INSTRUCTION MANUAL

FOR

ONAN HK & HN SERIES

ELECTRIC GENERATING PLANTS

50 & 60 CYCLE

SPECIFICATIONS
A THROUGH L

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

905-13 ***

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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 product of its manufacture to be free from defects in material and factory workmanship if properly installed, serviced and operated under normal conditions according to the Manufacturer's instructions.

Manufacturer's obligation under this warranty is limited to correcting without charge at its factory any part or parts thereof which shall be returned to its factory or one of its Authorized Service Stations, transportation charges prepaid, within ninety (90) days after being put into service by the original user, and which upon examination shall disclose to the Manufacturer's satisfaction to have been originally defective. Correction of such defects by repair to, or supplying of replacements for defective parts, shall constitute fulfillment of all obligations to original user.

This warranty shall not apply to any of the Manufacturer's products which must be replaced because of normal wear, which have been subject to misuse, negligence or accident or which shall have been repaired or altered outside of the Manufacturer's factory unless authorized by the Manufacturer.

Manufacturer shall not be liable for loss, damage or expense directly or indirectly from the use of its product or from any other cause. The Manufacturer makes no warranty whatsoever with respect to component parts which are warranted separately by their respective manufacturers.

The above warranty supersedes and is in lieu of all other warranties, expressed or implied, and no person, agent or dealer is authorized to give any warranties on behalf of the Manufacturer nor to assume for the Manufacturer any other liability in connection with any of its products unless made in writing and signed by an official of the Manufacturer.

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.

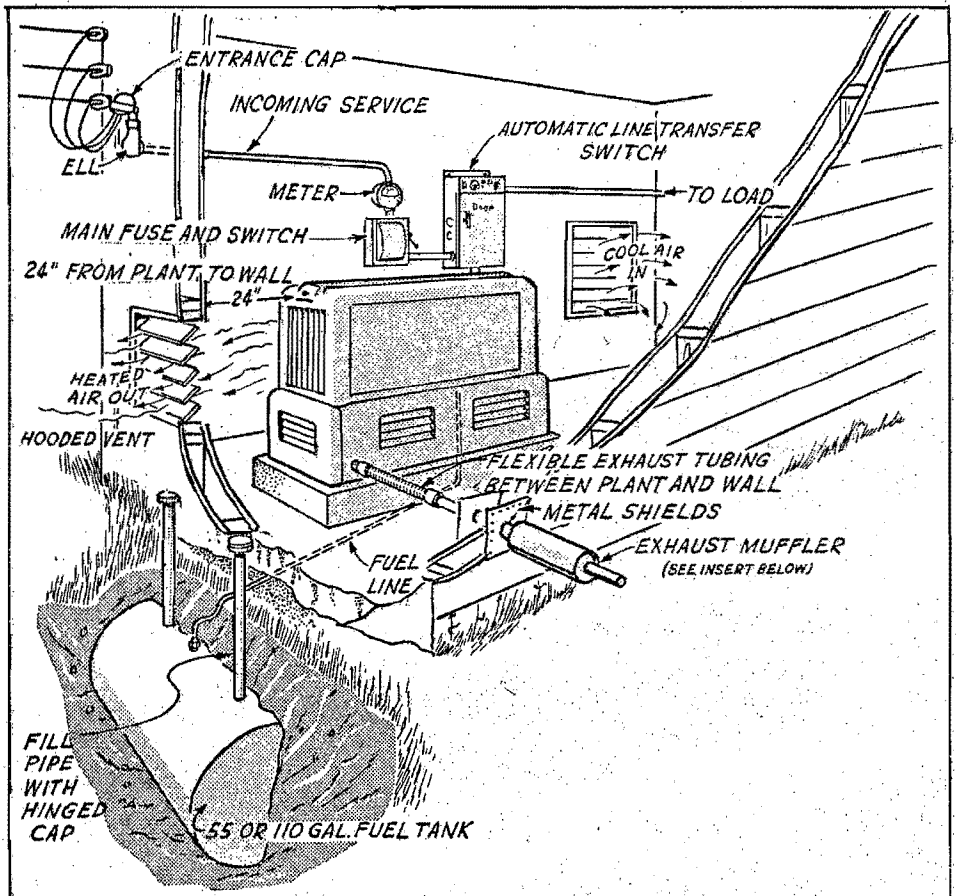
To arrive at an approximate figure of comparative generating plant running hours as against automobile engine running miles, multiply the total number of running hours by 41 to find the equivalent of running miles on an automobile.

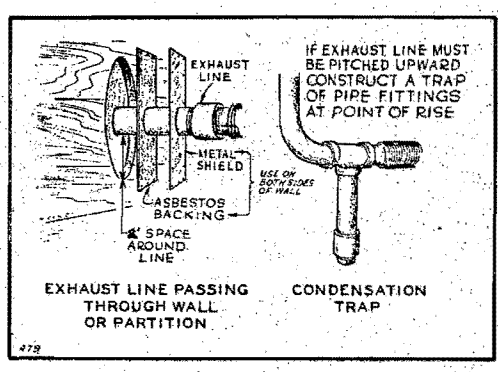
Your generating plant engine can "take it" and will give many hours of efficient performance provided it is serviced regularly.

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.





Typical Installation

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

Fig. 1
V

Always refer to this plant by the nameplate information

Take the information stamped on the PLANT nameplate (NOT the engine nameplate)

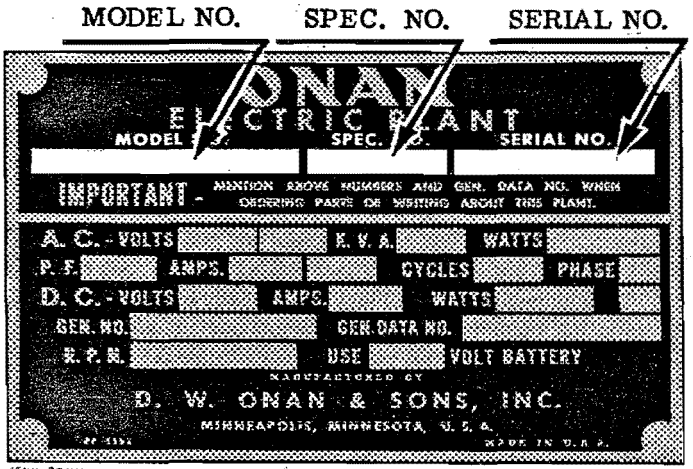


Fig. 2A.

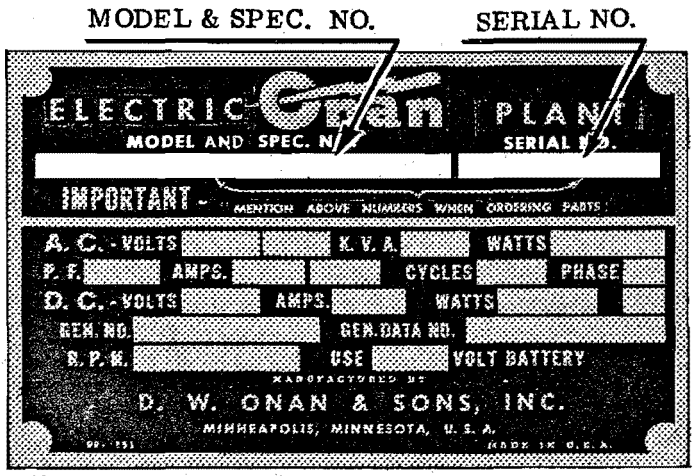


Fig. 2B.

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.

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 6 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 control and electrical meter panel. Unhoused models are of the open construction with a box on containing the necessary control parts mounted over the generator.

This instruction manual is supplied with all generating plants of the 15HK and 25HN 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, the operator should have no difficulty in making a good installation and in properly operating the generating plant.

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.

Always refer to this plant by nameplate information. Take the information stamped on the Plant nameplate (Not Engine Nameplate). The correct Model No., Spec. No., and Serial No. of the plant must be given. On all early Model plants the plant nameplate showed the Model No., Spec. No., and Serial No. in separate blocks as shown in Fig. 2A. On later model plants the plant nameplate shows only two blocks; one for the Model No. (includes Spec. No.); one for the Serial No., as shown in Fig. 2B.

ENGINE

The engine for the 25,000 watt 60 cycle, and the 20,000 watt 50 cycle generating plants is a Continental Model F226, specification 401. The bore is 3-5/16", the stroke 4-3/8", compression ratio 6 to 1, and the maximum horsepower rating at 1800 rpm is 54.2. The engine for the 15,000 watt 60 cycle, and the 14,000 watt 50 cycle generating plants is a Continental Model F186, specification 248. The bore is 3", the stroke 4-3/8", compression ratio 6.4 to 1, and the maximum horsepower rating at 1800 rpm is 45.4.

The cooling system capacity is approximately 18 quarts, U.S. standard measure. Full length water jackets surround the cylinders and valve seats. A belt driven, ball bearing water pump maintains circulation of the engine coolant. The temperature of the coolant is controlled by a thermostat. A pusher type fan forces cooling air out through the front of the radiator. The crankcase oil capacity is 5 qts. (U.S. measure) plus approximately 1 quart 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. Exhaust valves are the "ROTO" type, and have replaceable seats. Valve tappets are adjustable. 12 volt starting and ignition current is furnished by two 6 volt batteries connected in series. Charging current for the batteries is supplied by a separate automative type 12 volt generator. Ignition distributor rotation is counterclockwise. Firing order is 1-5-3-6-2-4. 60 cycle plants run at approximately 1800 rpm. 50 cycle plants run at approximately 1500 rpm. The engine is controlled by a flyweight type, gear driven, governor. Standard models burn gasoline fuel. Special models are equipped to burn gas fuel (natural gas or liquid petroleum gas, depending upon the model).

GENERATOR

The air cooled 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 are assembled into a single rotor which is directly connected to the engine flywheel. 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 the stationary armature windings of the alternator, and the smaller frame contains the stationary exciter field.

