

INSTRUCTION MANUAL

FOR

ONAN ELECTRIC GENERATING PLANTS

Series

W2C

Direct Current

Battery Charging

Alternating Current

ONAN

1400 73RD AVENUE N.E. • MINNEAPOLIS, MINNESOTA 55432

Important Safety Precautions

Read and observe these safety precautions when using or working on electric generators, engines and related equipment. Also read and follow the literature provided with the equipment.

Proper operation and maintenance are critical to performance and safety. Electricity, fuel, exhaust, moving parts and batteries present hazards that can cause severe personal injury or death.

FUEL, ENGINE OIL, AND FUMES ARE FLAMMABLE AND TOXIC

Fire, explosion, and personal injury can result from improper practices.

- Used engine oil, and benzene and lead, found in some gasoline, have been identified by government agencies as causing cancer or reproductive toxicity. When checking, draining or adding fuel or oil, do not ingest, breathe the fumes, or contact gasoline or used oil.
- Do not fill tanks with engine running. Do not smoke around the area. Wipe up oil or fuel spills. Do not leave rags in engine compartment or on equipment. Keep this and surrounding area clean.
- Inspect fuel system before each operation and periodically while running.
- Equip fuel supply with a positive fuel shutoff.
- Do not store or transport equipment with fuel in tank.
- Keep an ABC-rated fire extinguisher available near equipment and adjacent areas for use on all types of fires except alcohol.
- Unless provided with equipment or noted otherwise in installation manual, fuel lines must be copper or steel, secured, free of leaks and separated or shielded from electrical wiring.
- Use approved, non-conductive flexible fuel hose for fuel connections. Do not use copper tubing as a flexible connection. It will work-harden and break.

EXHAUST GAS IS DEADLY

- Engine exhaust contains carbon monoxide (CO), an odorless, invisible, poisonous gas. Learn the symptoms of CO poisoning.
- Never sleep in a vessel, vehicle, or room with a genset or engine running unless the area is equipped with an operating CO detector with an audible alarm.
- Each time the engine or genset is started, or at least every day, thoroughly inspect the exhaust system. Shut down the unit and repair leaks immediately.

- Warning: Engine exhaust is known to the State of California to cause cancer, birth defects and other reproductive harm.

Make sure exhaust is properly ventilated.

- Vessel bilge must have an operating power exhaust.
- Vehicle exhaust system must extend beyond vehicle perimeter and not near windows, doors or vents.
- Do not use engine or genset cooling air to heat an area.
- Do not operate engine/genset in enclosed area without ample fresh air ventilation.
- Expel exhaust away from enclosed, sheltered, or occupied areas.
- Make sure exhaust system components are securely fastened and not warped.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not remove any guards or covers with the equipment running.
- Keep hands, clothing, hair, and jewelry away from moving parts.
- Before performing any maintenance, disconnect battery (negative [-] cable first) to prevent accidental starting.
- Make sure fasteners and joints are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- If adjustments must be made while equipment is running, use extreme caution around hot manifolds and moving parts, etc. Wear safety glasses and protective clothing.

BATTERY GAS IS EXPLOSIVE

- Wear safety glasses and do not smoke while servicing batteries.
- Always disconnect battery negative (-) lead first and reconnect it last. Make sure you connect battery correctly. A direct short across battery terminals can cause an explosion. Do not smoke while servicing batteries. Hydrogen gas given off during charging is explosive.
- Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the area thoroughly.

DO NOT OPERATE IN FLAMMABLE AND EXPLOSIVE ENVIRONMENTS

Flammable vapor can be ignited by equipment operation or cause a diesel engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury and death. **Do not operate diesel equipment where a flammable vapor environment can be created by fuel spill, leak, etc., unless equipped with an automatic safety device to block the air intake and stop the engine.**

