the cause of the trouble should be found and corrected.

NOTE

> Sometimes, when the plant is stopped for a short time and an attempt to restart is made while the engine is still hot, it may be necessary to pull up on the automatic choke arm momentarily while cranking. The engine starts at full open throttle position, and so may require some choking under certain hot conditions.

If the generating plant is equipped for the use of gas fuel as well as gasoline fuel, the automatic choke control mounted atop the exhaust manifold is fitted with a lock device. See that the operating arm of the automatic choke is locked in the down position, so that the choke can not operate. NO CHOKING IS NECESSARY WHEN OPERATING ON GAS FUEL, AND THE CARBURETOR CHOKE VALVE SHOULD BE WIDE OPEN. The Ensign regulator requires a choke sleeve to be fitted to the air intake of the carburetor. The Garretson regulator requires no choking or priming.

Turn on the gas fuel supply and press the START switch. The plant was test run on 1000 BTU gas, and if a different BTU content gas is used, it may be necessary to readjust the carburetor gas adjustment valve slightly to assure smooth and economical operation. See the section headed ADJUSTMENTS.

STARTING THE PLANT MANUALLY. - If the starting batteries lack sufficient power to crank the engine, or the engine can not be cranked electrically for some other reason, the plant can be started manually.

To start the plant manually, see that the fuel system is ready for operation, as explained under STARTING ELECTRICALLY. Throw the ignition switch to the HAND START position. Engage the hand crank and crank the engine, using a quick upward pull on the crank handle. Do not "spin" the crank. The automatic choke provides full choking action only when the START switch is in contact, so it is necessary to block or hold up the choke arm for a few preliminary crankings. If gas fuel is being used, it may be necessary to press the priming button, at the center of the Ensign regulator, for an instant. Do not over prime. After the plant starts and has reached running speed, throw the ignition toggle switch to the ELECT. START position.

STANDBY SERVICE. - When the generating plant is used for standby service, upon failure of a regular source of electrical power, it is essential to start the plant regularly. If practicable, start the plant once each day and allow to run for approximately 15 minutes. The generating plant should never be allowed to stand for more than a week without such a "dry" run.

If the plant will start but does not continue to run, start the plant manually with the ignition switch in the HAND START position. If the plant continues to run with the ignition switch at the HAND START position, but stops when the switch is thrown to the ELECT. START position, trouble is indicated in one of the relays or a loose connection. Failure of the battery charging generator to deliver current to the stop relay will also prevent the plant from running with the ignition switch at the ELECT. START position.

CAUTION. - KEEP THE IGNITION TOGGLE SWITCH AT THE ELECT. START POSITION AT ALL TIMES EXCEPT WHILE ACTUALLY STARTING THE PLANT MANUALLY OR WHEN MAKING TESTS. WHEN THE SWITCH IS AT HAND START POSITION THE PLANT CAN NOT BE STOPPED REMOTELY NOR BY PRESSING THE STOP SWITCH AT THE PLANT. IF THE SWITCH IS LEFT AT THE HAND START POSITION WHEN THE PLANT IS NOT RUNNING, THE BATTERY MAY BECOME DISCHARGED!

CHECKING THE OPERATION, HOUSED PLANTS. - 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 30 pounds, the coolant temperature approximately 150° to 180° F. (65° to 82°C), and the battery charge rate between 2 and 20 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 ELECT. START position.

Connect a load to the plant by throwing the circuit breaker handle to the ON position. If the plant tends to surge, it is an indication the engine needs additional warm-up before connecting a heavy load.

The electrical meters indicate the output voltage and the amount of load connected to the output terminals. At no load, the voltage should be slightly above the nameplate rating, and with a full load the voltage should be slightly below the nameplate rating. Extremely close voltage regulation is provided by the automatic ac voltage regulator. Refer to the instructions under REGULATING THE VOLTAGE. A voltmeter-ammeter selector switch is provided for checking the individual phases of the circuit on the three phase plants.

If the voltmeter reading fluctuates, investigate for possible fluctuating load conditions before attempting any adjustments on the plant carburetor or governor.

The circuit breaker will open automatically and disconnect the load if the plant is severely overloaded. Correct the cause of overloading before again throwing the circuit breaker handle to the ON position. To disconnect the load, throw the circuit breaker handle to the OFF position.

CHECKING THE OPERATION, UNHOUSED PLANTS. - The unhoused plant is not equipped with the instrument panel supplied on the housed plant. The absence of the various instruments does not affect the efficiency of the plant in any way, but does impose upon the operator the responsibility of becoming sufficiently familiar with the performance of the plant to recognize any abnormal condition before damage may be done.

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 ground out the ignition, 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 ground out the ignition, 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 with the switch at the HAND START position. This is purely an emergency measure and should be resorted to only if necessary. All relays, etc. are cut out of the engine control circuit. Keep a careful check on the plant while operating under these conditions.

If the automatic voltage regulator fails, follow the instructions for normal rheostat operation under REGULATING THE A.C. OUTPUT VOLTAGE.

STOPPING THE PLANT. - If practicable, disconnect the electrical load. Press and hold the STOP switch firmly. The switch is a momentary contact type and must be held at STOP position until the plant completely stops. The ignition switch must be at the ELECT. START position, as pressing the STOP button will have no effect if the switch is at the HAND START position.

REGULATING THE A.C. OUTPUT VOLTAGE

All models are equipped with an external voltage regulator rather than the generator being inherently regulated. Normally, the regulator does not require attention during successive plant operations.

FUNCTION. - The voltage regulator is an automatic device for controlling the output voltage of the generator. It is basically a variable resistance inserted in the exciter field circuit of the generator. The generator output voltage actuates an electromagnet in the regulator. The magnet in turn varies the resistance value used. If the generator output voltage tends to drop, the regulator resistance is lowered, allowing the generator exciter field strength to increase, which in turn keeps the output voltage at its original value. If the generator voltage tends to rise, the regulator resistance is raised, reducing the exciter field strength, which in turn keeps the output voltage at its original value. The regulator provides automatically the same effect as is obtained by hand operation of a rheostat on a manually controlled generator.

REGULATOR CONTROLS. - There are three controls on the generating plant which affect the regulator operation, as follows:

1. The "REGULATOR ON - RHEOSTAT ON" toggle switch located on the plant control panel (see note). - When the switch is at the "REGULATOR ON" position, the voltage regulator is in operation. When the switch is at the "RHEOSTAT ON" position, the voltage regulator is NOT in operation and voltage MUST BE CONTROLLED BY HAND OPERATION OF THE RHEOSTAT. This switch is provided for emergency operation only, and should be left at "REGULATOR ON" position at all times, except in case of accidental failure of the regulator.

NOTE: Beginning with, Spec "B" plants built in June 1954, the REGULATOR ON - RHEOSTAT ON toggle switch is no longer mounted separately on the panel but is combined with the field rheostat and is operated automatically when the rheostat knob is turned all-the-way counterclockwise (maximum resistance, giving lowest ac voltage). The factory turns the field rheostat to REGULATOR ON position and covers the knob with a shield to prevent tampering. The position of the switch on the rear of the field rheostat must be in time with the rheostat for proper engagement !

2. The rheostat knob located on the plant control panel. - This panel rheostat knob is to be used for manual control of the generator output voltage ONLY when the toggle switch is at the "RHEOSTAT ON" position. Before switching to REGULATOR operation, this knob must first be turned to lowest ac voltage to avoid possible damage to the contact fingers of the regulator.

3. The voltage adjusting knob for the voltage regulator. - This knob is used for raising or lowering the output voltage when the regulator is in operation. The adjusting knob is on the voltage regulator box.

Turn the knob clockwise to increase voltage, or counterclockwise to lower the voltage.

VOLTAGE REGULATED OPERATION. - Except upon regulator failure, the plant should always be left at regulator operation and no attention is required during successive plant operations. Although the electrical circuit is the same, the procedure differs slightly, between earlier and later built plants. If the plant is running, the position of the manual field rheostat is critical, and it is also advisable to disconnect the electrical load, when switching to or from regulator operation.

1. To operate the later built plant equipped with a combined field rheostat and switch, simply turn the manual field rheostat all-the-way counterclockwise. The rheostat decreases the ac voltage before engaging the toggle switch and snapping it to REGULATOR ON position.

2. To operate the earlier built plant equipped with a regulator switch mounted separately on the panel, begin with the RHEOSTAT ON - REGULATOR ON switch at the RHEOSTAT ON position. Turn the manual rheostat to the maximum counterclockwise position (minimum ac voltage), then snap the switch to REGULATOR ON position.

Adjust the voltage regulator rheostat to obtain rated ac voltage.

Turn the knob clockwise to raise the voltage. Turn the knob counterclockwise to lower the voltage. It should not be necessary to use the adjusting knob under normal conditions.

If the generator voltage can not be set at the desired point by adjusting the regulator rheostat, then adjust the voltage adjusting resistor on the regulator. Refer to REGULATOR ADJUSTMENTS under Adjustments.

If a hunting condition exists, check the engine governor operation. Refer to GOVERNOR ADJUSTMENTS under Adjustments. If the hunting cannot be eliminated by adjusting the governor, the voltage regulator dashpot must be adjusted. See VOLTAGE REGULATOR DASHPOT ADJUSTMENT under Adjustments. The regulator dashpot adjustment is the only adjustment that should ever be attempted on the voltage regulator plug-in unit.

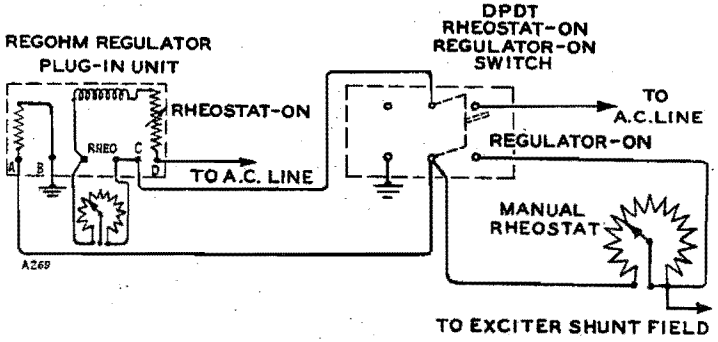
IMPORTANT

NEVER CHANGE THE FACTORY SETTINGS OF THE REGULATOR SPRINGS OR CONTACT FINGERS.