Due to the inherent design of the generator, voltage regulation between no load and full load is very close. Some special models are equipped with a separate voltage regulator for extremely close regulation. The frequency of the current is determined by the engine speed, and is

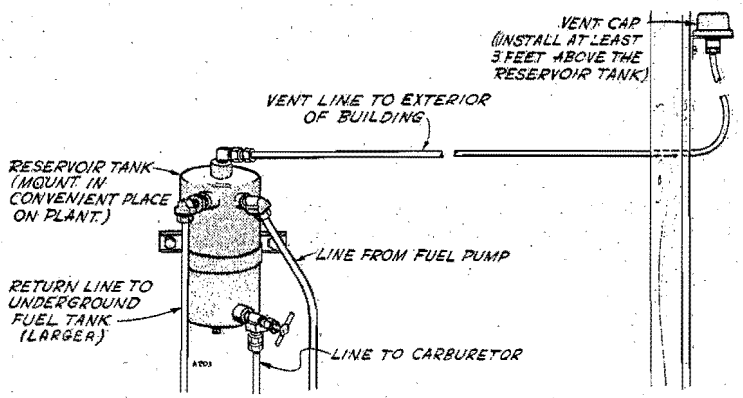
regulated by the engine governor. The speed is approximately 1800 rpm. for the 60 cycle plant, and 1500 rpm for the 50 cycle plant.

CONTROLS

The electrical control equipment varies with the plant model. Housed plants are equipped with an instrument panel mounting 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. Optional equipment such as automatic line failure, or remote control switches, may be connected.

Refer to the wiring diagram furnished with the plant when servicing the controls.

FUEL RESERVOIR (DAY) TANK. - In standby service, the generating plant may stand unused for many days. In this period of shut-down, sufficient gasoline may evaporate from the carburetor to lower its fuel level considerably. Prolonged cranking may then be necessary in order to pump enough gasoline into the carburetor for the engine to start. On installations where automatic, unattended starting after extended shut-down is necessary, an auxiliary, gravity feed fuel tank should be installed. Fuel from this tank flows by gravity to the carburetor, thus replacing any fuel lost through evaporation and promotes quick starting after an idle period.



FUEL RESERVOIR (DAY) TANK

LOCATION. - If possible, install the plant inside a building or covered vehicle for protection from extremes in weather conditions. The site should be dry, clean, and well ventilated. Either a damp or dusty location will require more frequent inspection and servicing of the plant. For permanent installations, the plant may be mounted on a raised concrete base. Allow at least 24" space on all sides for ease in servicing.

If the plant is mounted aboard a truck or trailer, see that it is fastened securely when in transit, and that it sets in a level position when 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 is 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 right 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.

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 muffler outlet has 2-1/2" standard pipe threads. Do not use pipe smaller than 2-1/2 inch size, and avoid sharp turns as much as possible when running an exhaust line. 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 occasionally. See illustration of typical installation Fig. 1.

FUEL TANK. - Observe provisions of local fire underwriters codes in the installation of any separate fuel supply tank. If an underground tank is installed, the lift of fuel from the bottom of the tank to the fuel pump inlet on the plant should not exceed 8 ft., which is the practical limit of its efficient lift.

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.

NOTE

On natural gas installations the atmospheric regulator on the plant is designed to operate on a line pressure not to exceed 5 pounds. If the line pressure exceeds 5 pounds pressure, it will be necessary to install a primary regulator in the line to reduce the pressure before it enters the atmospheric regulator.

BATTERIES. - Two 6 volt batteries are required. Use the short (6") cable to connect the positive post of one battery to the negative post of the second battery. For housed plants, connect the battery cable which is attached to the start solenoid switch to the remaining positive (+) post of the two batteries. Connect the cable which is grounded to the engine to the remaining negative (–) post of the batteries.

For unhoused plants, screw terminals for the battery cables are provided inside the control box. Run the battery cables in through the rubber grommets at the rear of the box. Use care to connect the battery cables to the proper terminals as marked on the control box.

Be sure battery connections are tight. Coat the battery clamps and posts lightly with grease or vaseline to minimize corrosion. Batteries shipped "dry" must be prepared for use as directed on the tag attached to each battery. Batteries shipped ready for use were fully charged when shipped. Such batteries slowly lose their charge when standing idle and it may be necessary to give them a "freshening" charge before putting them in use. Use a hydrometer to determine the charge condition.

CONNECTING THE LOAD WIRES - HOUSED PLANTS

GENERAL. - The AC output terminal studs, to which the load wires are to be connected, are located behind the control panel, on the chassis. Remove the right side grille for access to the terminals. Wiring and connections must conform to electrical codes in force in the community. Follow the directions for connecting to the plant terminals, 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. -

The center terminal is grounded, See Fig. 3. For 115 volt current, connect the grounded load wire to the center terminal, and the other load wire to either of the two outside terminals, A or B. Two 115 volt circuits are thus obtainable with not more than 1/2 the plant rating available on each circuit. Balance the load as closely as possible between the two circuits.

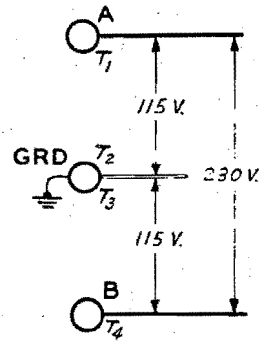


Fig. 3.

For 230 volt current, connect the load wires to the upper and lower terminals, A and B, leaving the center terminal unused.

A load not to exceed 15 amps., 115 volts may be connected to each outlet of the receptacle mounted on the control panel. Any load connected to this receptacle will not register on the meters.

230 VOLT, 3 PHASE, 3 WIRE PLANT. -

No terminal is grounded, Fig. 4. For three phase current, connect a separate load wire to each plant terminal A, B, or 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.

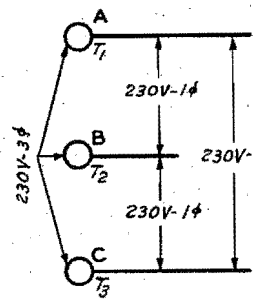


Fig. 4.

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 10, 000 watt load is used. This leaves 15, 000 watts available for single phase, if the plant capacity is 25, 000 watts. One third of this 15, 000 watts is 5, 000 watts, which is the

amount that may be taken from each of the 3 single phase circuits. Do not attempt to take all 15,000 in this example off one circuit, as overloading of the generator will result.

SINGLE PHASE 120 VOLT, 3 PHASE 208 VOLT, 4 WIRE PLANT. - The topmost terminal is grounded. See Fig. 5. 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.

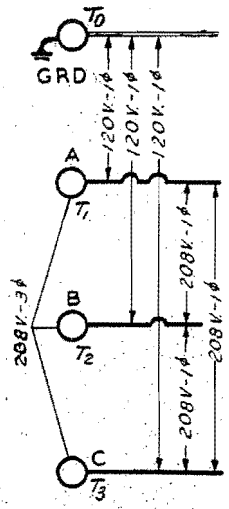


Fig. 5.

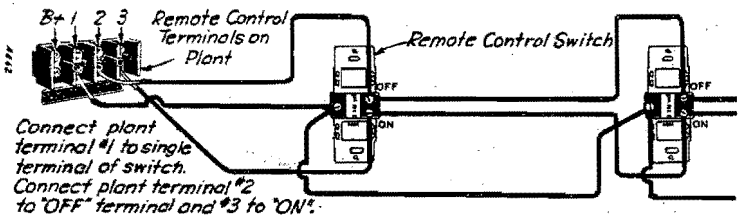
NOTE: When taking a single phase load off the plant, the single phase (line to neutral) voltage is 120 volts when the AC Voltmeter connected across the line (line to line) terminals reads 208 volts.

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 connection.

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.

REMOTE CONTROL CONNECTIONS, HOUSED PLANTS. - A small 4 place terminal block marked "REMOTE-DC OUTPUT" on the wiring diagram, is mounted to the left of the a.c. output terminals. One or more remote control switches may be connected to this block for remote starting and stopping. Connect the switch terminals as shown in Fig. 6 to the terminals number 1, 2, 3 on the terminal block. Leave the B+ terminal unused. Terminal #1 is a common ground, terminal #2 connects to the plant stop circuit, and terminal #3 connects to the plant start circuit.

The wire length from the plant to the switch determines the wire size necessary. Use #18 wire up to 75 feet, #16 wire up to 120 feet, #14 wire up to 200 feet, and #12 wire up to 300 feet. If automatic line transfer equipment is to be connected, follow the directions supplied with the equipment.



REMOTE STATIONS - HOUSED PLANTS
Fig. 6.

CONNECTING THE LOAD WIRES - UNHOUSED PLANTS

GENERAL. - The generator lead wires are within the small cast iron box at the rear of the generator. The load wires may be brought through the hole at one end of the box. 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 the 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 the 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 of 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 load as equally as

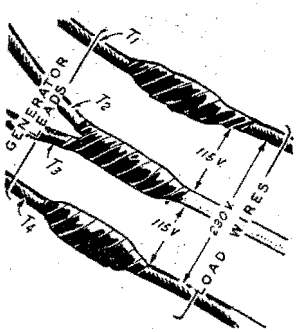


Fig. 7.

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.

SINGLE PHASE 120 VOLT, 3 PHASE 208 VOLT, 4 WIRE 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.

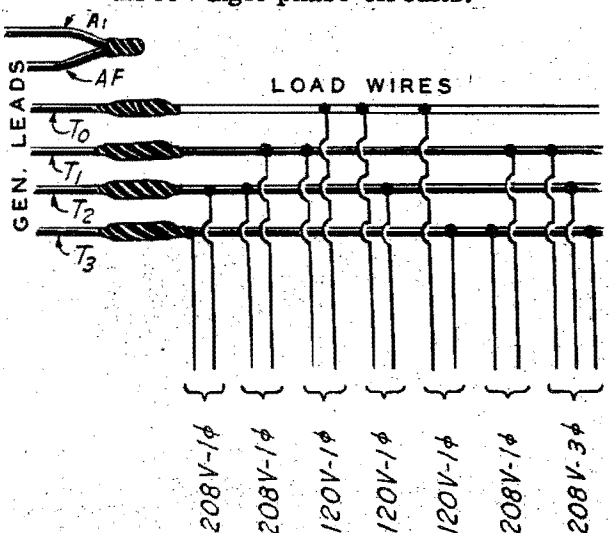


Fig. 8.

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 of load distribution 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.