HOT COOLANT CAN CAUSE SEVERE PERSONAL INJURY

- Hot coolant is under pressure. Do not loosen the coolant pressure cap while the engine is hot. Let the engine cool before opening the pressure cap.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not service control panel or engine with unit running. High voltages are present. Work that must be done while unit is running should be done only by qualified service personnel.
- Do not connect the generator set to the public utility or to any other electrical power system. Electrocutation can occur at a remote site where line or equipment repairs are being made. An approved transfer switch must be used if more than one power source is connected.
- Disconnect starting battery (negative [-] cable first) before removing protective shields or touching electrical equipment. Use insulative mats placed on dry wood platforms. Do not wear jewelry, damp clothing or allow skin surface to be damp when handling electrical equipment.
- Use insulated tools. Do not tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- With transfer switches, keep cabinet closed and locked. Only authorized personnel should have cabinet or operational keys. Due to serious shock hazard from high voltages within cabinet, all service and adjustments must be performed by an electrician or authorized service representative.

If the cabinet must be opened for any reason:

1. Move genset operation switch or Stop/Auto/Handcrank switch (whichever applies) to Stop.
2. Disconnect genset batteries (negative [-] lead first).
3. Remove AC power to automatic transfer switch. If instructions require otherwise, use extreme caution due to shock hazard.

MEDIUM VOLTAGE GENERATOR SETS (601V TO 15kV)

- Medium voltage acts differently than low voltage. Special equipment and training are required to work on or around medium voltage equipment. Operation and maintenance must be done only by persons trained and qualified to work on such devices. Improper use or procedures will result in severe personal injury or death.
- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Induced voltage remains even after equipment is disconnected from the power source. Plan maintenance with authorized personnel so equipment can be de-energized and safely grounded.

GENERAL SAFETY PRECAUTIONS

- Do not work on equipment when mentally or physically fatigued or after consuming alcohol or drugs.
- Carefully follow all applicable local, state and federal codes.
- Never step on equipment (as when entering or leaving the engine compartment). It can stress and break unit components, possibly resulting in dangerous operating conditions from leaking fuel, leaking exhaust fumes, etc.
- Keep equipment and area clean. Oil, grease, dirt, or stowed gear can cause fire or damage equipment by restricting airflow.
- Equipment owners and operators are solely responsible for operating equipment safely. Contact your authorized Onan/Cummins dealer or distributor for more information.

KEEP THIS DOCUMENT NEAR EQUIPMENT FOR EASY REFERENCE.

GENERAL INFORMATION

THIS INSTRUCTION BOOK CONTAINS INFORMATION FOR THE PROPER INSTALLATION, OPERATION AND MAINTENANCE OF YOUR EQUIPMENT. WE SUGGEST THAT THIS BOOK BE KEPT HANDY SO THAT IT CAN BE REFERRED TO WHEN NECESSARY.

THIS EQUIPMENT IS THE RESULT OF PROVEN ENGINEERING DESIGN, HIGHEST QUALITY MATERIALS, AND EXPERT WORKMANSHIP. THOROUGH INSPECTION AND TESTING ASSURES YOU THAT THIS EQUIPMENT WILL PERFORM AS EXPECTED.

IF YOU WISH TO CONTACT YOUR DEALER OR THE FACTORY REGARDING THIS EQUIPMENT, BE SURE TO SUPPLY THE COMPLETE MODEL AND SPEC. NO., AND THE FULL SERIAL NUMBER OF THE EQUIPMENT AS SHOWN ON THE NAMEPLATE. THIS INFORMATION IS NECESSARY TO IDENTIFY THE EQUIPMENT AMONG THE MANY BASIC AND SPECIAL OPTIONAL TYPES MANUFACTURED.

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IV 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's to approximately 4100 running miles on an automobile.

However, do not conclude that the wear on the generating plant engine and the wear on the automobile engine would be the same. The generating plant engine is built much more ruggedly, (having larger main bearings, bigger oil capacity and has a heavier crankshaft proportionately per horsepower) than most automobile engines. Given the proper care and periodic servicing the generating plant engine will continue to give many more hours of efficient service than an automobile engine will after having been run the equivalent number of running miles.

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																																															
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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.

GENERAL. - The AC and DC plants to which this manual applies are complete electric generating plants. Each plant includes an engine, generator, and necessary accessories. Each plant is carefully tested before leaving the factory to assure that it is in good condition and that each plant will produce its rated output. Inspect the plant when received. Damaged parts must be repaired or replaced.