When the regulator is operating properly the output voltage can be varied by adjusting the voltage regulator rheostat. The REGOHM regulator is designed to control the ac voltage within + or - 2% of the

desired voltage. The voltage output may be adjusted to approximately + or - 5% of the rated voltage of the plant by turning the voltage adjusting knob.

The regulator will keep the voltage at the same value regardless of changes in temperature, load, or power factor. However, the voltage regulator can not be expected to compensate for poor governor operation, low engine speed, or loss of engine power under load conditions.



VOLTAGE REGULATOR CONTROL CIRCUIT

RHEOSTAT OPERATION (For Emergency Only!). - When the regulator toggle switch is at the "RHEOSTAT ON" position, the output voltage must be manually controlled by adjusting the panel rheostat knob. CAUTION: Before starting the plant, turn the knob counterclockwise to lower the voltage. (On plants having the combined rheostat and switch the extreme counterclockwise position disconnects the manual rheostat making it necessary to start slightly clockwise.) This is necessary to compensate for naturally higher voltage produced by a cold generator, and not under load. The voltage will drop somewhat as it warms up.

The setting of the rheostat must be changed with changes in the electrical load. At a light load, the rheostat must be toward a counterclockwise position. As electrical load is increased, the generator voltage will drop, and it is necessary to turn the rheostat clockwise to bring the voltage up to proper value.

Do not fail to adjust the voltage with the panel rheostat whenever a substantial change is made in the electrical load on the generator. If a substantial electrical load is reduced, turn the rheostat counterclockwise to lower the voltage. If this is not done, the voltage may be so high as to damage a light load. If a light electrical load is increased substantially turn the rheostat clockwise to raise the voltage to the proper value. If this is not done, the voltage may be so low as to cause motors to overheat, etc.

The rheostat is provided solely for emergency operation in case of failure of the voltage regulator. Care must be used in the use of the rheostat and repairs or replacement of the regulator should be made as promptly as possible.

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 10 in the crankcase. For temperatures below 0° F. (-18° C.) use SAE number 10W, or number 5W if necessary for engine cranking. Use heavy duty detergent type oil.

If number 5W oil is not obtainable, dilute number 10W oil with not more than 1 part of kerosene to 4 parts of oil. Do not put diluted oil into the engine until ready to start the plant. 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. Always use a mixture of the same proportions when adding oil between changes. When using diluted oil, change the oil every 50 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. Do not use diluted oil in the air cleaner.

COOLING SYSTEM. - The coolant must be protected if there is any possibility of its freezing. Use any good anti-freeze solution, in the porportion recommended by the anti-freeze manufacturer for the lowest temperature to which the plant will be exposed. The capacity of the cooling system is 10-1/2 quarts, U.S. Measure.

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 used. Check the antifreeze solution frequently.

If the cooling system is drained to prevent freezing, BE SURE TO REMOVE THE RADIATOR CAP in order to prevent formation of a vacuum in the cooling system, which would prevent complete draining. Open both the radiator and the cylinder block drain cock.

FUEL, GASOLINE. - Fresh, clean, winter "regular" grade gasoline is an aid to easy starting in cold weather. Moisture condensation can cause considerable trouble from ice formation in the fuel system. Do not fill the fuel tank entirely full of cold gasoline, as expansion may cause it to overflow. However, moisture condensation will be reduced if the tank is kept as full as practicable.

BATTERIES. - Check the charge condition of the batteries frequently, to be sure that they are kept in a well charged condition. A discharged battery will freeze at approximately 20°F. (-7°C.) and may be permanently damaged. A fully charged battery will not freeze at -90°F. (-67°C).

HIGH TEMPERATURES

COOLING SYSTEM. - 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. Keep the radiator well filled, the fan belt tension properly adjusted, and the crankcase oil level at, but not above the full mark on the oil level gauge.

NOTE

For best cooling effects for housed plants, keep the door panels in place on the plant when it is in operation. Do not obstruct the flow of air to the plant.

Use SAE number 30 oil for temperature up to 100°F. (38°C.) and SAE No. 40 for higher temperatures. Check the oil level frequently, and change the crankcase oil at least every 100 hours. Keep the electrolyte level in the batteries up to normal.

BATTERY. - For a usual plant installation, follow the instructions for Batteries under INSTALLATION. If the installation agrees with the following description, prepare the battery to assure long battery life by REDUCING BATTERY SPECIFIC GRAVITY.

Standard automotive type storage batteries will self discharge very quickly when installed where ambient temperature is always above 90°F., such as in a boiler room. To lengthen battery life, adjust the electrolyte from a normal 1.275 reading at full charge to a 1.225 reading.

The cranking power of the battery is also reduced when electrolyte is diluted to reduce acid activity and thus lengthen battery life. If temperature is consistently above 90°F. (32.2°C.) adjust the electrolyte as instructed below.

1. Fully charge the battery. DO NOT BRING AN OPEN FLAME OR

BURNING CIGARETTE NEAR THE BATTERIES ON CHARGE BECAUSE THE GAS RELEASED DURING THE CHARGING IS VERY INFLAMMABLE.

2. While battery is on charge, use a hydrometer or filler bulb to siphon off all of the electrolyte above the plates in each cell. Don't attempt to pour off!! Dispose of the removed electrolyte. AVOID SKIN OR CLOTHING CONTACT WITH ELECTROLYTE.
3. Fill each cell with pure distilled water.
4. Recharge the batteries for one hour at a 4 to 6 ampere rate.
5. Use a reliable battery hydrometer, to test each cell. If the specific gravity is above 1.225, repeat steps number 2, 3 and 4 until the highest specific gravity reading of the fully charged battery is not over 1.225. Most batteries require repeating steps 2, 3, and 4 two times.

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 as necessary, before the normal time has elapsed between changes.

Follow a definite schedule of inspection and servicing to assure the best performance and long life of the plant. Service periods outlined below are for average service and normal operating conditions. Under unusual service or abnormal operating conditions, service the plant more frequently. Keep a record of the hours the plant is operated each day to assure servicing at the proper time.

	HOURS OF OPERATION					
	Daily	50	100	200	500	1000
Oil level.	X					
Coolant.	X					
Air cleaner cup and filter.	X					
Crankcase vent cap.		X				
Battery electrolyte level.		X				
Oil-charge generator start motor.			X			
Change engine oil.			X			
Change oil filter element.			X			
Lubricate distributor.			X			
Inspect and adjust points*.			X			
Fan belt tension			X			
Clean spark plugs*.			X			
Magneto points*.				X		
Compression pressure.					X	
AC-DC generator brushes*.					X	
Charging generator brushes*.					X	
Tappet clearance.					X	
Starting motor brushes.					X	
Inspect commutator.					X	
Grind valves*.					X	
Clean carbon.					X	
Remove and clean oil pan and oil pump inlet screen.						X
Flush cooling system.						X
AC-DC generator bearing.						X
Clean carburetor. □						X
Complete reconditioning.	5000 Hours					

* - Replace as Required.
□ - Service as Required.

If it is necessary to remove parts for inspection and gaskets are disturbed, they should be replaced with new ones.

When brushes are replaced be sure the commutator and slip rings are in good condition.

Recommended Fuel: Use a regular grade of gasoline. If a high lead content is used, it will be necessary to remove the lead deposits more frequently.

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. The running time meter records the TOTAL number of hours the plant has been in operation.

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 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 non-permanent type antifreeze is used, check the protective strength of the coolant. The cut-off switch will not protect against evaporation.

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 100 operating hours. If the plant has been operating with diluted oil, change the oil after 50 hours operation. Drain the oil filter can to coincide with each oil change and drain the oil while hot. Never flush with kerosene.

GENERAL LUBRICATION. - Put a little powdered graphite oil on each of the governor to carburetor link ball joints. 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.

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 AND GENERATOR BELT. - Check the tension of the fan belt. Adjust to permit about 3/4" play when pressure is applied midway between the pulleys. Install a new belt if the old one is badly worn.

BATTERIES. - See that the battery connections are clean and tight. Keep the electrolyte level approximately 3/8" 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. If hard starting occurs when using gaseous fuel, correct the spark plug gap as shown in the Table of Clearances.

IGNITION. — Check the ignition contact points. If they are only slightly burned or pitted, resurface them on a fine stone. Install new contact points if the old ones are badly burned. Keep the gap adjusted according to the type ignition used as shown in the Table of Clearances. Excessive burning or pitting of the points usually 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.

GASOLINE SUPPLY. - If the plant has a mounted tank, close the gasoline shut off valve and remove and clean the sediment bowl and screen. Be sure the bowl gasket is in good condition when reassembling.

Remove the pipe plug at the bottom of the carburetor and drain the bowl of any sediment which may have accumulated. Remove the fuel pump bowl and clean the screen and sediment recess.

Turn on the gasoline supply and inspect for leaks, correcting any found.

IGNITION. - Place a light coating of grease on the breaker cam of the unit.

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

OIL FILTER. - Engine condition , hours of running time, accumulation of sludge in the filter can, and a crankcase oil change to a different SAE number are determining factors for the necessity of changing the oil filter element. Oil discoloration is normal with heavy duty detergent oils. Clean out the oil filter and install a new element. The new filter element will absorb approximately one pint 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. A difference of more than 10 pounds pressure between cylinders or uniformly low compression indicates a compression loss which should be corrected. High compression is an indication of excessive carbon or lead deposits in the combustion chambers. Compression reading of 115 lbs. or over at battery cranking speed is considered good compression.

CRANKCASE BREATHER HOSE. - To assure proper crankcase ventilation, this hose must not be restricted by sludge accumulation. Engine condition will greatly determine necessity for periodic inspection and cleaning of the hose.

CARBON (OR LEAD) REMOVAL. - In some cases, lead deposits build up around valves and in the combustion chamber very rapidly. Burned valve faces or seats may soon result, leading to poor compression and a noticeable loss of power. When using the average automotive gasoline, remove the engine cylinder head each 500 operating hours. Carefully clean all carbon and lead deposits from the combustion chamber, paying particular attention to the valves. If valves do not seat perfectly, a valve grind job should be done. If carbon and lead deposits are removed frequently enough, the frequency of necessary valve grinding jobs can be substantially reduced.