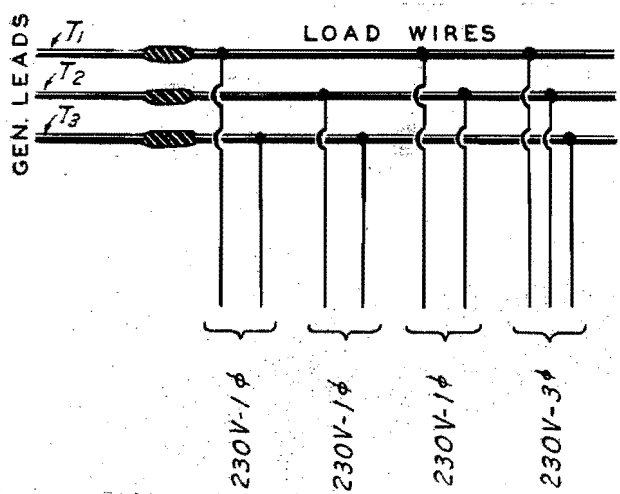


Fig. 9.

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, T2-T3, and T1-T3. Not more than one third of the generator capacity is available on each single phase circuit.

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

REMOTE CONTROL CONNECTIONS, UNHOUSED PLANTS. - A small 4 place terminal block marked " REMOTE CONTROL " is located inside the control box. If automatic or line failure controls are to be connected follow the directions for connections as supplied with the control equipment.

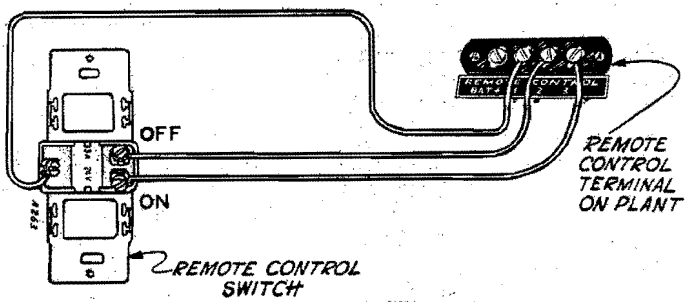
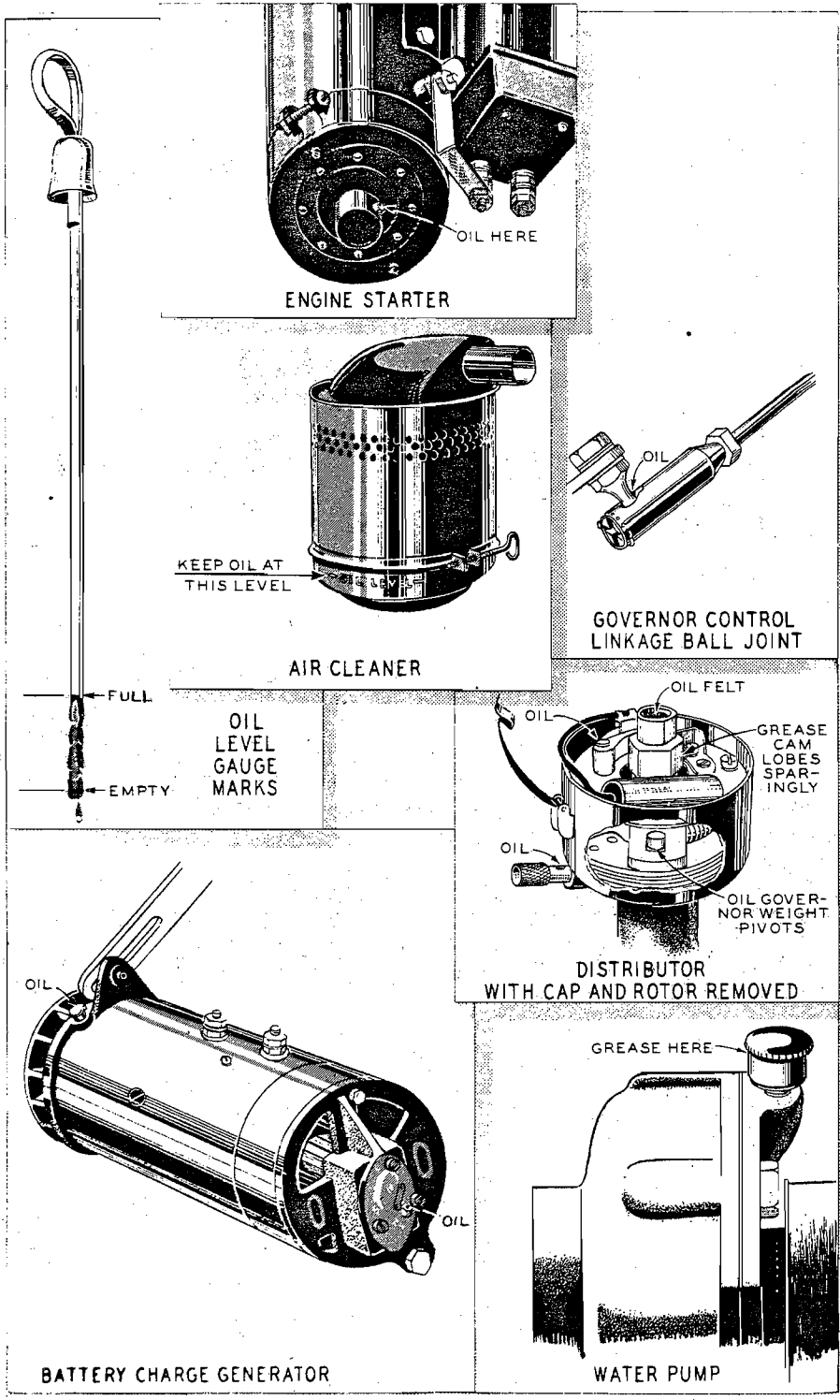


Fig. 10.

This switch and additional switches may be installed at convenient points. The wire length from the plant to the switch determines the wire size necessary. Use #18 wire up to 75 feet, #16 wire up to 120 feet, #14 wire up to 200 feet, and #12 wire up to 300 feet.

To install remote control switch, connect plant terminal #1 to single unlabeled terminal of switch; connect plant terminal #2 to switch terminal labeled "OFF"; connect plant terminal #3 to switch terminal labeled "ON". As many Start-Stop stations as are desired may be connected as shown.



LUBRICATION

Fig. 11

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 5 quarts (U.S. Measure) of a good quality heavy duty oil classified by the American Petroleum Institute as Service "DG" or, as marketed by most manufacturers, "MS/DG". The use of service "DS" is satisfactory, but its higher cost is not justified. Approximately 1 quart of oil remained in the oil filter when the crankcase was drained at the factory. Do not use an oil heavier than SAE number 20 in a plant being put into service the first time. After the first oil change, use an oil of the proper SAE number, according to the lowest temperature to which the plant will be exposed, as indicated in the following table.

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

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.

Pour a few drops of oil into the oil cup on the side of the distributor.

The ball joints of the governor to carburetor control linkage should be lubricated with powdered graphite or a light non-gumming oil.

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 reinstalled.

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 20 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 only a fresh automotive type gasoline of the "regular" grade. Do not use any highly leaded premium 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. The pressure regulator mounted on the plant is a secondary or atmospheric type, capable of handling line pressure up to 5 pounds. If the pressure exceeds 5 pounds, install a primary type regulator in the line to reduce the pressure to 5 pounds or less.

Refer to the Table of Clearances for proper spark plug gap.

RADIATOR. - The capacity of the cooling system is 18 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 antifreeze solution. Use the correct proportion of antifreeze as recommended by the antifreeze 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 and 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.

CAUTION

On the initial start (starting the plant for the first time after it has been installed or taken out of storage) check the oil pressure immediately. Long storage periods may cause the oil pump to lose its prime.

STARTING THE PLANT ELECTRICALLY. - Set the ignition toggle switch at the ELEC.START position. Press the START switch to electrically crank the 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 second 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, 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 may not operate. NO CHOKING IS NECESSARY WHEN OPERATING ON GAS FUEL, AND THE CARBURETOR CHOKE VALVE SHOULD BE WIDE OPEN. A choke sleeve fitted to the air intake of the carburetor, and operated by the flow of air to the carburetor, provides all the choking action necessary for gas operation.

Turn on the gas fuel supply and press the START switch. To start a plant the first time, it may be necessary to press the priming button, at the center of the regulator, for an instant. Do not overprime. Release the START switch when the plant reaches running speed. 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 to insure 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 if the batteries have sufficient power to provide ignition current.

To start the plant manually, see that the fuel system is ready for operation, as explained under STARTING ELECTRICALLY. Throw the ignition toggle 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 cranks. If gas fuel is being used, it may be necessary to press the priming button, at the center of the regulator, for an instant. Do not overprime. 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 practical, 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, the high water temperature switch, 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.

CAUTION

KEEP THE IGNITION SWITCH AT THE ELECT. START POSITION AT ALL TIMES EXCEPT WHEN ACTUALLY STARTING THE PLANT MANUALLY. THROW THE SWITCH TO THE HAND START POSITION WHILE CRANKING THE PLANT MANUALLY, BUT RETURN IT TO THE ELECT. START POSITION AS SOON AS THE PLANT STARTS. IF THE SWITCH IS LEFT AT THE HAND START POSITION WHEN THE PLANT IS NOT RUNNING, THE BATTERY MAY BECOME DISCHARGED AND THE IGNITION COIL DAMAGED.

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 40 pounds, the coolant temperature approximately 150° to 180°F. (65° to 82° C.), and the battery charge rate between 2 and 12 amperes, depending upon the charge condition of the batteries.

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

Connect a load to the plant by throwing the 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. A voltmeter-ammeter selector switch is provided for checking the individual phases of the circuit on the three phase plants. Plants equipped with an output receptacle on the control panel will not register any load which may be connected to the receptacle. This receptacle is provided for a trouble light or similar light load, up to 15 amps. for each outlet.

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, UN-HOUSED 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 the ignition coil having the same effect as pressing the stop button on the plant. The engine must cool off approximately 10^{O}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 the ignition coil, 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 prevent normal operation of the plant with the ignition switch at the ELECT. START position, the plant may be run temporarily with the switch at the HAND START position. This is purely an emergency measure and should be resorted to only if necessary. Keep a careful check on the plant while operating under these conditions.