This manual is supplied to assist the operator in installing and operating the plant and in maintaining it so that it will provide maximum service at minimum cost. One copy of this manual is supplied with each plant of the basic models and with other models which differ slightly from these basic models.

BATTERY CHARGING PLANTS. - This type of plant is operated to generate electricity which is supplied directly to the storage battery. Electricity may be used while the plant is running or, as limited by the charge in the battery, while the plant is not running. NEVER OPERATE THIS TYPE OF PLANT WITHOUT HAVING THE BATTERY CONNECTED.

DIRECT SERVICE PLANTS. - This type of plant must be operated whenever electricity is being used. The battery for the electric start models is used to furnish power for cranking the engine. The plant may be operated without the battery connected. However, the battery must be connected when starting the plant electrically.

50 & 60 CYCLE PLANTS

All instructions contained in this manual apply to 50 cycle plants as well as to 60 cycle plants unless otherwise noted. The main difference is in the current frequency. Most electrical appliances can be used on either frequency but it is advisable to check appliances for use with 50 cycle plants before purchasing to assure that they are adaptable to the frequency of the current.

ENGINE

The engine is a two cylinder, upright, four cycle, water cooled, gasoline burning engine. The speed of the engine is controlled by a centrifugal, weight type, gear driven governor. Ignition current is supplied by two 6-volt batteries or by an impulse coupling type magneto. The engine is cooled by water circulating from an automotive type radiator to and around the cylinder walls and back through the radiator. A pusher type fan draws air from around the engine and forces this air through the radiator core. The internal working parts of the engine are pressure and spray lubricated. The correct oil pressure is maintained by an adjustable, spring loaded, by-pass. The engine is directly connected to the generator, forming a single compact unit.

GENERATOR

The generators of all models are of the four pole, air cooled, revolving armature type. The armature is supported at the inner end by the rear main crankshaft bearing and at the outer end by a ball bearing. The frame is a rolled steel ring, machined on the inside, in which the pole pieces and coils are mounted.

The battery charging plants have a saturated field, a series winding for cranking purposes, and interpoles to improve commutation.

The direct service plants are compound wound, the electric start models having a series winding for cranking purposes.

The alternate current plants are saturated shunt wound, the remote start models having a series winding in addition for cranking purposes.

CONTROLS

The electric start plants are equipped with a control box containing the necessary controls for starting electrically or manually. Provisions are made within the control box for connecting remote start-stop stations for remote control of the AC plants.

The manual start plants are equipped with a manual choke and a stop button.

NEMA RATINGS. - In previous editions of this manual voltage ratings were listed as 115, 230, and 115/230, but they are now listed as 120, 240, and 120/240 to conform to NEMA standards.

IMPORTANCE OF PROPER INSTALLATION. - It is important that the plant be properly installed to give good service. It may be operated outdoors, but rain, snow, dust, dirt, and grit are unfavorable to satisfactory operation. If practicable, install the plant in a building or inside a mobile vehicle. Remove the plant from the packing case with care to avoid damage.