These engines have "positive-rotor" type valves. Consequently under ideal operating conditions necessary periods might be extended but never exceeding 500 hours.

GENERATOR. - Check the condition of the commutator, slip rings, and brushes. In service, the commutator and slip 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 slip rings become heavily coated, clean with a lint free cloth. Slight rough [illegible] may be remedied by lightly sanding with #00 sandpaper. Clean out [illegible] on 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.

Check the brush rig for proper alignment of the reference marks on the brush rig and its support.

Refer to the Maintenance and Repair section for generator service details.

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

Perform the following services every six months or after each 1200 hours of running time, whichever occurs first.

On standard models beginning with model Spec "C", the rotor ball bearing is a double sealed prelubricated type and no future lubrication is required. Lubrication instructions apply to the earlier and special models.

GENERATOR BEARING. - Clean all dirt from around the generator bearing cover and remove the cover. On some models the cover is pressed into the bearing support and is removed by prying it out. Other models have a cover held in place by screws.

Some models have a double shielded generator ball bearing. This type of bearing will not require any further lubrication.

Lithium base type bearing grease is used by and recommended by the factory. This bearing grease is superior because it does not run, and will not become hard or caked when used at temperatures ranging from minus 90°F. to 125°F. With lithium base grease, service the generator ball bearing each 5000 operating hours or each 2 years. Only a small quantity of this grease need be used. With a clean finger, remove as much as possible of the old grease. Force fresh grease into a 1/4 section of the bearing. DO NOT fill the entire bearing. Do not put a reserve of grease in the bearing recess nor in the bearing cover. If dirt has gotten into the bearing, remove the bearing and clean it in a good solvent. Dry the bearing thoroughly and reinstall it.

If ordinary good ball bearing grease is used, service the generator ball bearing each 2000 operating hours or each 6 months. With a clean finger remove all the old lubricant and work approximately one tablespoonful of new bearing lubricant into the bearing. Again clean out the bearing, then refill about 1/2 full, packing the lubricant well into the lower half of the bearing.

Reinstall the bearing cover gasket and cover, using care that no [illegible] into the bearing.

CARBURETOR, GASOLINE ONLY. - 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 places when reassembling.

Changes in the type of gasoline used, or in operating conditions may necessitate a readjustment of the carburetor. Before readjusting the carburetor, make sure that the ignition system, valves, and other parts of the fuel system are operating properly. The main jet adjustment is at the bottom of the carburetor and should be adjusted with a full load on the plant, and with the plant at operating temperature.

Turn the adjusting needle in (clockwise) until the voltage, as shown on the AC VOLTMETER drops noticeably. 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 more than one half turn 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.

After the plant has been adjusted for load operation, disconnect the load and adjust the idle adjustment screw in the same manner. This adjustment is usually not as critical as the main jet adjustment. The throttle lever idling stop screw should be adjusted 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 AND GASOLINE COMBINATION. - A change in the BTU rating of the fuel used will probably necessitate readjusting the gas adjustment screw 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. 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.

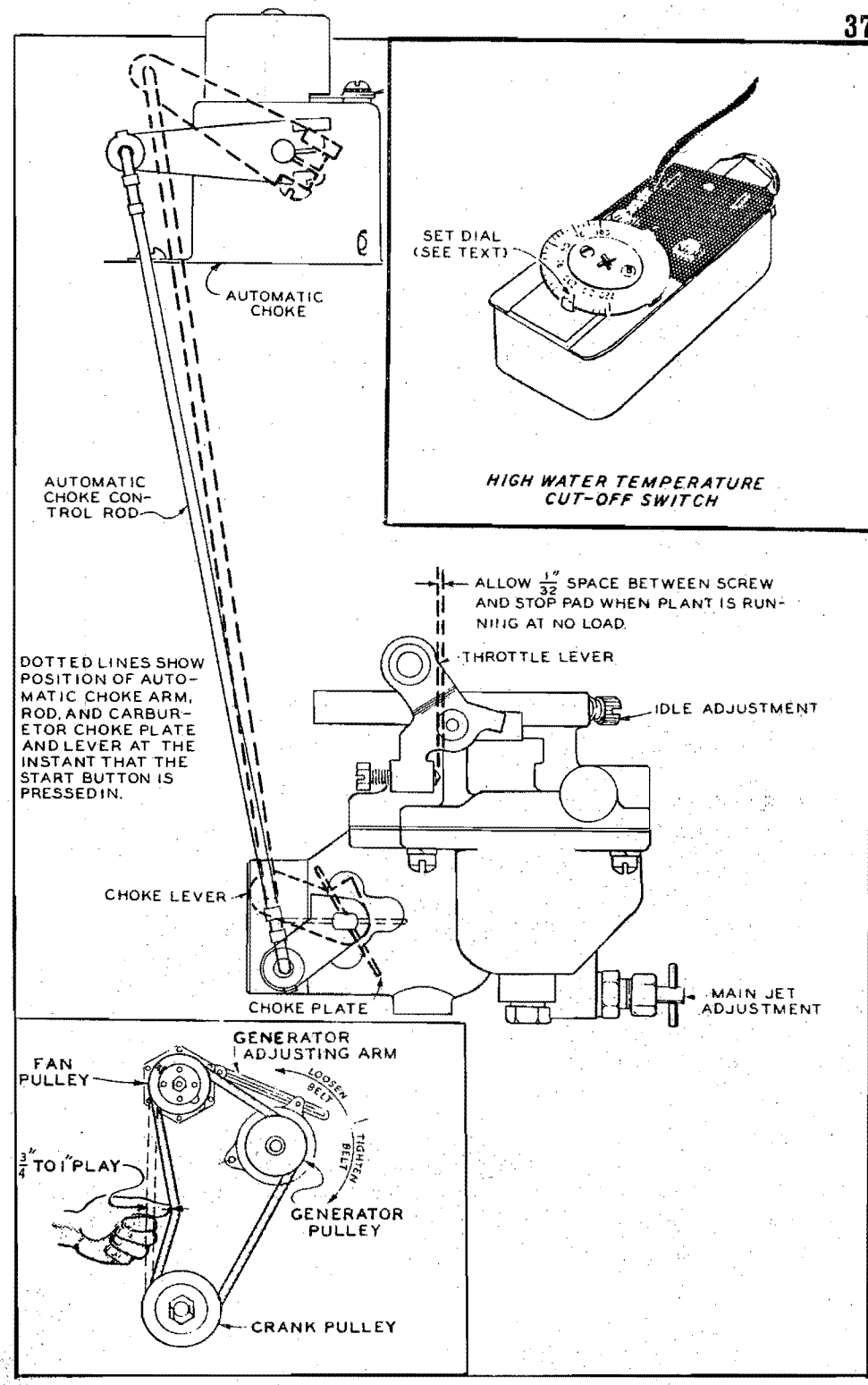
CARBURETOR, GAS ONLY. - No choking is required with a Garretson regulator. The carburetor has an adjustable main jet and idle jet. Main jet adjustments should be made at full load to attain proper voltage and speed as instructed for the combination carburetor above. Idle jet adjustments should be made at light load to

attain smoothest operation. The throttle lever idling stop screw should be adjusted so that there is 1/32" space between the screw end and throttle stop when the plant is operating at no load.
Only a very slight readjustment of both jets should be necessary with a change in the BTU rating of the fuel used. With a lower BTU rating turn the jets open (counterclockwise) slightly, or with a higher BTU close them slightly.

HIGH WATER TEMPERATURE SWITCH. - The high water temperature switch (optional on unhoused plants) operates to stop the engine if the coolant temperature rises too high. This prevents overheating, which could cause serious damage to 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 operating temperature. The switch will not operate if the ignition switch is at the HAND START position.

FAN AND GENERATOR BELT ADJUSTMENT. - The belt tension is determined by the position of the battery charging generator. To readjust the belt tension, loosen the generator adjusting arm bolt and nut slightly. Move the generator toward the engine to loosen the belt, or away from the engine to tighten the belt. Adjust to permit 3/4" to 1" play in the belt when pressure is applied at a point midway between the fan and crankshaft pulleys. Be sure to retighten the adjusting arm screw and nut when the adjustment is completed. Too tight a belt will wear out rapidly and cause excessive strain on the water pump and battery charging generator bearings. A belt which is too loose will slip, causing rapid belt wear, inefficient cooling, and possible low battery charge rate.

AUTOMATIC CHOKE. - The choke control should not need seasonal adjustments, but may be adjusted in the following manner. Turn the shaft of the control to the position where a 3/32" diameter rod may be passed down through the hole in the end of the shaft opposite the lever. Engage the rod in the notch in the edge of the mounting flange. Loosen the lever clamp screw just enough to allow the lever to be turned slightly. To adjust the choke for a richer mixture, pull the lever upward. To adjust for a leaner mixture, push the lever downward. Retighten the lever clamp screw and remove the rod from the hole in the shaft. Check to see that when the lever is lifted up to the limit of its travel, the carburetor choke valve is completely closed, and when the lever is pushed down, the carburetor choke valve is wide open. For gas or vapor operation, the choke arm should be locked in the wide open position.



ADJUSTMENTS

MANIFOLD HEAT ADJUSTMENT. - This valve speeds up engine warm-up. It does not aid engine starting. Normally a slightly longer engine warm-up time is better than altering the valve adjustment. The valve must work freely.

Under certain atmospheric conditions, such as cold and damp weather, it may be necessary to change the setting of the manifold heat control valve. Moisture in the air may condense and freeze as it passes into the carburetor, causing ice formation in the carburetor venturi. Ice formation would cause low power output. To increase the heat deflected to the intake manifold and carburetor venturi, loosen the heat control valve sector lock nut and turn the shaft counterclockwise to the desired position. This loosens the tension on the operating spring which allows exhaust heat to be deflected for a longer period of time. In very cold weather it may be necessary to turn the valve counterclockwise to the limit of its travel. Under extreme conditions it may be necessary to install an auxiliary air heater around the manifold to deflect more heat to the carburetor air intake.

GOVERNOR. - The governor controls the speed of the engine, and therefore the frequency of the current. Plant speed affects ac output voltage. Either a tachometer or frequency meter may be used to check engine speed for proper governor adjustment. The ac output is rated at 0.8 power factor, which is an electrical load consisting mostly of electric motors and transformers rather than entirely of lights and heating elements.