STOPPING THE PLANT. - If practicable, disconnect the electrical load. Press the STOP button firmly. 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.

SPECIAL OPERATING INSTRUCTIONS FOR GENERATING PLANTS EQUIPPED WITH AN AC VOLTAGE REGULATOR

To clarify for the reader, remember the standard type plants of these series have generators in which the output voltage is regulated inherently and consequently these following special instructions do not apply to the standard plants. A voltage regulator connot be installed on an inherently regulated plant. To assist the reader having a voltage regulated plant, first determine the type of regulator used, then read all of General Description and Manual Rheostat Operation, then turn to those instructions which apply to the specific type regulator. Normally, the regulator does not require attention during successive plant operations.

GENERAL DESCRIPTION. - Several types of voltage regulators have been used (SILVERSTAT "SRA-10", SILVERSTAT "SRA-JR", REGOHM) in the manufacture of these plants. The operating procedure and circuits of each type regulator is different. Before checking or servicing a regulator determine the type on your plant by referring to the nameplate on the regulator and the wiring diagram.

TYPES OF VOLTAGE REGULATORS USED

MAKE	TYPE	SPEC. LETTER OR UNIT DATE	CONTROL SWITCH
Westinghouse	Silverstat SRA-JR	1946 - 1947	SPDT
Westinghouse	Silverstat SRA-10	1946 - 1947	SPST
Westinghouse	Silverstat SRA-JR	1947 - 1950	SPST
Regohm		Sept. 1950-Nov. 1952 Spec 192 or Higher	SPST
Regohm		Nov. 1952 to Date Spec L	DPDT *

Note * Switch combined with rheostat June 1954.

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 shunt field circuit of the exciter. The generator ac output voltage actuates an electromagnet in the regulator. The magnet in turn varies the resistance value used. If the generator ac output voltage tends to drop, the regulator resistance is lowered, allowing the generator exciter field strength to increase, which in turn keeps the ac output voltage at its original value. If the generator ac output voltage tends to rise, the regulator resistance is raised, reducing the exciter field strength, which in turn keeps the ac output voltage at its original value. The regulator provides automatically the same effect

(regulator cont'd)

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 "L" 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 a.c. output voltage). Also on some plants a shield covering the field rheostat knob prevents tampering. This design insures proper operation.

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. This rheostat knob must be left in the correct operating position during regulator operation depending upon the type of automatic voltage regulator being used. See the following instructions.

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.

MANUAL RHEOSTAT OPERATION. - Manual Rheostat Operation 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 replacements of the regulator should be made as promptly as possible. The procedure for Manual Rheostat operation is the same regardless of the type of voltage regulator circuit used. When the panel 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. (However, on later models having a combined rheostat and switch, turn the field rheostat knob slightly clockwise from lowest voltage

position to snap the switch to "RHEOSTAT ON" position.) This is necessary to compensate for naturally higher voltage produced by a cold generator, and not under load. The voltage will drop somewhat as the generator warms up.

The setting of the rheostat must be changed with changes in the electrical load. It will be necessary to watch the voltmeter so that corrections can be made with load changes. As electrical load is increased, the generator voltage will drop, and it is necessary to readjust the rheostat to maintain the desired voltage.

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.

WESTINGHOUSE TYPE "SRA-JR" SILVERSTAT VOLTAGE REGULATOR WITH SINGLE POLE DOUBLE THROW (SPDT) SWITCH. - The manual rheostat is disconnected from the generator circuit when the RHEOSTAT ON - REGULATOR ON toggle switch is thrown to the "REGULATOR ON" position. This places the voltage regulator in complete control of the AC voltage. The AC voltage can be adjusted with limits of 5% above and 5% below rated voltage by adjusting the rheostat located on the voltage regulator.

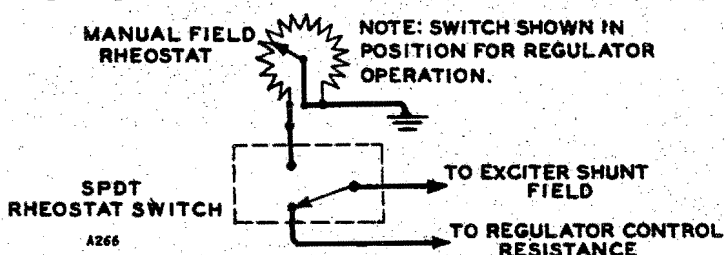


FIG. 12 WESTINGHOUSE TYPE "SRA-JR" REGULATOR CONTROL CIRCUIT

WESTINGHOUSE TYPE "SRA-10" SILVERSTAT VOLTAGE REGULATOR . - The Westinghouse Type "SRA-10" Silverstat regulator uses a regulating resistance which is connected in the exciter shunt field circuit in series with the exciter field rheostat. This exciter field rheostat is the Manual Rheostat. The regulator and "regulating resistance" become effective after the Rheostat Switch is opened and the Manual Rheostat is turned towards or near the resistance "all-out" position. The regulator becomes inoperative and the A.C. generator voltage is controlled manually by the position of the Manual Rheo-

stat when it is turned toward the "all-in" position. This type of regulator is designed to be used with some resistance of the Manual Rheostat left in the circuit while using regulator operation. The correct position of the Manual Rheostat for this resistance is determined at the factory and it is marked on the control panel with white paint.

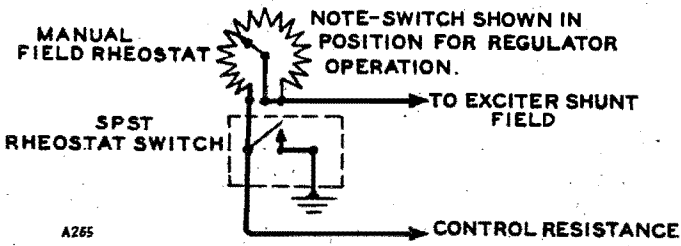


Fig. 13. Wesinghouse Silverstat Type "SRA 10" Control Circuit

To put the regulator in operation - proceed as follows:

1. Place the Manual Rheostat in the position marked on the panel with white paint.
2. Place the Rheostat Switch in the position for regulator operation. (The Regulator should take control and automatically regulate the AC voltage).
3. Adjust the Voltage Adjusting Rheostat which is mounted near the regulator to the required value of the AC voltage.

CAUTION

ALWAYS MAKE SURE THAT THE MANUAL RHEOSTAT IS ON THE MARKED POSITION WHEN THE REGULATOR IS LEFT IN CONTROL OF THE AC GENERATOR VOLTAGE. (MAKE SURE THAT THE RHEOSTAT HANDLE DOES NOT SLIP ON ITS SHAFT.)

To remove the regulator from control, proceed as follows:

1. Turn the Manual Rheostat in the direction to lower the voltage until the AC voltage begins to drop.
2. Place the Rheostat Switch in the position for Manual Rheostat operation.
3. Normal values of AC voltage may be obtained by Manual Rheostat control. (See preceding paragraph on Manual Rheostat operation).

(regulator cont'd)

WESTINGHOUSE TYPE "SRA-JR" SILVERSTAT VOLTAGE REGULATOR WITH SINGLE POLE SINGLE THROW (SPST) SWITCH. - The Westinghouse SRA-JR" Silverstat type voltage regulator uses a regulating resistance which is connected in the exciter shunt field circuit in series with the exciter field rheostat. This exciter field rheostat is the Manual Rheostat. The regulator and "regulating resistance" become effective after the rheostat Switch is opened and the Manual Rheostat is turned towards or near the resistance" all-out" position. The regulator becomes inoperative and the AC generator voltage is controlled manually by the position of the Manual Rheostat when it is turned toward the "all-in" position. This type of regulator is designed to be used with some resistance of the Manual Rheostat left in the circuit while using regulator operation. The correct position of the Manual Rheostat for this resistance is determined at the factory and it is marked on the control panel with white paint.

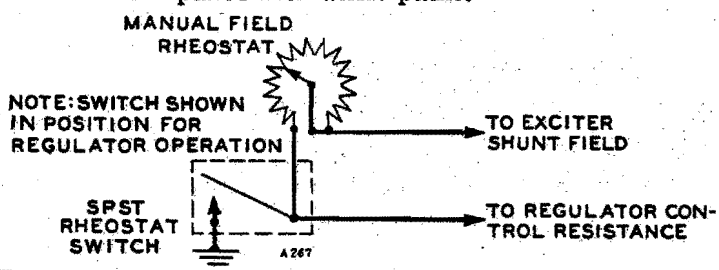


Fig. 14. Westinghouse Silverstat "SRA-JR" Control With Switch

To put the voltage regulator in operation proceed as follows:

1. Place the Manual Rheostat in the position marked on the panel with white paint which is for regulator operation.
2. Place the Rheostat Switch in the position for regulator operation. (The regulator should take control and automatically regulate the AC voltage).
3. Adjust the Voltage Adjusting Rheostat knob which projects thru the regulator cover to the required value of AC voltage.

CAUTION!

ALWAYS MAKE SURE THAT THE MANUAL RHEOSTAT IS ON THE MARKED POSITION WHEN THE REGULATOR IS LEFT IN CONTROL OF THE AC GENERATOR VOLTAGE. (MAKE SURE THAT THE RHEOSTAT HANDLE DOES NOT SLIP ON ITS SHAFT).

To remove the regulator from control, proceed as follows:

1. Turn the Manual Rheostat in the direction to lower the voltage until the AC voltage begins to drop.

(regulator cont'd)

2. Place the Rheostat Switch in the position for Manual Rheostat operation.

3. Normal values of AC voltage may be obtained by Manual Rheostat control.

REGOHM REGULATOR WITH SPST AND DPDT SWITCH. - The regulator operating procedure is the same for both types of switches (SPST) and (DPDT) except that for the circuit using the double pole double throw (DPDT) switch the manual rheostat is disconnected from the circuit when using voltage regulator operation.

To operate the generator using the voltage regulator, and equipped with the combined field rheostat and DPDT switch proceed as follow:

The procedure is the same as that below except that the switch is automatically snapped to "REGULATOR ON" position when the field rheostat knob is turned all-the-way counterclockwise. Then by turning the knob slightly clockwise the switch is automatically snapped to "RHEOSTAT ON" position.