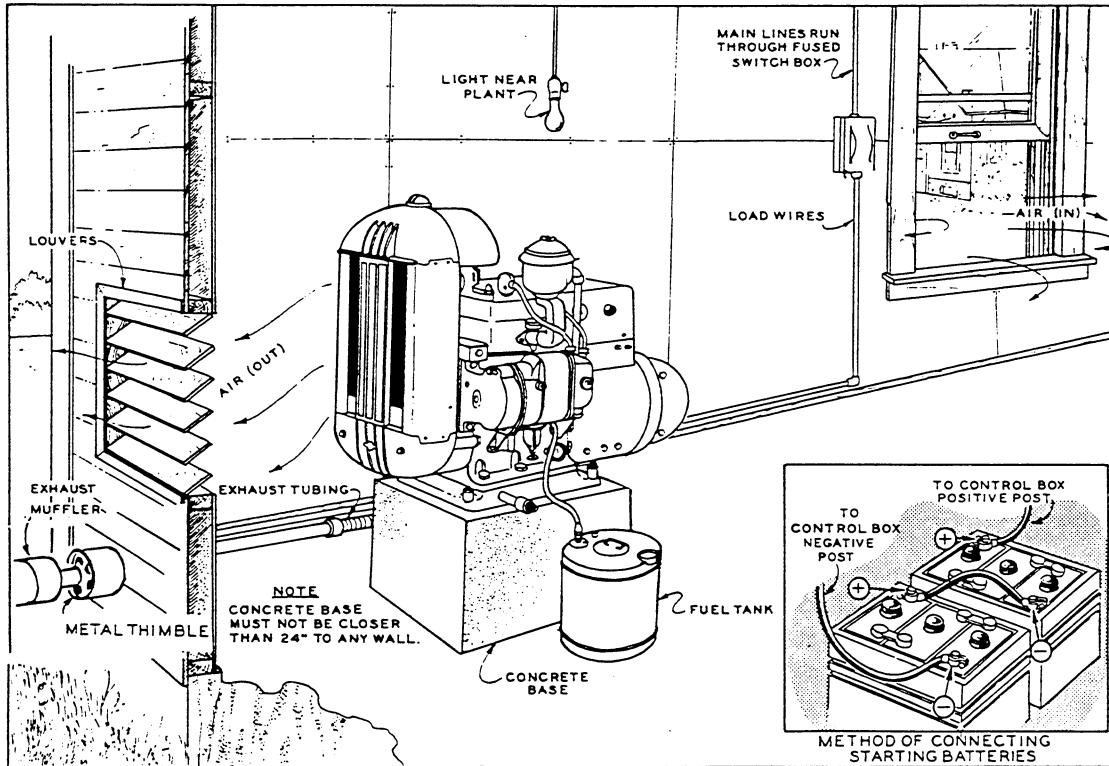
CAUTION

Proper ventilation must be provided. Exhaust gases are poisonous. Excessive inhalation will cause severe sickness or death. Do not operate the plant in a building or other confined space without piping all exhaust gases outdoors.