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

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

3. Adjust the speed. With no electrical load connected, adjust the speed screw to attain the proper no load (n.l.) speed as shown in the speed chart. Apply a full rated load at 0.8 power factor and again check the speed. Be sure the voltage is safe for the load applied. An incorrect speed drop from full load to no load necessitates a sensitivity adjustment.

Although the plant is rated at 80% power factor load, the speed and voltage regulation at full load may be made by connecting the type of load that corresponds with the application. At unity (1.0) power factor the KW rating is equal to the KVA rating.

4. If the plant tends to hunt (alternately increase and decrease speed) under load conditions, increase very slightly the distance between the governor main shaft and the sensitivity screw on which the spring link pivots. For best regulation keep the sensitivity screw up as closely as possible without causing hunting.

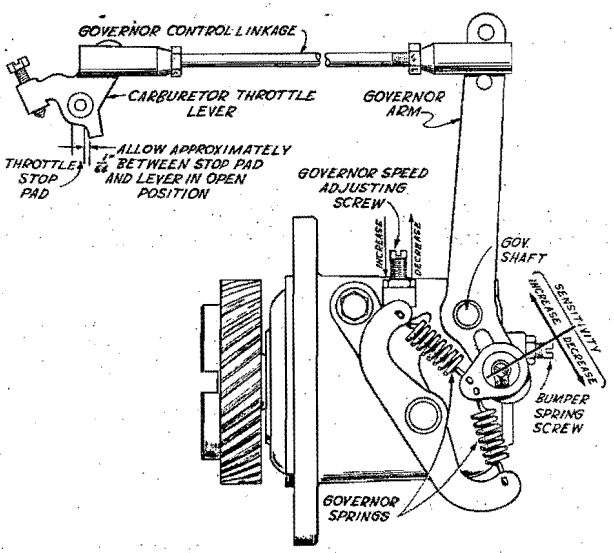
Any change in the setting of the sensitivity screw will require correcting the speed screw adjustment. Decreasing sensitivity by turning the screw clockwise causes a slight speed increase which can be corrected by turning the speed screw slightly counterclockwise to decrease spring tension.

SPEED CHART FOR CHECKING GOVERNOR REGULATION

		SPEED RANGE LIMITS		SPEED SPREAD (WITHIN RANGE) PREFERRED	LIMITS	
		MAX.	MIN.	F. L.* to N. L.	MAX.	MIN.
FOR ALL 60 CYCLE PLANTS	CYCLE→63		59	59 - 61	3	1.5
	RPM——→1890		1770	1770-1830	90	45
FOR ALL 50 CYCLE PLANTS	CYCLE→53		49	49-51	3	1.5
	RPM——→1590		1470	1470-1530	90	45

* Speed Regulation for Full Rated Load is at 0.8 Power Factor.

5. If hunting occurs at NO LOAD, screw the small bumper spring 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.



GOVERNOR ADJUSTMENT

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 probably that the engine is low on power and should be repaired as necessary.

Recheck the ac output voltage.

A.C. VOLTAGE REGULATOR ADJUSTMENT PROCEDURE. - See also the instructions REGULATING THE VOLTAGE under Operation section of this manual.

This procedure will be necessary only after installation of new parts or after disturbing the setting of original parts. Reference to the plant wiring diagram will be helpful.

Be sure engine speed is correct before attempting to correct output voltage by adjusting the ac voltage regulator.

1. Snap the toggle switch to RHEOSTAT ON position.

2. Adjust the manual rheostat to obtain an exciter voltage of 70 volts. Use a dc voltmeter across two adjacent dc brushes (A1 and A2).

3. Set the DC brushes. With the brush rig loosened shift it to the position which gives the highest voltage. The peak dc exciter voltage gives the peak ac output voltage. This brush rig position will be the same as neutral position resulting in the least arcing at the brushes.

4. Adjust the manual rheostat to obtain rated AC voltage.

5. Snap the toggle switch to REGULATOR ON position. (On later models with combination rheostat and switch, turn the knob all the way counterclockwise).

6. Set the regulator rheostat at approximately the middle of its rotation.

7. Set the adjustable resistor, which is mounted either separately or on the regulator base, to obtain the rated AC voltage. Very little movement of the sliding clip will be necessary. Be sure to retighten the clip after the adjustment is completed.

8. The adjustable range of the regulator rheostat should be not less than 10% above and 10% below rated AC voltage.

9. Refer to the VOLTAGE CHART and regulate the ac output voltage as instructed under REGULATING THE VOLTAGE under Operation section of this manual.

REGOHM VOLTAGE REGULATOR DASHPOT ADJUSTMENT. - If a hunting voltage condition exists, after the Governor has been adjusted, the voltage regulator dashpot must be adjusted on plants using a Regohm Voltage Regulator. See the illustration, Regohm Voltage Regulator Adjustments.

1. Remove the louvered cover from the regulator box.

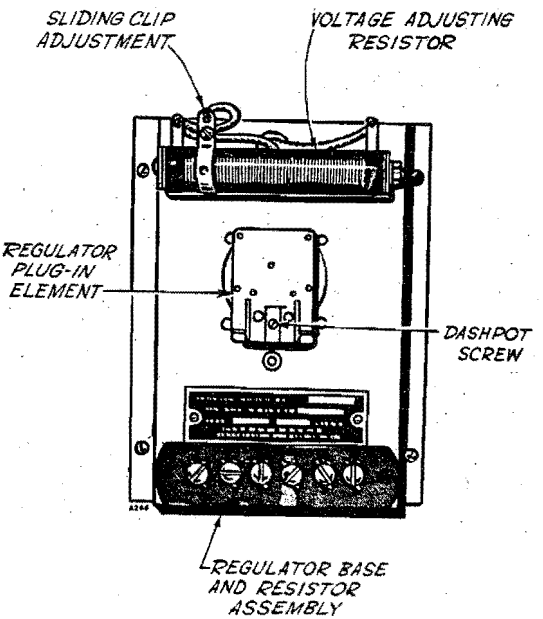
2. Remove the clamping bar from the metal cover of the regulator plug-in unit.

3. Remove the cover, held in place by two screws at the top.

4. Turn the slotted screw at the center, until the hunting just stops.

IMPORTANT

THIS IS THE ONLY ADJUSTMENT THAT WILL BE NECESSARY AND NO ADJUSTMENT TO ANY OTHER PART OF THE REGULATOR PLUG-IN UNIT SHOULD EVER BE ATTEMPTED.



REGOHM VOLTAGE REGULATOR ADJUSTMENT

VOLTAGE CHART

TYPE OF PLANT			VOLTAGE LIMITS	
VOLT	PHASE	WIRE	MAXIMUM NO LOAD VOLTAGE	MINIMUM FULL LOAD *VOLTAGE
115	1	2	117	113
230	1	2	234	226
115/230	1	3	234	226
120/208	3	4	212	204
230	3	3	234	226
460	3	3	468	452
220/380	3	4	388	372
127/220	3	4	224	215
575	3	3	586	564
230/460	1	3	468	452
115	3	3	117	113
120/240	3	4-Delta	244	236

* Voltage Regulation for Full Rated Load is at 0.8 Power Factor.

GENERAL. - Refer to the SERVICE DIAGNOSIS section for assistance in locating and correcting troubles which may occur. Should a major overhaul become necessary, the plant should be carefully checked and all necessary repairs made by a competent mechanic who is thoroughly familiar with modern internal combustion engines and revolving field generators.

ENGINE

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

The tappets should be adjusted with the engine hot and with each respective piston at Top Dead Center on the compression stroke. Set the tappets in firing order sequence, turning the hand crank 1/2 revolution to put the next piston at Top Dead Center. Firing order is 1, 3, 4, 2.

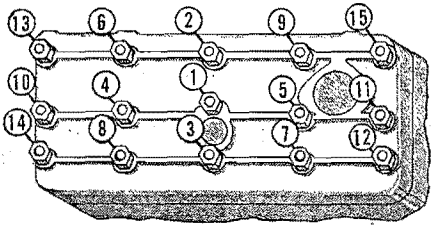
Adjust the tappets to 0.014" clearance for both the intake valves and the exhaust valves. If possible, make a final check with the engine running at a slow idle, and at operating temperature. Make certain that the lock nut on each tappet adjusting screw is tightened securely after the adjustment is completed.

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 top of the 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 reassembled to their original seats. Grind only enough to assure a perfect seal. Be careful to remove all traces of grinding compound from valves and seats. Lightly oil valves and guides before reassembly.

Both the intake valves and the exhaust valves are of the "Positive Roto" type, each valve having a cap under the end of the stem. When reassembling, install the cap on the end of the valve stem before installing the spring retainer locks. Note that the valve spring retainer locks have a very slight taper. The thinner edge of the lock must face upward. Be sure two locks are properly installed on each valve stem. If the valves are properly installed, it will be possible to turn them in their guides when the valves are wide open, but only in one direction.

Set all the tappet clearances after the valves have been reassembled. When tightening the cylinder head nuts, start at the center and work outward and towards the ends. Tighten cylinder head nuts to a tension of 80 pounds foot torque. See the paragraph IGNITION TIMING for instructions on proper installation of the magneto and its drive shaft.



CYLINDER HEAD TIGHTENING SEQUENCE

To prevent distortion, tighten the cylinder head in the sequence shown above. "Snug up" twice before a third and final tightening.

When the engine is started, allow it to thoroughly warm up and carefully check the tappet clearances, making any necessary corrections with the engine running at a slow idle. After approximately 10 hours operation, again check the tappets, making any necessary adjustments. Tappets set too tightly may cause burned or warped valves and cutting of the camshaft and tappets.

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.