The plant leaves the factory with the field rheostat turned for "REGULATOR ON" operation. Some plants have a removable cover over the knob to prevent unnecessary tampering. No further change should be made during future operation unless the regulator fails. If failure occurs, first check the rear of the field rheostat to see that the DPDT toggle switch is in time with the rheostat.

To operate the generator using the voltage regulator but not equipped with the combined field rheostat and switch, proceed as follows:

1. Start with the RHEOSTAT ON - REGULATOR ON switch at the RHEOSTAT ON position.

2. Turn the manual rheostat to the maximum counterclockwise position (minimum AC voltage). This procedure protects the contact fingers of the voltage regulator.

3. Throw the switch to regulator operation.

   WARNING !
   NEVER THROW THE SWITCH TO REGULATOR OPERATION UNLESS THE MANUAL FIELD RHEOSTAT IS IN THE MAXIMUM RESISTANCE POSITION (MINIMUM AC VOLTAGE).

4. The manual rheostat MUST be turned to the maximum clockwise (zero resistance) position after switching to regulator operation. (Not necessary if the regulator has a DPDT switch.)

(regulator cont'd)

5. Adjust the voltage regulator rheostat to obtain rated a.c. voltage.

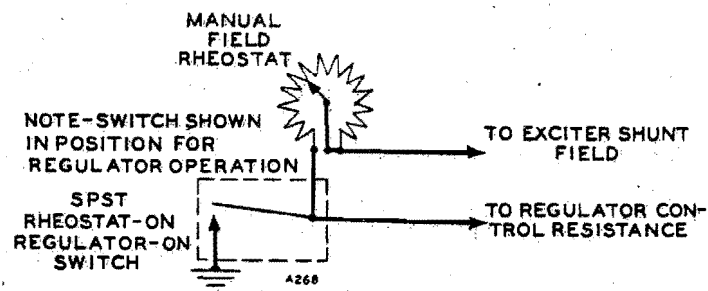


Fig. 15. Regohm Regulator Control With SPST Switch

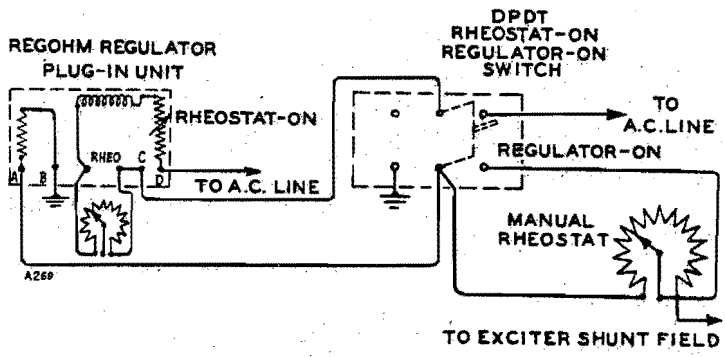


Fig. 16. Regohm Regulator Control With DPDT Switch

6. 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.

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

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.

If the regulator is ever disconnected, be sure to keep the panel switch at the "RHEOSTAT ON" position.

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 20 W in the crankcase. For temperatures below 0°F. (-18°C.) use SAE number 5W oil. The oil should be the detergent, or heavy duty type.

If number 5W oil is not obtainable, dilute number 10W oil with approximately 1 part of kerosene to 4 parts of oil. 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 the changes. When using diluted oil, change the oil every 25 operating hours and check the oil level frequently. Use undiluted oil again as soon as temperature conditions permit.

CAUTION

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

AIR CLEANER. - If congealed oil or frost formation within the air cleaner restricts the air flow, remove and clean the air cleaner. Reassemble and use the air cleaner without oil until conditions permit the use of oil in the normal manner. 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 proportion recommended by the anti-freeze manufacturer for the lowest temperature to which the plant will be exposed. The capacity of the cooling system is 18 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 temperatures up to 100°F. (38° C.) and SAE number 40 for higher temperatures. Check the oil level frequently and change the crankcase oil at least every 50 hours. Keep the electrolyte level in the batteries up to normal.

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 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 elect-

trolyte from a normal of 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 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 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 if it becomes discolored before the normal time has elapsed between changes.

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

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

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

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

WEEKLY SERVICE

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

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

GENERAL LUBRICATION. - Put a little powdered graphite on each of the governor to carburetor link ball joints, and fill the distributor oil cup. Put several drops of oil in the oil holes at each end of the battery charging generator, and in the oil hole at the forward end of the starting motor.

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 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 adjust the electrodes gap as specified in the Table of Clearances. More frequent spark plug service may be necessary if leaded gasoline is used.

WATER PUMP. - Note that later model pumps do not require periodic lubrication. For earlier models use a good grade of water pump grease in the water pump grease cup. Turn the grease cup cap down 1 turn each 50 hours of operation. If grease appears in the coolant, the water pump is being overlubricated.

DISTRIBUTOR. - Check the distributor 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 to 0.020". Excessive burning or pitting of the points usually indicates a faulty condenser, which should be replaced with a new one. Lubricate as directed above under GENERATOR LUBRICATION.

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 and clean the fuel pump bowl and screen.

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

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

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

OIL FILTER. - It is normal for detergent type crankcase oil to become discolored in use. Intervals of filter cartridge renewal must be determined by hours of operation, operation conditions, and engine condition rather than by oil discoloration when using detergent type oils. Clean out the oil filter and install a new cartridge when required, to coincide with an oil change. The new filter cartridge will absorb approximately one quart of oil when the plant is started up. After a short running period, stop the plant and check the crankcase oil level. Add oil as necessary to bring the oil up to the proper level.

ENGINE COMPRESSION. - Check the compression of each cylinder, using a compression gauge. 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. New engine compression is approximately 110 lbs.

CRANKCASE BREATHER VALVE. - To assure proper crankcase ventilation, this gravity operated weight type valve must be free from varnish and sludge accumulation. Remove the valve from the intake manifold and take it apart. Thoroughly wash it in a varnish remover or a solvent such as alcohol or acetone. Install it with the arrow up as instructed on the valve body.

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 200 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.

Engine compression should not be below 80 lbs. pressure at sea level. New engine compression is approximately 110 lbs. at cranking speed.

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 roughness may be remedied by lightly sanding with #00 sandpaper. Clean out all carbon and sandpaper dust.

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

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

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

GENERATOR BEARING LUBRICATION

LITHIUM BASE GREASE. - Every 5,000 hours or 2 years whichever occurs first, service the generator ball bearing with factory recommended lithium base grease (conforms to MILITARY SPECIFICATION MIL-G-10924).

Avoid mixing different bearing greases.

Remove the plate from the housing rear end. Thoroughly clean all dirt from around the bearing cover and remove the cover and gasket. Using the factory recommended lithium base bearing grease, first thoroughly clean out the bearing with a good solvent such as carbon tetrachloride or gasoline. Then allow the bearing to dry. With a finger, fill ONLY a 1/4 section of the bearing with grease, removing any excess. Do NOT build up a reserve supply in the bearing recess nor in the bearing cover.

STANDARD BEARING GREASE. - If ordinary bearing grease is used, service the generator ball bearing every 6 months or 1200 operating hours whichever occurs first and proceed as follows:

Using the ordinary good bearing grease, first remove the old lubricant from the bearing with a clean finger. Then work about one tablespoon of new ball bearing lubricant into the bearing and again remove the lubricant. Refill the bearing housing less than one-half full of bearing lubricant, packing it well into the lower half of the bearing.

Reinstall the bearing cover gasket and cover, using care that no dirt gets into the bearing.

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

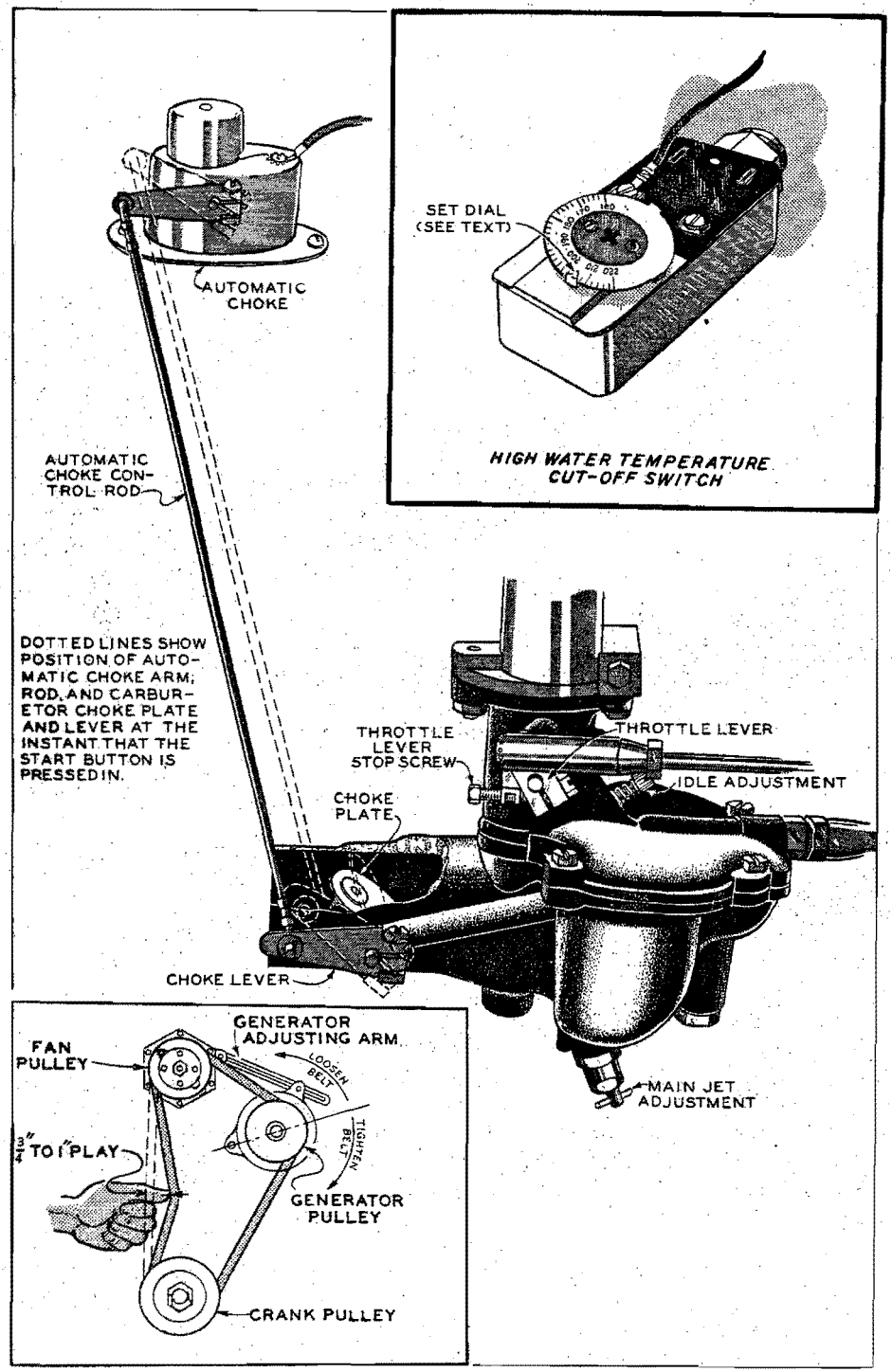
Changes in the type of gasoline used, or in operating conditions may necessitate a readjustment of the carburetor. Before readjusting the carburetor, make sure that the ignition system, valves, and other parts of the fuel system are operating properly. The main jet adjustment is at the bottom of the 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. - 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.