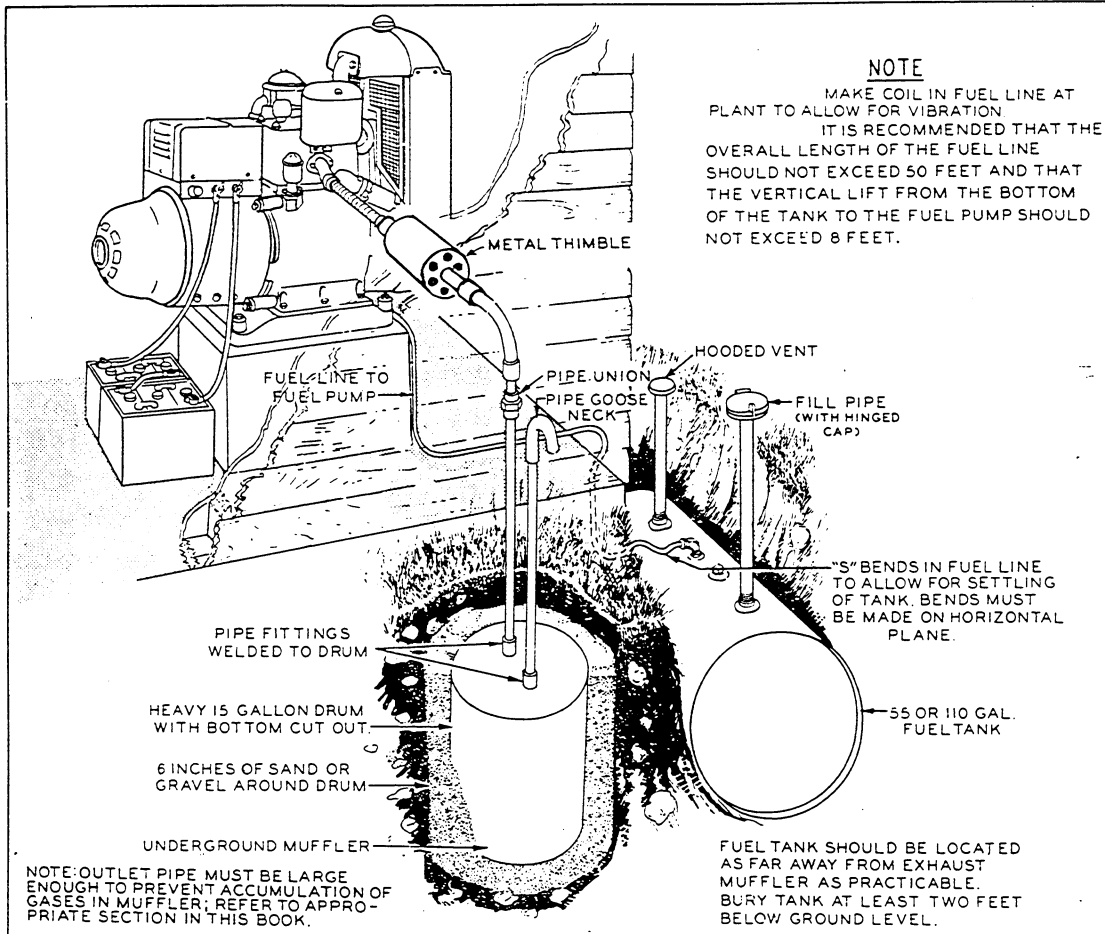
INDOOR STATIONARY INSTALLATION. - The location selected should be as near the electrical center of the load as practicable. The room should be clean, dry, well ventilated, and if necessary, heated in very cold weather. Attach the plant securely to either a timber or concrete base in such position that it will set level when operating. Locate it so as to provide proper ventilation and space for servicing. There must be an air inlet and outlet, each at least 3-1/2 sq. ft. in area, for proper ventilation. Pipe the exhaust gases outside the building with pipe as large as the exhaust outlet of the plant, increasing the pipe one size for each 10 ft. used. Attach the flexible tubing to the exhaust outlet, the exhaust pipe to the tubing, and the muffler to the pipe outside of the building. See illustration. Keep the exhaust pipe at least several inches from inflammable material. Avoid using elbows, if possible. If the exhaust line must be pitched upward, construct a condensation trap of pipe fittings and install at the point where the upward pitch begins.

PORTABLE INSTALLATION. - The manual start plant is supplied with a bracket and clamp for mounting the muffler on the plant. Use the pipe nipple and elbow, point the muffler toward the upper part of the radiator and using the upper radiator side panel screw to mount the muffler bracket. For a mobile installation, follow the principles for indoor installation, taking care to provide for ample ventilation if the vehicle is a closed one.

UNDERGROUND EXHAUST INSTALLATION. - If so desired, an underground exhaust muffler may be installed instead of the automotive type. There are two precautions, however, which must be mentioned: be very certain that the outlet pipe from the underground installation is large enough to expel all of the gases, as an accumulation can cause a great deal of damage; do not use an underground installation if there is a possibility of it filling up with water. Use about a 15 gallon drum, and cut out the bottom. Weld a one inch or larger fitting on the drum for the inlet and another one for the outlet; connect the inlet and outlet pipes to the fittings. Dig a