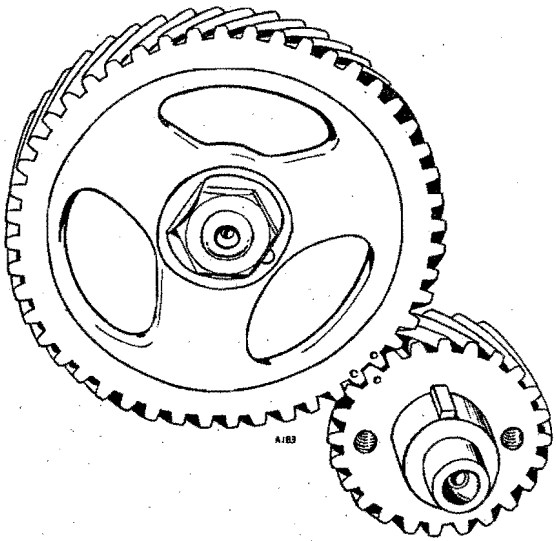
IGNITION TIMING. - When timing the distributor, follow the same procedure as given for timing the magneto.

Crank the engine until the number 1 piston is coming up on the compression stroke. Continue slowly to crank the engine until the flywheel mark IGN is in the center of the inspection hole located just above the starter.

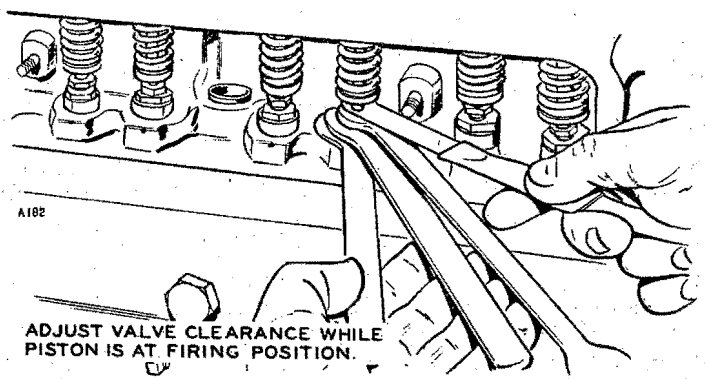
If the magneto drive shaft has been removed, install it properly engaged with its drive member. Install the magneto and its adapter to the cylinder head. The magneto coupling is off-set to insure proper engagement when the magneto rotor points toward the front of the engine. If the rotor fails to point to the #1 tower, the magneto drive shaft must be lifted up, rotated, and reinstalled to the correct position.

See that the magneto ignition points gap, at full separation, is correct for the type of magneto used as shown in the Table of Clearances. Loosen the magneto adjusting clamp screw and turn the magneto body counterclockwise to close the ignition points. Use a series type timing light, if available. Slowly turn the magneto clockwise until the ignition points just separate. At this point the timing is correct for average operating conditions. To advance the timing, turn the magneto body slightly in a clockwise direction, or to retard timing turn it counter-clockwise. Keep the spark advanced as far as possible without causing a "ping". Ignition timing is 17 degrees advance at cranking speed.

The Fairbanks Morse magneto is stamped with a "1" to mark the tower for the number 1 spark plug cable.



TIMING GEARS



VALVE ADJUSTMENT

To help determine if parts have been correctly installed, refer to the following conditions which should prevail when the piston in #1 cylinder is at top dead center (#1 D.C.); Number 4 exhaust valve will have just closed as viewed through the spark plug hole; The slot in the oil pump drive shaft which drives the magneto drive shaft will be almost parallel to the "front to rear" direction of the engine; The magneto rotor will be at #1 tower and will point toward the front of the engine. The flywheel marks will align with the inspection hole.

PISTON RING REPLACEMENT. - The piston and connecting rod assemblies are removed from the top of the cylinder. Three compression rings and one oil control ring are used on each piston. Check the cylinders for an out-of-round or tapered condition, reboring for oversize pistons if necessary. Any ridge worn at the top of the bore should be removed, even if not reboring. Fit each ring to its individual cylinder, being sure that the gap between the ends of the ring, when in the cylinder, is within the limits described. The ring gap is .007 to .017". The compression rings are interchangeable, one groove to the other. Fit the proper ring in each ring groove on the piston, with the ring gaps spaced an equal distance around the piston. The wide oil control ring fits the bottom piston ring groove. Be sure the ring grooves are clean and free of carbon deposits, and the oil holes are open before installing the rings on the piston. The rings should have between 0.0015" and 0.002" clearance in their grooves. Replacement rings of the tapered type will be marked "TOP", or identified in some other unmistakable manner, and this mark must be installed toward the top of the piston.

PISTON PINS. - The hardened piston pins are selected in production to obtain a 0.0004" loose fit in connecting rod pin bushing, and a light push fit in piston boss. Maintain these clearances to fit oversize piston pins. 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.

CONNECTING RODS. - (See note "Bearing Caution"). The steel backed connecting rod lower end bearings are readily replaceable. When removing the connecting rods, note the markings on the camshaft side of the rods and caps, so as to reassemble in the original manner. Notches machined in the connecting rod halves receive matching projections stamped into the steel backs of the bearing shells. If a shell becomes worn, discard both shells for that rod and install new ones. The shells are designed to provide a clearance of 0.0002" to 0.0022". Never attempt fitting a bearing by scraping or filing of either the cap or upper half of 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 has been firmly seated in the rod.

The sides of the connecting rod crank ends are not babbitt lined. It is of vital importance that the side play clearance of 0.006" to 0.010" be maintained. Be sure that piston and connecting rod assemblies are properly aligned before installation.

MAIN BEARINGS. - (See note "Bearing Caution"). The crankshaft main bearings are of the same type as the connecting rod bearings. Front, intermediate, or rear bearing shells are not interchangeable between the other locations. Bearing caps are numbered on the camshaft side and are doweled to assure proper reassembly. 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 0.0002" to 0.0024". The rear face of the front main bearing takes the end thrust of the crankshaft. The crankshaft end play should be 0.003" and is regulated by a shim pack to the rear of a removable thrust collar behind the crankshaft gear. When servicing the crankshaft or related parts always make sure that all oil holes in the shaft are open and clean.

BEARING CAUTION: Certain engines are equipped with MORAINE DUREX-100 main bearings and (or) connecting rod bearings. After a few hours of operation the bearing becomes a leaden gray in color and develops minute craters, almost cellular in appearance. THIS APPEARANCE IS A NATURAL CHARACTERISTIC OF THIS TYPE BEARING AND IN NO WAY INDICATES FAILURE. Reasons for necessary bearing replacement are: Worn bearings, causing a noticeable drop in oil pressure; Damaged bearings, due to deep scratches or gouges; Loss of babbitt overlay, due to lubrication failure, overheating or other abnormal conditions. Before replacing bearings clean them thoroughly but NEVER USE ABRASIVES which may become imbedded. Improved performance is gained by this bearing.

CAMSHAFT. - Provided that proper lubrication is supplied, the camshaft and its bearings should never require servicing. If the cams are cut by too close adjustment of the tappets, they can be reconditioned by careful honing if not too badly scored.

The camshaft bearings are bushings which are line reamed, after installation in the crankcase. The installation of new camshaft bearings is not practicable without the proper line reaming equipment. Clearances are given in the Table of Clearances.

WATER PUMP. - The water pump on this engine is a centrifugal, self sealing, prelubricated ball bearing type. To dismantle the pump follow this procedure.

1. Remove the four screws that mount the water pump assembly to the engine.

2. Remove the screws that hold the end plate on the back of the water pump assembly.
3. Use a suitable puller to remove the pulley from the impeller shaft.
4. Remove the lock ring that retains the bearing at the pulley end.
5. Press the impeller shaft out of the body casting from the rear of the water pump. This frees the impeller.
6. Tap the shaft seal out by inserting a plug through the front of the casting. Tap out the seal gently to prevent any damage to the seal.
7. Reverse the disassembly steps in order to assemble the pump. Note that the impeller hub is assembled to the impeller shaft with the fins facing the water pump seal.

LUBRICATION SYSTEM. - A gear type oil pump supplies oil under pressure through drilled passageways to the crankshaft main, lower connecting rod bearings, camshaft bearings, timing gears, and valve tappets. When ever the engine is disassembled for service, make sure that all oil passages are clean and unobstructed. Thoroughly clean the engine oil pan and the oil pump strainer screen. An oil pressure relief valve is adjusted at the factory to give a pressure of 20 to 30 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 close to the fuel pump. Oil pressure may be increased by adding plunger washers or reduced by removing plunger washers. Never attempt to adjust the oil pressure without first testing with a gauge which is known to be accurate. Also refer to LOW OIL PRESSURE, first, under Service Diagnosis. Be sure the gauge is not defective. Too high or too low pressure may be caused by a sticking plunger. Remove the assembly and clean thoroughly. Continued low oil pressure indicates excessively worn bearings.