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 tem-



ADJUSTMENTS

Fig. 17.

perature 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.

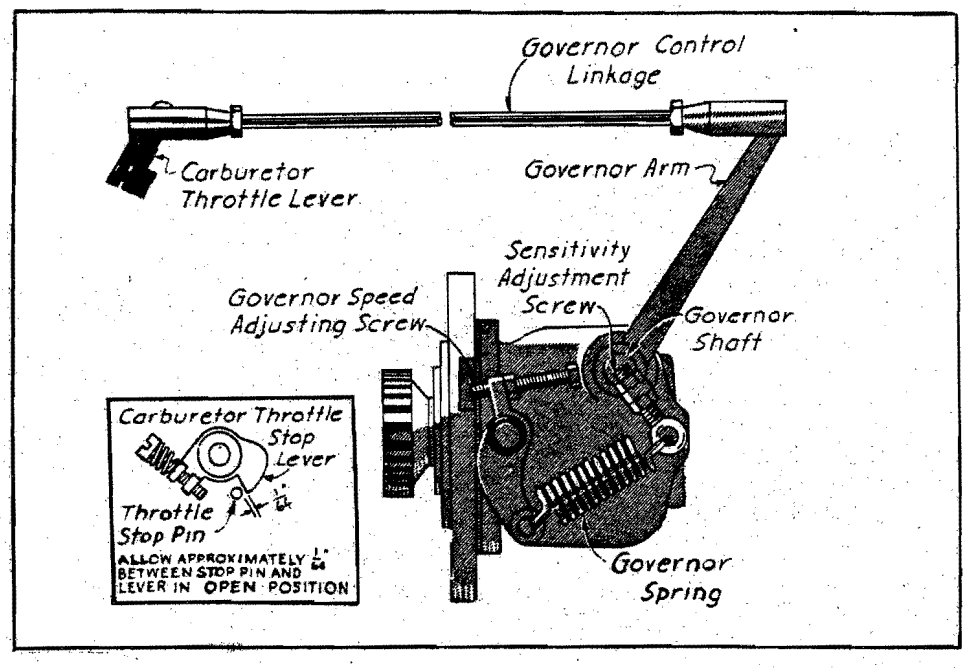
FAN AND GENERATOR BELT ADJUSTMENT. - The belt tension is determined by the position of the battery charging generator. To readjust the belt tension, loosen the generator adjusting arm bolt and nut slightly. Move the generator toward the engine to loosen the belt, or away from the engine to tighten the 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 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.

MANIFOLD HEAT ADJUSTMENT. - 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 sector counterlockwise to the desired position. 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 voltage and frequency of the current. Should resetting of the governor become necessary, proceed as follows, referring to the illustration GOVERNOR ADJUSTMENT.

1. With the engine stopped, and tension on the governor spring, adjust the governor linkage length so that the carburetor throttle stop lever clears the stop pin by not less than 1/64" as shown. See insert.
2. Start the plant and allow it to reach operating temperature.



GOVERNOR ADJUSTMENT

Fig.18.

3. With no electrical load connected, adjust the speed screw to the point where the panel voltmeter shows approximately 126 volts for a 115 volt A.C. plant. Apply a full load to the plant and again check the voltage, which should be approximately 110 volts for a 115 volt A.C. plant. Voltage will be proportionately higher for plants of other voltages. Engine speed, for a 60 cycle plant, as checked with a tachometer, should be within the limits of 1890 rpm at no load, to 1710 rpm at full load, with the actual spread between no load and full load conditions not more than 100 rpm.

4. If the plant tends to hunt (Alternately increase and decrease speed) under load conditions, increase very slightly the distance between the eye of the sensitivity screw and its support. For best regulation keep the sensitivity screw in as close as possible without causing hunting. Any change in the setting of the sensitivity screw will require correcting the speed screw adjustment.

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

REGHOM 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 Fig. 19.

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.

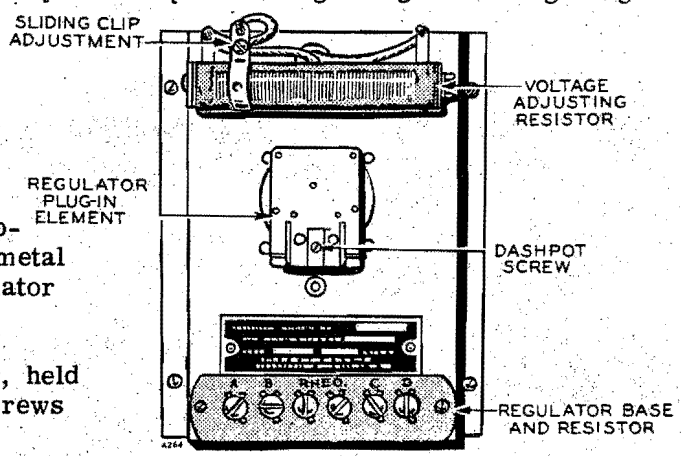


FIG. 19 - REGOHM VOLTAGE REGULATOR ADJUSTMENTS

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 !

A.C. VOLTAGE REGULATOR ADJUSTMENT PROCEDURE. - See also the instructions REGULATING THE VOLTAGE under Operation section of this manual for plants using a Regohm voltage regulator only.

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.
6. Set the regulator rheostat at approximately the middle of its rotation.
7. To set the adjustable resistor, which is mounted on the automatic voltage regulator base, to obtain the rated AC voltage proceed as follows:
   (a) Set the regulator adjusting knob at its center position.
   (b) Loosen the sliding clip on the adjusting resistor and move the clip backward and forward as necessary to obtain the desired voltage. See Fig. 19.
   (c) 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. Regulate the ac voltage output as instructed under REGULATING THE VOLTAGE under Operation section of this manual.

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 covers. 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. Adjust the tappets to clearances of 0.014" for the intake valves and 0.014" for the exhaust valves. Exhaust valves are numbers 1, 4, 6, 7, 9, and 12. 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. Install a new valve, if 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.

The exhaust valves are of the "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 exhaust 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 exhaust valves are properly installed, it will be possible to turn them in their guides when the valves are wide open. This is not possible with the intake valves, which are of the conventional type.

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 distributor and its drive shaft.