GENERATOR

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

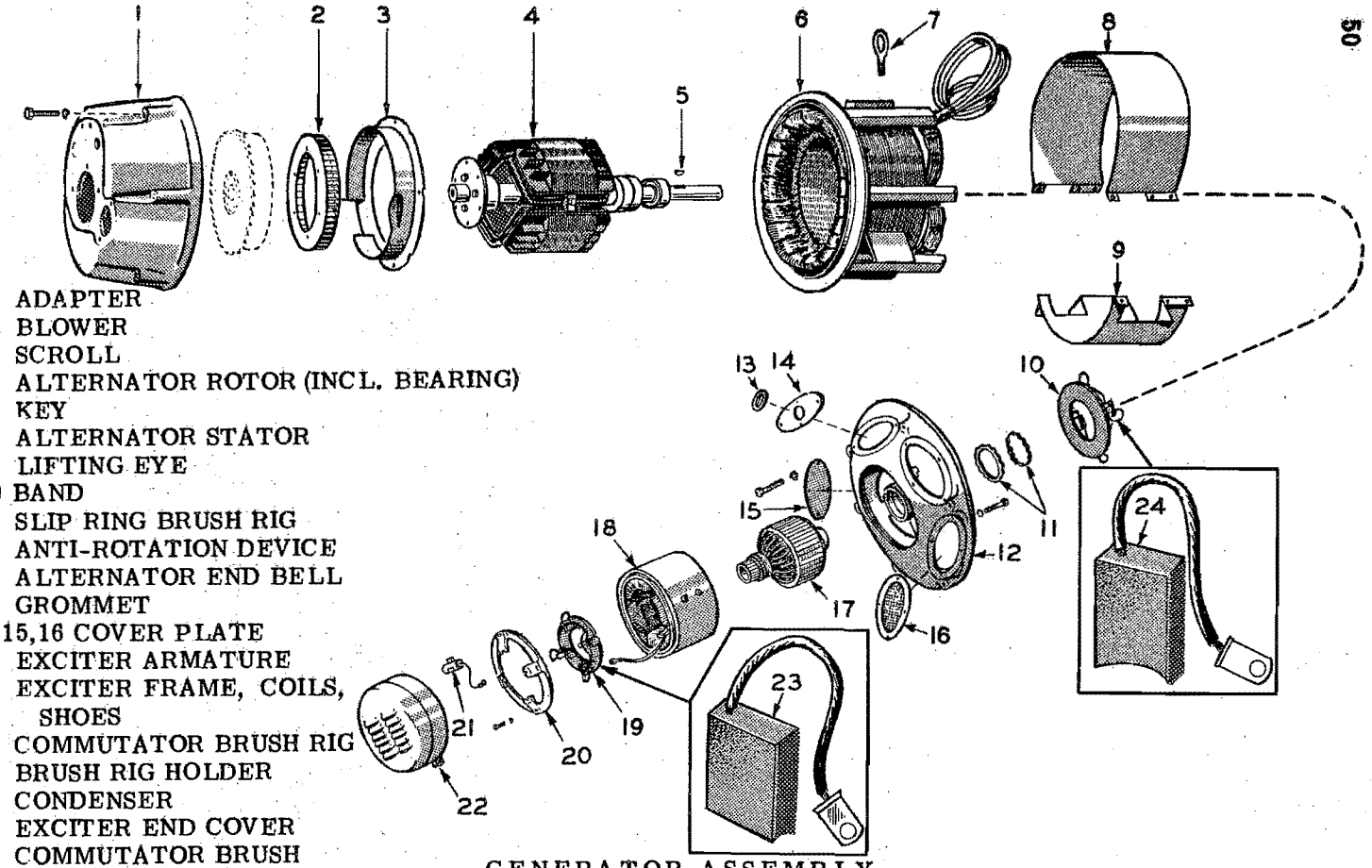
GENERATOR FAILURE. - If the generator should fail to produce electrically, it may be a fault in one of the several windings and should be located by a competent electrician who is familiar with generating plants. Replace the faulty part with a new one.

GENERATOR DISASSEMBLY AND ASSEMBLY. - This subject is treated generally, because except for a few precautions and design knowledge, the procedure is self-evident. Some type of hoist or support such as a rope sling should be provided.

Keep in mind that two general designs of generators have been used on standard models. One shaft contained both the alternator field and the exciter armature on the first design (referred to as "prior to spec C"), while two separate shafts are used on the second design. Obviously disassembly procedure differs somewhat.

On models prior to Spec C, lift the brushes from the commutator and collector rings as instructed below. Disconnect the exciter leads at the control end and tag them to insure proper reassembly. Disconnect the alternator output leads. It is not necessary to remove the brush rig from the end bell. Detach and carefully work the exciter frame assembly off to avoid damaging the armature. The bearing stop clip will usually cling to the bearing, watch for it. Keep the bearing clean. If available, a sheet of aluminum foil can quickly be wrapped and crimped around the bearing until reassembly to keep it clean. The alternator stator and the rotor assembly can then be removed. When reassembling see that the matching surfaces of the engine flywheel and the rotor drive disc are free from nicks and dirt to avoid run-out at the bearing. Be sure the ball bearing stop clip is in place. See that brush contact is good. Reference to the plant wiring diagram will be helpful.

On models beginning with Spec C, lift the brushes from the commutator and collector rings as instructed below. Disconnect the exciter leads at the control end and tag them to insure proper reassembly. Disconnect the alternator output leads. The exciter frame assembly together with the brush rig and its holder may be removed as one unit. To facilitate removal, the exciter armature shaft has 3/4-10 threads in the outer end into which a bolt may be screwed to pull the armature from the rotor assembly. The threaded portion of the bolt should be equal to the length of the shaft. If the available bolt proves too short, try adding a stack of washers or other objects larger than 3/8 inch O.D. to build up the cavity inside the shaft. Avoid damaging the windings or



1. ADAPTER
2. BLOWER
3. SCROLL
4. ALTERNATOR ROTOR (INCL. BEARING)
5. KEY
6. ALTERNATOR STATOR
7. LIFTING EYE

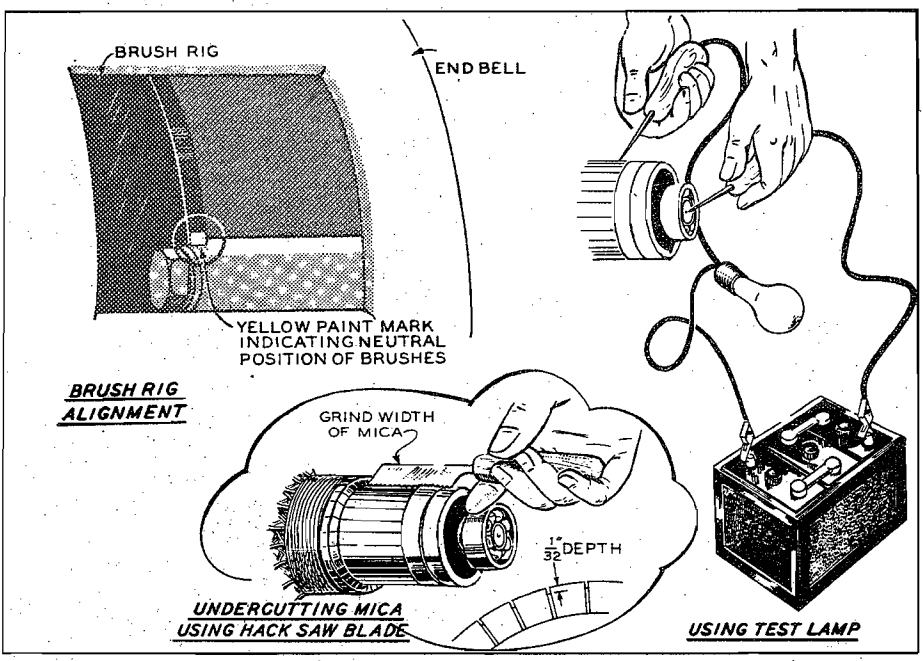
8,9 BAND

10. SLIP RING BRUSH RIG
11. ANTI-ROTATION DEVICE
12. ALTERNATOR END BELL
13. GROMMET

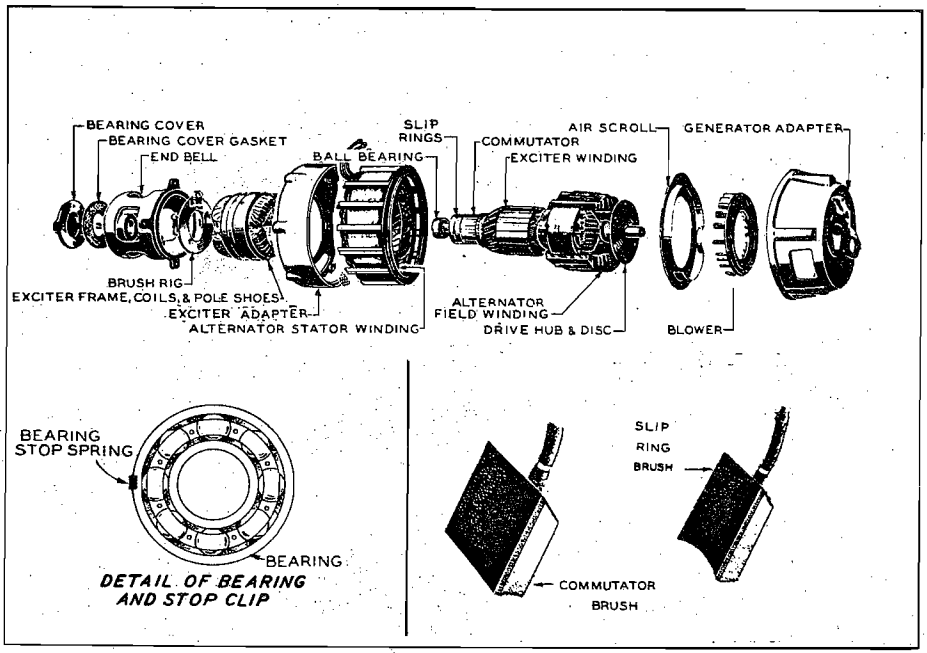
14,15,16 COVER PLATE

17. EXCITER ARMATURE
18. EXCITER FRAME, COILS, SHOES
19. COMMUTATOR BRUSH RIG
20. BRUSH RIG HOLDER
21. CONDENSER
22. EXCITER END COVER
23. COMMUTATOR BRUSH
24. SLIP RING BRUSH

GENERATOR ASSEMBLY
(Removable Type Exciter Armature)



CARE OF COMMUTATOR AND BRUSHES



GENERATOR ASSEMBLY
(Integral Type Exciter Armature)

insulation. Don't lose the key. It is not necessary to remove the collector ring brush rig from the stator end bell when disassembling the alternator. The end bell houses the ball bearing and contains a rubber ring type anti-rotation device and its steel expander in the groove of the bearing bore. Then, the alternator stator and the alternator rotor may be removed. When reassembling, have the bearing anti-rotation device in the groove and carefully expand it as necessary for the ball bearing to pass through it. Also see that the commutator brush rig has not shifted from neutral position and that brush contact is good. Reference to the plant wiring diagram will be helpful.

COMMUTATOR AND SLIP RINGS. - After a long period of service, the surface of the commutator may become worn to such an extend 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". 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 slip rings to become grooved, out of round, pitted, or rough, it will be necessary to remove the rotor and turn the commutator or slip rings down in a lathe. Remove or protect the ball bearing during turning down to prevent any foreign material getting into it. After the commutator is turned down, the mica between the bars must be undercut as described above.

BRUSH RIG. - Witness marks (chisel mark or paint) show the neutral position alignment of the brush rig and its support. A deviation from the proper position 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 AND SPRINGS. - 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. Poor brush contact leads to excessive brush sparking and pitting of the commutator or slip 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.

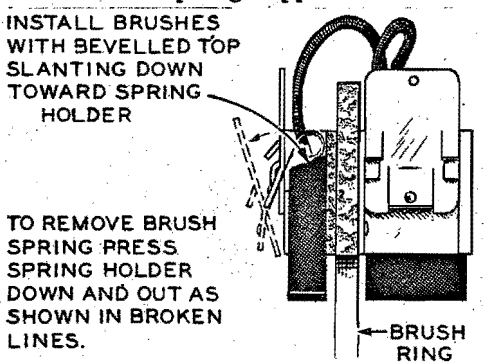
Each brush spring is attached permanently to a brass support which is detachable from the brush guide. These springs are designed to provide constant pressure as brushes wear shorter. To unclip the spring and support from the brush guide, push it toward the commutator or slip-ring and away from the brush guide.

Use care not to damage the spring by bending it against the spring support.

Correct spring tension is 9 to 13 ounces. It is difficult to accurately measure the spring tension in the field, or to determine if a spring has become fatigued. Under normal conditions the springs may never require replacement, but after long usage or if they appear damaged, replacement is good preventive insurance.

Note that on special models which are exciter cranked, the springs for the commutator brushes are slightly larger in diameter than the slip ring brush springs, and exert greater pressure. The use of the wrong spring will result in improper operation of the brush.

When replacing a brush in its guide, be sure that the low side of the beveled top edge is toward the spring support side of the brush 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 slip 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 exciter armature for an internal short circuit. Exciter or alternator field coil windings may be tested for an internal short circuit by comparative ohmmeter readings.

If one or more exciter field coils test defective, install a new set of field coils. If an alternator stator winding tests defective, install a new stator assembly. If a rotor winding tests defective, install a new rotor assembly. The exciter armature and the alternator rotor are available separately on those generators having the armature on a separate shaft. 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. Refer to the plant wiring diagram.

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 or a loose connection.

Failure of the battery charging generator to deliver current to 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 POSITION LONGER THAN NECESSARY TO MAKE TESTS. CURRENT FED TO THE METERS MAY DISCHARGE THE BATTERY WHILE THE PLANT IS IDLE.

TORQUE WRENCH DATA

(Limits in Pounds Ft. Torque)

Cylinder Head - 7/16"	70-75
Main Bearing Caps and Connecting Rods 3/8"	35-40
Flywheel - 3/8"	35-40
Manifolds - 3/8"	25-30
Gear Cover , Water Pump, Front and Rear End Plates, Oil Pan - 5/16"	15-20

TROUBLE SHOOTING

A good rule to follow in locating engine trouble is to never make more than one adjustment at a time. Stop and think how the engine operates, and figure out the probable cause of any irregular operation. Then locate the trouble by a process of elimination. In many instances, a symptom indicating trouble in one unit may be caused by improper function of a closely related unit or system. Remember that the cause usually is a SIMPLE ONE, rather than a mysterious and complicated one.

If a general tune-up is found necessary, perform necessary operations in this sequence: Spark Plugs; Battery and Ignition Cables; Magneto; Ignition Timing; Valve Clearance; and Carburetor.

TABLE OF CLEARANCES AND SPECIFICATIONS

	MINIMUM	MAXIMUM
Valve Tappets - Intake - Warm Engine, Preferably Idling	0.014"	
Valve Tappets - Exhaust - Warm Engine, Preferably Idling	0.014"	
Valve Seat Angle - Intake	30°	
Valve Seat Angle - Exhaust	45°	
Valve Stem Clearance in Guide - Intake - DESIRED	0.0015"	
Valve Stem Clearance in Guide - Exhaust - DESIRED	0.0045"	
Crankshaft Main Bearing (Desired .001")	0.0002"	0.0024"
Crankshaft Main Bearing Journal Size	2.249 "	2.250"
Connecting Rod Bearing (Desired .001")	0.0002"	0.0022"
Crankshaft Rod Bearing Journal Size	1.9365"	1.9375"
Connecting Rod Side Play	0.006"	0.010"
Camshaft Bushings - #1 and 3	0.002"	0.004"
Camshaft Bushing - #2	0.003"	0.0045"
Camshaft Bearing Journal Dia. #1	1.8715"	1.8725"
Camshaft Bearing Journal Dia. #2	1.7457"	1.7465"
Camshaft Bearing Journal Dia. #3	1.2465"	1.2475"
Camshaft End Play	0.0005"	0.0015"
Piston (Alum. Alloy) to Cylinder, 002" thick, 1/2" wide feeler -	5 to 10 lb. pull	
Cylinder Bore Size	3.4375"	3.4395"
Piston Pin in Rod Bushing (Desired .0004")	0.0002"	0.0006"
Piston Pin in Piston	Light Push Fit	
Ring Gap, 3 Top Grooves	0.007"	0.017"
Ring Gap, Bottom Groove	0.007"	0.017"
Magneto Points Gap - WICO (Spec "A" plants only)	0.020"	
Magneto Points Gap - FAIRBANKS MORSE	0.015"	
Distributor Points Gap - 12 volt battery ignition	0.020"	
Spark Plug Gap - Comm 5		
For Gasoline Fuel Operation	0.025"	
For Gaseous Fuel (LPG or Natural Gas) Operation - (When necessary to aid starting)	0.015"	0.018"
Ignition Timing - At Cranking Speed	17° Advance	
Magneto Rotation - As Viewed From ROTOR End.	Counterclockwise	
Firing Order	1 - 3 - 4 - 2	
Cylinder Head Nut - Torque	80 lbs. ft.	
Oil Capacity - Excluding Filter	4 U.S. Qts.	
Oil Pressure at 1800 RPM	20 #	30#
Oil Recommendation - High Viscosity, Heavy Duty Detergent		
Over 32° F.	SAE 30	
32° F. to 0° F.	SAE 10	
Below 0° F.	SAE 10W or 5W	
A.C. Generator Maximum Permissible Run-out at Rotor Bearing		0.010"

POSSIBLE CAUSE	REMEDY
GENERATOR OVERHEATING	
Overloaded.	Reduce load.
Brush rig out of position.	Be sure to line up marks.
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.
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 or lead 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.
Intake air leak.	Tighten or replace gaskets.
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, 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.
ENGINE MISFIRES AT HEAVY LOAD	
Spark plugs defective.	Replace.
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, etc., or retime ignition.
Clogged carburetor.	Clean jets.
Clogged fuel screen.	Clean.
Defective spark plug cables.	Replace.

POSSIBLE CAUSE	REMEDY
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.
LOW OIL PRESSURE	
Oil too light.	Drain, refill with proper oil.
Oil badly diluted.	Drain, refill with proper oil.
Oil too low.	Add oil.
Oil relief valve not seating.	Remove and clean, or replace.
Badly worn bearings.	Replace.
Sludge on oil screen.	Remove and clean.
Badly worn oil pump.	Replace.
Defective oil pressure gauge.	Replace.
HIGH OIL PRESSURE	
Oil too heavy.	Drain, refill with proper oil.
Clogged oil passage.	Clean all lines and passages.
Oil relief valve stuck.	Remove and clean.
Defective oil pressure gauge.	Replace.
PLANT STARTS BUT DOES NOT CONTINUE TO RUN	
START button released too soon.	Hold in contact longer.
Defective charging generator.	Repair.
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 carb.
Poor fuel.	Refill with good, fresh fuel.

POSSIBLE CAUSE	REMEDY
ENGINE BACKFIRES AT CARBURETOR (CONT.)	
Spark too late.	Retime ignition.
Spark plug wires crossed.	Install wires correctly.
Intake valves leaking.	Grind or replace.
EXCESSIVE OIL CONSUMPTION, LIGHT BLUE SMOKY EXHAUST	
Worn piston rings.	Install new piston rings.
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.
Too large bearing clearance.	Replace bearings.
Oil pressure too high.	Refer to symptoms of high oil pressure for remedies.
Engine misfires.	Refer to symptoms of engine misfires.
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, 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.
Dirty air cleaner.	Clean, refill to proper level.
LIGHT POUNDING KNOCK	
Loose connecting rod bearing.	Replace.
Low oil supply.	Add oil.
Low oil pressure.	Refer to symptom of low oil pressure for remedies.
Oil badly diluted.	Change oil.

PCSSIBLE CAUSE	REMEDY
ENGINE STOPS UNEXPECTEDLY	
Fuel tank empty.	Refill.
Fuel pump failure.	Repair or replace.
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.
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.
Wrong spark plugs.	Install correct plugs.
Spark plugs burned or carboned.	Install new plugs.
Valves hot.	Adjust tappet clearance
Fuel stale or low octane.	Use good fresh fuel.
Lean fuel mixture.	Clean or adjust 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, etc. or retime ignition.
Lack of fuel or faulty carburetion.	Refill the tank. Check the fuel system. Clean, adjust, or replace parts necessary.

POSSIBLE CAUSE	REMEDY
ENGINE WILL NOT START WHEN CRANKED (CONT.)	
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.
Wrong timing.	Retime ignition.
Poor choking.	If plant is cold, adjust choke. If plant is warm, pull up on choke arm momentarily, while cranking.
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.
Faulty voltage regulator.	Adjust or replace, tighten connections.
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.

POSSIBLE CAUSE	REMEDY
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 TOO 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.
EXCESSIVE ARCING OF BRUSHES	
Rough commutator or rings.	Turn down.
Dirty commutator or rings.	Clean.
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 ignition timing.
Improper ventilation.	Provide for better air change.

PREPARING UNITS FOR STORAGE OR EXTENDED OUT-OF-SERVICE PERIODS. - Electrical generating sets are often taken out of service for extended periods of time. Too often they are left to stand idle without being protected against possible damage from rust and corrosion or the elements. The factory recommends that any unit to be removed from service for 30 days or more be protected by this method:

Shut off the fuel supply at the tank and allow the unit to run until it stops from lack of fuel. The fuel system will then be free of gasoline except for the tank.

If the fuel tank will be subjected to temperature changes, fill the tank nearly full to lessen chances of condensation forming within the fuel tank.

Drain the oil from the oil base while the engine is warm. Replace the drain plug. See that the oil filler cap is in place. Attach a warning tag that oil has been drained.

If the cooling system does not have antifreeze and rust inhibitor, drain the entire cooling system. Be sure to drain both the radiator and the block.

Remove each spark plug and pour two tablespoonfuls of rust inhibitor oil (Use SAE 50 motor oil as a substitute) into each cylinder. Crank the engine over slowly by hand to lubricate the cylinders. Stop the engine with the TC (top center) mark on the flywheel indicating at least one piston is at top center position. Replace the spark plugs.