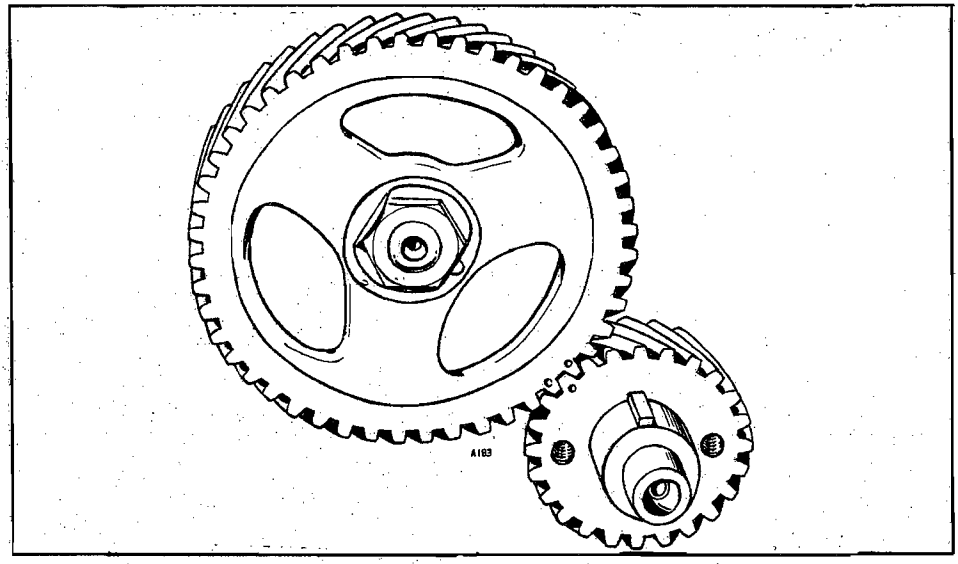


FIG. 20. TIMING GEARS

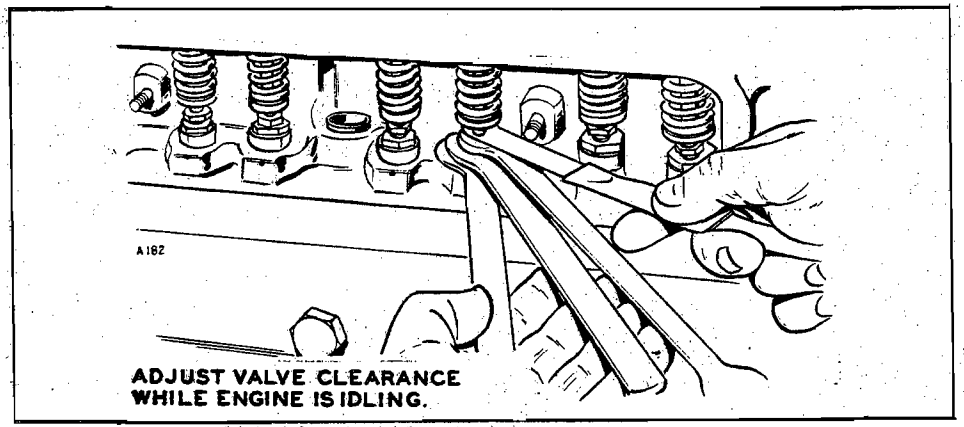


FIG. 21. TAPPET ADJUSTMENTS

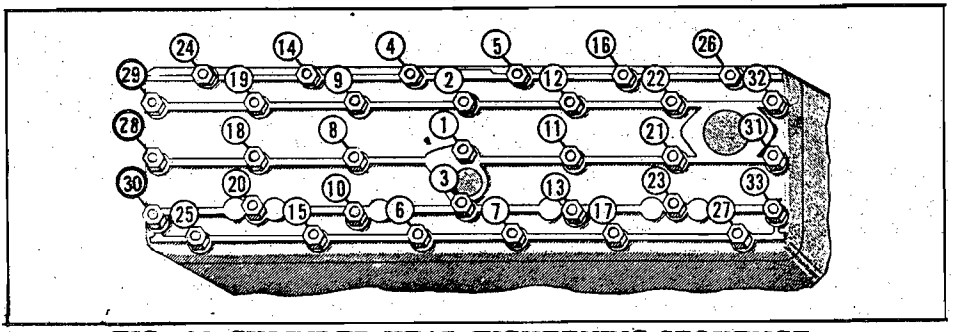
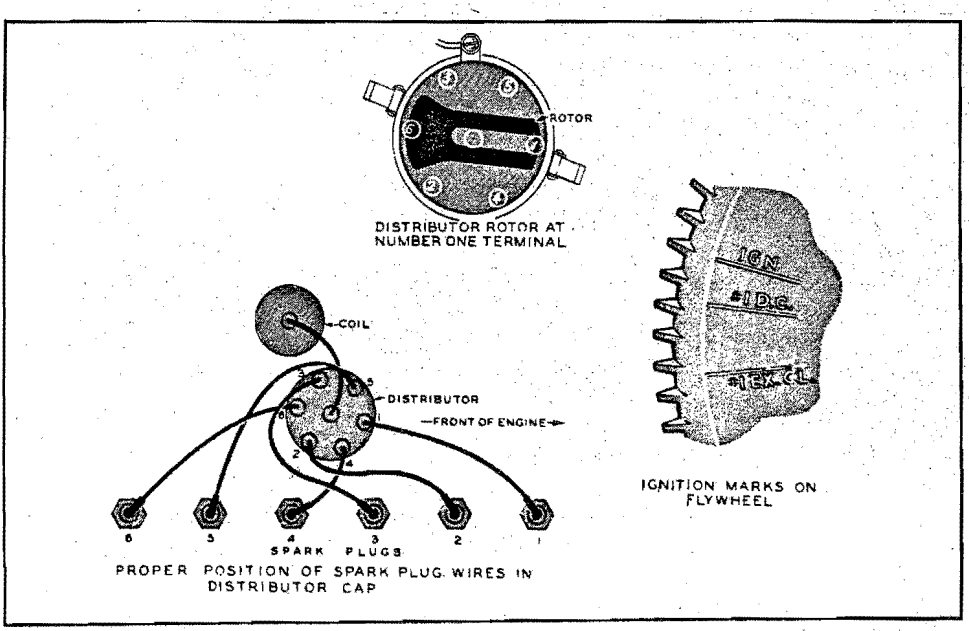


FIG. 22. CYLINDER HEAD TIGHTENING SEQUENCE

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 Fig. 20., TIMING GEARS.

IGNITION TIMING. - When the piston in #1 cylinder is at top dead center (D.C.) after the compression stroke the following should be true: Number 6 exhaust valve will have just closed as viewed through spark plug hole; slot in oil pump drive shaft which drives the distributor drive shaft will be almost parallel to the engine. The unpainted side of the distributor drive shaft coupling will be toward the manifold side of the engine and properly engaged with its drive member; The distributor rotor will point toward the front of the engine. The flywheel marks will align with the inspection hole on certain engines only!



IGNITION TIMING
FIG. 23.

Make reinstallations to comply with the conditions above. Set the contact points to 0.020" gap at full separation. Loosen the distributor adjusting clamp screw and turn the distributor body counterclockwise to close the contact points. Use a series type timing light, if available. Slowly turn the distributor clockwise until the contacts just separate. From this point (#1 D.C.) the timing must be advanced slightly (about 5°) as indicated by best performance under full load operation. To advance the timing turn the distributor body slightly in a clockwise direction, or to retard timing turn it counterclockwise. Keep the spark advanced as far as possible without causing a "ping".

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 cylinder for an out of round or taper-ed condition, reboring for oversize pistons if necessary. Any ridge wor- 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 oil ring gap for the F186 engine (15,000 watt plant) is .009" to .014" The oil ring gap for the F226 engine (25,000 watt plant) is .010" to .020". The compression rings for the F186 engine are interchangeable, one groove to the other, and the ring gap should be within .008 to .014". For the F226 engine the top (plain compression) ring and 2nd groove (taper compression) ring gap is .005" to .015". For the F226 third groove (grooved compression) ring, the gap is .005" to .015". 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 if necessary 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 0.0015" to 0.002". 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, and rear bearing shells are not interchangeable, although the two intermediate pair are. 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 bearing. The clearance, when installed, should be 0.0015" to 0.002". 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: Wear on 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 material of the camshaft used in the engine beginning with Continental Serial number 10581 (Onan serial #458803) was changed from forged alloy steel to proferal cast iron. If a steel camshaft is ordered and it is necessary to supply a cast iron camshaft, then a new oil pump drive gear is furnished and must be installed to assure long life. See the parts list.

The camshaft bearings are bushings which are line reamed, after installation in the crankcase, to a clearance of 0.002" to 0.004". The installation of new camshaft bearings is not practicable without the proper line reaming equipment.

WATER PUMP (For Models Prior to "SPEC. K"). - The water pump on this engine is a centrifugal, ball bearing, self sealing type. To dismantle the pump proceed as follows:

1. Remove the nut and lockwasher from the front of the water pump shaft and, using a suitable puller, pull the pulley off the shaft.
2. Remove the three nuts mounting the shaft support to the body and remove the support assembly.
3. To remove the impeller, remove the set screw and pull or press the impeller from the shaft. Note that if the set screw is loosened only a few turns it will not be free from the hole in the shaft.
4. To remove the shaft and bearings from the support, remove the set screw from the top of the support and press the assembly out through the front.
5. The seal will be found assembled in the impeller hub. Care must be taken in removing this assembly as the carbon seal is fragile and easily broken. The holes in the brass cup holding the seal should be lined up with the slots in the impeller hub. These are provided to prevent dirt from forming behind the seal ears and preventing efficient sealing. To reassemble, reverse the procedure used in disassembly. When reassembling the pump make sure that the set screw projects far enough to line up the impeller on the shaft. Pack the space between bearings with a good grade of sodium soap type grease such as Mobile grease No. 5.

WATER PUMP (For Models Beginning with "SPEC. K"). - 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. Whenever 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 40 pounds at the governed speed, with the engine oil hot. The oil pressure relief adjustment is reached by removing a large hexagon shaped plug in the side of the crankcase close to the fuel pump. Oil pressure may be increased by adding plunger washers or reduced by removing plunger washers. Too high or too low pressure may be caused by a sticking plunger. Remove the assembly and clean thoroughly. Continued low oil pressure usually indicates excessively worn bearings.

TABLE OF CLEARANCES appear at the end of Maintenance and Repair section!!

GENERATOR

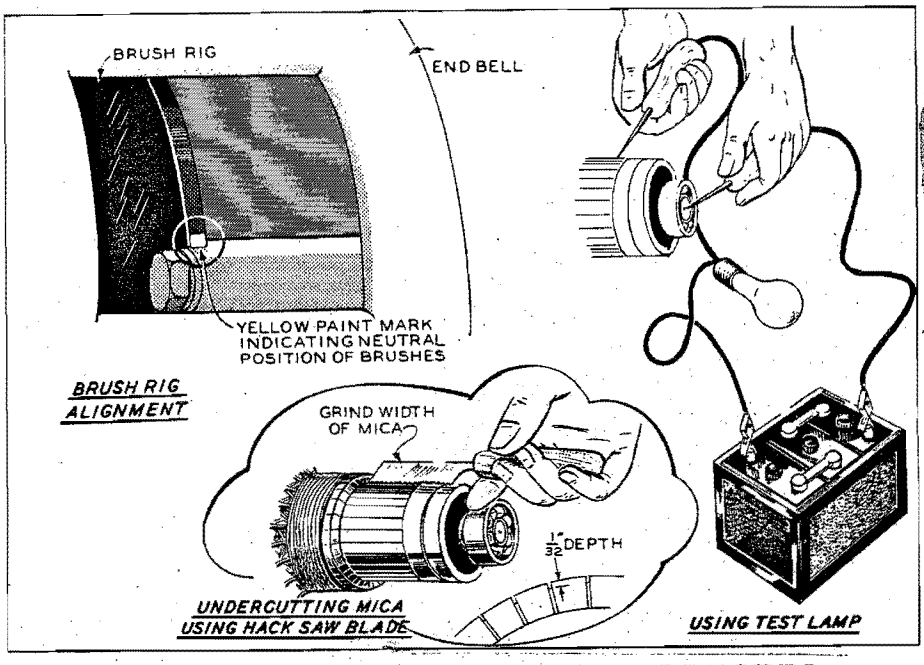
GENERAL. - The generator normally requires little maintenance other than the PERIODIC SERVICE.

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

Should dusty operating conditions cause the surface of the commutator or 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. It will be necessary to remove the generator frame before the rotor can be removed. Remove the ball bearing from the rotor shaft before turning down to prevent any foreign material getting into it. After the commutator is turned down, the mica between bars must be undercut as described above. When the rotor is reinstalled, align it as carefully as possible before installing the frame and end bell.

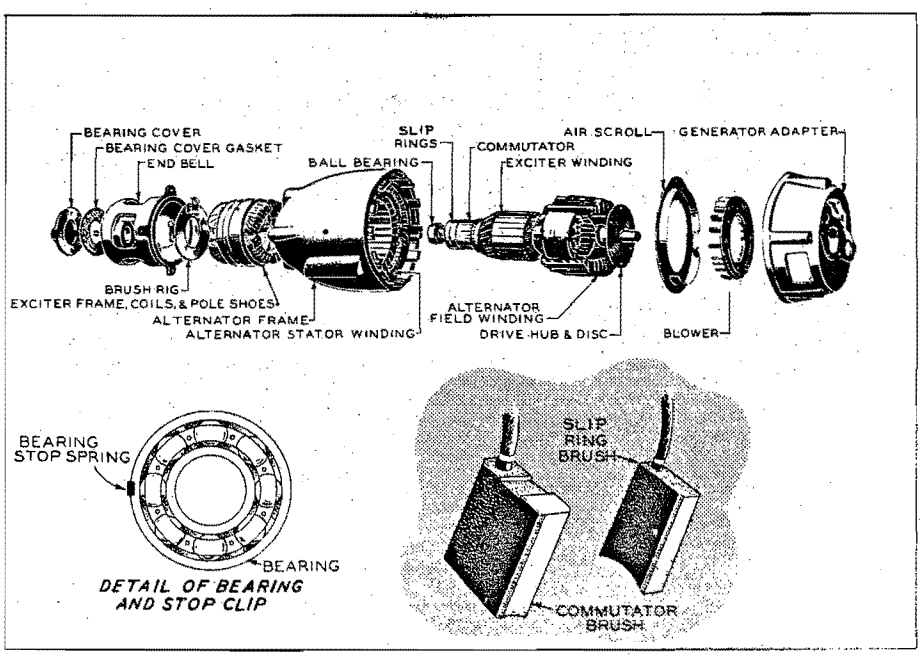
BRUSH RIG. - It is unnecessary to remove the brush rig from the end bell when servicing the generator. If it has been removed mistakenly, line up the paint mark on the outer edge of the brush rig with the mark on the brush rig support in the end bell. A deviation from the proper positioning of the brush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

BRUSHES. - Install new brushes when the old ones are worn so that the top of the brush is below a point midway between the top and bottom of the brush guide. Do not continue to use brushes that are worn too short, because the spring tension lessens as the brush becomes shorter, and weak spring tension leads to excessive brush sparking and pitting of the commutator or 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.



CARE OF COMMUTATOR AND BRUSHES

Fig. 24.



GENERATOR ASSEMBLY

Fig. 25.

See that the brushes ride freely in their guides and the spring tension is uniform. The correct tension is 30 oz. for the commutator brush springs and 18 oz. for the slip ring brush springs, measured with the contact point of the spring level with the top of the guide.

GENERATOR WINDINGS. - Use a continuity type test lamp set to test for grounded or open circuits in the generator windings. Be sure that all brushes are lifted away from contact with the commutator and 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 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. 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 wiring diagram furnished with the plant.

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.

TORQUE WRENCH DATA
(Limits in Pounds Ft. Torque)

Cylinder Head - 3/8"	35-40
Main Bearing Caps and Connecting Rods 1/2"	85-95
Flywheel - 3/8"	35-40
Manifolds - 3/8"	25-30
Gear Cover, Water Pump, Front and Rear End Plates, Oil Pan - 3/8"	25-30

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 motor 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; Distributor; 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").	0.0000"	0.002"
Crankshaft Main Bearing Journal Size - (F226 Engine)	2.3744"	2.3752"
Crankshaft Main Bearing Journal Size - (F186 Engine)	2.249"	2.250"
Connecting Rod Bearing (Desired 0.001") (F226 Engine)	0.0000"	0.0018"
Connecting Rod Bearing (Desired 0.001") (F186 Engine)	0.0002"	0.0022"
Crankshaft Rod Bearing Journal Size - (F226 Engine)	2.0619"	2.0627"
Crankshaft Rod Bearing Journal Size - (F 186 Engine)	1.9365"	1.9375"
Connecting Rod Side Play	0.006"	0.010"
Camshaft Bushings #1, 2 and 4	0.002"	0.004"
Camshaft Bushing #3	0.003"	0.0045"
Camshaft Bearing Journal #1	1.8745"	1.8755"
Camshaft Bearing Journal #2	1.8115"	1.8125"
Camshaft Bearing Journal #3	1.7495	1.7502"
Camshaft Bearing Journal #4	1.2495	1.2505"
Camshaft End Play	0.005"	0.009"
Piston Fit In Cylinder Bore 5-10 lb. pull with 1/2" wide feeler	0.003"	
Piston Pin in Rod Bushing (Desired 0.0002")	0.0002"	0.0006"
Piston Pin in Piston	Light Push Fit	
Ring Gap, 3 Top Grooves (F226 Engine)	0.010"	0.020"
Ring Gap, Bottom Grooves (F226 Engine)	0.008"	0.016"
Ring Gap, 3 Top Grooves (F186 Engine)	0.008"	0.013"
Ring Gap, Bottom Grooves	0.010"	0.017"
Distributor Points Gap	0.020"	
Spark Plug Gap - Gasoline Fuel	0.025"	
Spark Plug Gap - Gaseous Fuel	0.018"	
Distributor Rotation	Counterclockwise	
Firing Order	1-5-3-6-2-4	
Cylinder Head Nut - Torque	35-40 Pounds Foot	
Oil Capacity - Excluding Filter	5 Qts.	

TABLE OF CLEARANCES AND SPECIFICATIONS

	MINIMUM	MAXIMUM
Oil Pressure at 1800 RPM	20#	30#
Oil Recommendation - High Viscosity...		
Heavy Duty Detergent		
Over 50°F		SAE 30
50° to 20°F		SAE 20W
20°F to 0°F		SAE 10W
AC 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, coil, etc., or retime ignition.
Uneven compression.	Tighten cylinder head and spark plugs. If still not corrected, grind valves. Replace piston rings, if necessary.
Worn intake valve stems or guides.	Replace valves or guides.
ENGINE MISFIRES AT HEAVY LOAD	
Spark plugs defective.	Replace.
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condensers, coil, etc., or retime ignition.

POSSIBLE CAUSE	REMEDY
ENGINE MISFIRES AT HEAVY LOAD (CONT.)	
Clogged carburetor.	Clean jets.
Clogged fuel screen.	Clean.
Defective spark plug cables.	Replace.
ENGINE MISFIRES AT ALL LOADS	
Fouled spark plug.	Clean and adjust.
Defective or wrong spark plug.	Replace.
Sticking valves.	Clean stems and guides.
Broken valve spring.	Replace.
Defective ignition wires.	Replace.
Defective or improperly adjusted points.	Adjust or replace breaker points.
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.

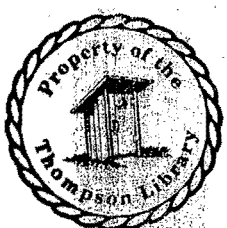
POSSIBLE CAUSE	REMEDY
ENGINE BACKFIRES AT CARBURETOR	
Lean fuel mixture.	Clean carburetor.
Clogged fuel screen.	Clean screen.
Intake air leak.	Replace flange gaskets, tighten carburetor.
Poor fuel.	Refill with good, fresh fuel.
Spark too late.	Retime ignition.
Spark plug wires crossed.	Install wires 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, coil, etc., or retime ignition.
Unit operated at light or no load for long periods.	No remedy needed.
Too much oil.	Drain excess oil.
BLACK, SMOKY EXHAUST, EXCESSIVE FUEL CONSUMPTION, FOULING OF SPARK PLUGS WITH BLACK SOOT, POSSIBLE LACK OF POWER UNDER HEAVY LOAD.	
Fuel mixture too rich..	Adjust choke. Install needed carburetor parts, adjust float level.
Choke not open.	See that choke opens properly.
Dirty air cleaner.	Clean, refill to proper level.

POSSIBLE CAUSE	REMEDY
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.
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, EXPECIALLY 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.

POSSIBLE CAUSE	REMEDY
PINGING SOUND WHEN ENGINE IS RAPIDLY ACCELERATED OR HEAVILY LOADED (CONT.)	
Lean fuel mixture.	Clean or adjust carburetor.
ENGINE CRANKS TOO STIFFLY	
Too heavy oil in crankcase.	Drain, refill with light oil.
Engine stuck.	Disassemble and repair.
ENGINE WILL NOT START WHEN CRANKED	
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, coil, etc., or retime ignition.
Lack of fuel or faulty carburetion.	Refill the tank. Check the fuel system. Clean, adjust, or replace parts necessary.
Clogged fuel screen.	Clean.
Cylinders flooded.	Crank few times with spark plugs removed.
Poor fuel.	Drain, refill with good fuel.
Poor compression.	Tighten cylinder head and spark plugs. If still not corrected, grind the valves. Replace piston rings, if necessary.
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.

POSSIBLE CAUSE	REMEDY
CURRENT UNSTEADY BUT ENGINE NOT MISFIRING (CONT.)	
Poor commutator or brush contact.	See that brushes seat well on commutator and slip rings, are free in holders, are not worn too short, and have good spring tension.
Loose connections.	Tighten connections.
Fluctuating load.	Correct any abnormal load condition causing trouble.
TAPPING SOUND	
Tappet clearance too great.	Adjust or replace tappets.
Broken valve spring.	Install new spring.
HOLLOW CLICKING SOUND WITH COOL ENGINE UNDER LOAD	
Loose pistons.	If noise only slight and disappears when engine warms up, no immediate attention needed. Otherwise replace worn parts.
VOLTAGE LOW AT FAR END OF LINE BUT NORMAL NEAR POWER UNIT	
Too small line wire for load and distance.	Install larger or extra wires or reduce load.
MOTORS RUN 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.

POSSIBLE CAUSE	REMEDY
ENGINE OVERHEATING	
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. In many cases 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 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.

CAUTION

On the initial start (starting the plant for the first time after it has been installed or taken out of storage) check the oil pressure immediately. Long storage periods may cause the oil pump to lose its prime.

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.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