Clean the generator brushes, brush holders, commutator and collector rings by wiping with a clean cloth. Do not coat with lubricant or other preservative.

Remove, clean and replace the air cleaner.

Wipe all exposed parts clean and coat with a film of grease all such parts liable to rust.

Oil the governor to carburetor linkage with SAE 50 oil.

Plug the exhaust outlet with a wood plug to prevent entrance of moisture or foreign matter.

Where batteries are likely to be exposed to freezing temperatures, they must be removed and stored where there is no danger of freezing. A fully charged battery can withstand very low temperatures but an idle battery gradually loses its charge and may become discharged to the point where it will freeze. An idle battery should be given a freshening charge about every 40 days.

If the battery is not removed, disconnect the cables from the unit. Arrange the cables so that the lugs cannot come in contact with each other or with metal parts.

Provide a suitable cover for the entire unit, particularly if it will be exposed to the elements.

RETURNING THE UNIT TO SERVICE AFTER EXTENDED OUT-OF-SERVICE PERIODS. - Remove all protective coatings of grease from external parts. Wipe the entire unit clean of accumulated dust or other foreign matter.

Inspect the unit carefully for damage and for other conditions requiring attention. Service as needed. Keep the side panels and top plate on the housing except while servicing. They help direct the cooling air properly and reduce radio interference.

Remove the plug from the exhaust outlet.

Remove, clean and adjust spark plugs. While the plugs are out, crank the engine over several times by hand to distribute oil over the cylinder walls. If the cylinders are dry, put a tablespoonful of oil into each cylinder and turn the engine over several times by hand to distribute the oil. Replace the spark plugs and gaskets.

Examine all fuel, oil and water lines and connections. Service as needed.

Refill the cooling system with clean, fresh water.

If antifreeze was left in the cooling system, check the level and add a 50-50 solution of water and the type of antifreeze originally used to bring the cooling liquid up to proper level. If desired, the antifreeze solution can be drained and the cooling system refilled with clean, fresh water.

Refill the crankcase and air cleaner with the correct amount and grade of oil.

Check carefully for leaks of water, fuel or oil after servicing the unit. Correct any leaks before starting the unit.

Connect the battery cables to the unit. Carefully recheck to make sure the unit is ready for operation. Then start the unit in the regular manner as described under OPERATION in the instruction manual. Always connect the ground cable lastly.

SPECIAL PURPOSE SECTION

FOLLOWS:

CONTAINS

SUPPLEMENTARY INSTRUCTIONS

FOR

LIFTING—MAGNET SERVICE PLANTS
(Model contains "150", such as 15HQ-150R)

STANDBY SERVICE "PENNSYLVANIA APPROVED" PLANTS
(Model contains "30" or "31", such as 15HQ-4R30)

LIFTING—MAGNET SERVICE PLANTS

ONAN GENERATING PLANT MODELS 10HQ-150R & 15HQ-150R, 250 VOLT DC, RHEOSTAT CONTROL REQUIRED, DESIGNED FOR LIFTING -MAGNET SERVICE.

GENERAL. - This supplementary instruction manual covers ONAN generating plant Model No's. 10HQ-150R and 15HQ-150R which have been specially designed for magnet service. Disregard all instructions regarding generator operation and governor adjustment in this instruction manual which covers 50 and 60 cycle alternating current generating plants. All other instructions covering standard models are applicable.

GENERATOR AND CONTROL DESCRIPTION. - The correct size of manual field rheostat must be properly connected to the generator before it can be operated.

CAUTION!

DO NOT OPERATE THE GENERATOR WITHOUT A MANUAL FIELD RHEOSTAT OR SWITCHBOARD. SERIOUS DAMAGE TO GENERATOR WILL RESULT.

Manual field rheostat specifications are listed below.

	Ohms	Watts	Onan Part No.
10KW Units	250	300	303P84
15KW Units	160	500	303-82

Listed below are the specially designed wall mounted switchboards which are normally used with the magnet service generating plant.

Plant KW Rating	Switchboard Model No.	Equipment Included
10KW	10S-150/15A	Voltmeter, Rheostat
10KW	10S-150/16A	Rheostat, Ammeter
10KW	10S-150/17A	Rheostat, Voltmeter-Ammeter
15KW	15S-150/15A	Rheostat, Voltmeter
15KW	15S-150/16A	Rheostat, Ammeter
15KW	15S-150/17A	Rheostat, Voltmeter, Ammeter

GENERATOR INSTALLATION. - The wall mounted switchboard or the proper size manual field rheostat must be connected before operating the generator. If a separate manual field rheostat is used, connect it to the generator terminals F2 and A2. The load terminals are S2 and A2. See wiring diagram which follows.

LIFTING-MAGNET SERVICE PLANTS (Cont.)

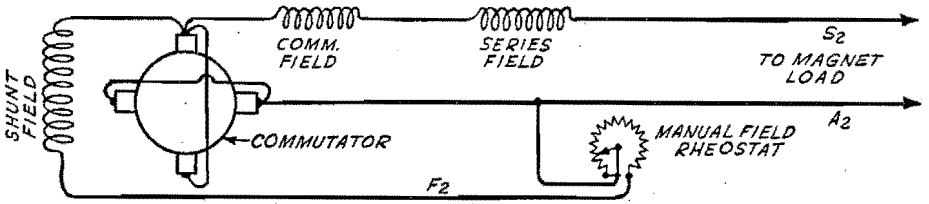


DIAGRAM OF GENERATOR AND MANUAL FIELD RHEOSTAT

PLANT INSTALLATION. - It is necessary to remove the rear housing panel and generator bearing cover when adjusting the governor. Therefore it is recommended that the plant be installed so that there is easy access to the rear of the plant. Sufficient space should be left so that a mechanical tachometer can be placed against the generator shaft while checking the engine speed.

GENERATOR OPERATION. - Before starting the plant be sure that the manual field rheostat is in the maximum resistance (minimum voltage) position. The manual field rheostat should be connected so that the generator voltage is increased as the rheostat knob is turned in a clockwise direction. The generator output voltage may be checked, as recommended during operation, if a d.c. voltmeter is installed. Start the plant and adjust the generator voltage by means of the manual field rheostat to 250 volts or to the rated voltage of the magnet. Connect the magnet to the generator by operating the magnet controller. After the magnet is connected to the generator, the voltage should again be adjusted to 250 volts or to the rated voltage of the magnet. As the magnet warms up its resistance increases until it reaches normal operating temperature. The voltage of the generator should be readjusted to the proper value when the magnet reaches normal operating temperature.

GOVERNOR ADJUSTMENT. - The governor controls the speed of the engine and voltage of the generator. Use a mechanical tachometer to check the engine speed for proper governor adjustment. Remove the rear housing panel and the generator bearing cover to check the speed. Place the tachometer shaft against the end of the generator shaft, which rotates at engine speed.

SPEED CHART FOR CHECKING GOVERNOR REGULATION

RPM RANGE LIMITS		PREFERRED RPM SPREAD	
MIN.	MAX.	FULL LOAD	NO LOAD
1970	2030	1980	2020

LIFTING-MAGNET SERVICE PLANTS (Cont.)

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

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

3. Adjust the speed. With no electrical load connected, adjust the speed screw to attain the proper no load speed as shown in the speed chart. Apply a full rated load and again check the speed. Check the voltage to be sure the voltage is safe for the load applied. An incorrect speed drop from full load to no load requires a governor sensitivity readjustment.

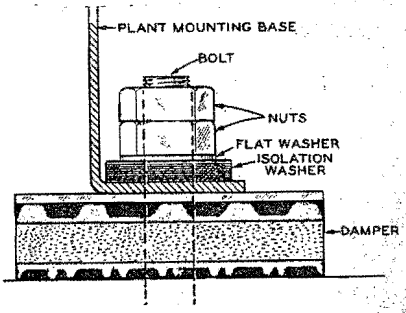
4. If the plant tends to hunt (alternately increase and decrease speed) under load conditions, increase very slightly the distance between the governor main shaft and the sensitivity screw on which the spring link pivots. For best regulation, keep the sensitivity screw up as close as possible without causing hunting.

Any change in the setting of the sensitivity screw will require correcting the speed screw adjustment. Decreasing sensitivity by turning the screw clockwise causes a slight speed increase which can be corrected by turning the speed screw slightly counterclockwise to decrease spring tension.

5. If hunting occurs at NO LOAD, screw the small bumper spring screw in until the hunting 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 properly made, it is probable that the engine is low on power and should be repaired as necessary.

MOUNTING. - Units may be mounted on vibration dampers to reduce vibration. Special dampers shown in the illustration may be procured from the factory.



"PENNSYLVANIA APPROVED" GENERATING PLANTS

The "Pennsylvania Approved" generating plant is a term applied to a plant designed to meet the rigid requirements published by the Commonwealth of Pennsylvania, Department of Labor and Industry, as contained in "REGULATIONS FOR PROTECTION FROM FIRE AND PANIC."

These plants are quickly recognized by the number 30 appearing in the model of gasoline fuel plants or by the number 31 appearing in the model of gaseous fuel plants.

"Standby" service generating plants (the source supplying energy for lighting when the normal source fails) are subject to those regulations when located in the area under its jurisdiction. The regulations apply to the installation requirements also. These include the exhaust system, cooling, fuel system, mounting base, location, batteries, etc.

A wiring diagram according to the particular model in question is furnished.

Most of the instructions given for standard models apply also for "Pennsylvania Approved" generating plants. The plant characteristics listed below will help isolate those foregoing instructions given for standard models which might have to be modified to become applicable to the "Pennsylvania Approved" plants.

PLANT CHARACTERISTICS (Subject to change)

36-volt exciter cranking (special design generator).
36-volt start solenoid.
No automotive type charging generator.
No automotive type starting motor.
High compression cylinder head on gas fuel models, provides greater than minimum required horsepower and standard output rating applies.
A normally closed solenoid valve is used in a gaseous fuel system.
No gasoline supply tank mounted in plant housing.
A reservoir "Day" tank (of 1 quart capacity, maximum) is optional.
No protective shut-down devices.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- Two-Bearing Generators
- Air Cooled Engines

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