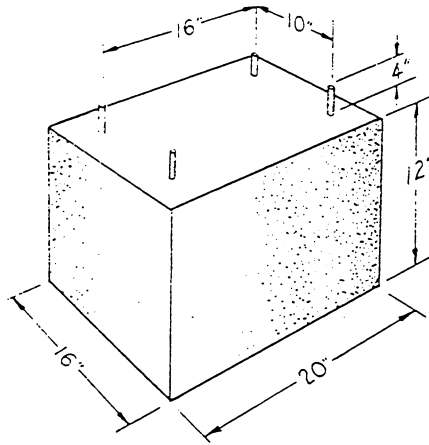


TYPICAL INSTALLATION

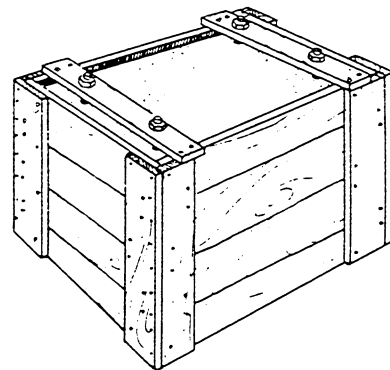


UNDERGROUND MUFFLER AND FUEL TANK

pit which is at least six inches larger on all sides than the drum. Fill the bottom of the pit with loose sand or gravel, lower the drum into the pit, and fill in around the drum with loose sand or gravel. See the illustration in this section. The outlet pipe should be at least 24" above ground with a gooseneck fitting on the end. The inlet pipe must be shielded with a thimble approved by the National Board of Fire Underwriters.



CONCRETE BASE



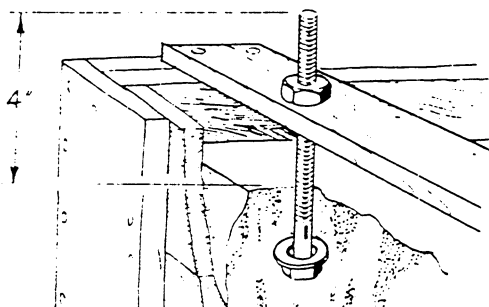
CONCRETE FORM

Above overall dimensions are a minimum and may be slightly larger. Keep the same bolt spacing. The base must be at least 24" from any wall.

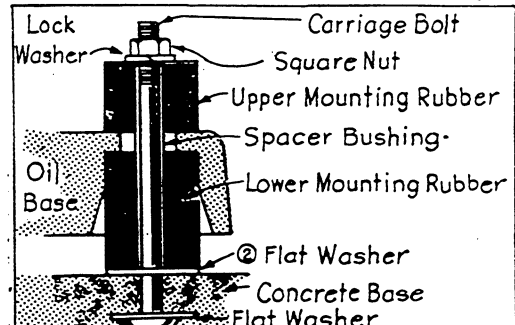
Use 4 - 3/8" x 8" bolts. See that they extend 4" above the top of the concrete.

A form should be built into which the concrete can be poured and allowed to harden. Be sure the top of the foundation is level and smooth to prevent plant base breakage.

A mixture of 1 part cement, 2 parts sand and 4 parts gravel or crushed stone may be used. Fill form, tap down but do not move bolts. Suspend mounting bolts from cross cleats nailed to the top of the concrete form before pouring concrete. Place a large washer under the head of each bolt and adjust for proper height - 4". Allow to harden for three days.



MOUNTING BOLT SUSPENSION



RUBBER BUSHING DETAILS

UNDERGROUND FUEL TANK. - Underground fuel tanks with capacities of 55, 110, 285, and 560 gallons are available at extra cost at Onan. Check all applicable codes before installing a tank. See the illustrations for suggestions on installation.

FUEL LINES. - For plants having a remote fuel tank, connect the flexible fuel line extending out from the fuel pump to the fitting on the fuel tank.

GROUNDING THE PLANT. - If grounding is called for in local codes, or radio interference necessitates it, drive a 1/2 inch pipe into the ground as close to the plant as practicable. This pipe must penetrate moist earth. Connect an approved ground clamp to this pipe and run a No. 10 or 12 wire from it to either the negative battery terminal on the control panel or the white (ground) main line wire at the plant. Never connect this wire to a water pipe or to a ground used by a radio system.

WIRING. - Use sufficiently large insulated wire to connect the load to the plant. The size will depend largely on the distance and permissible voltage drop between the plant and the load and the amount and kind of load. Consult a competent electrician. Check national and local codes before installing. Install a circuit breaker or fused main switch in the load circuit near the plant. On battery charging units install a fused switch between the batteries and the plant.

All leads that must be joined together should be connected with solderless connectors and thoroughly taped with two layers of half-lapped, electricians' tape and two layers of half-lapped friction tape, extending both well beyond the ends of the connection. Where leads connect to terminal studs or screws, taping is unnecessary.

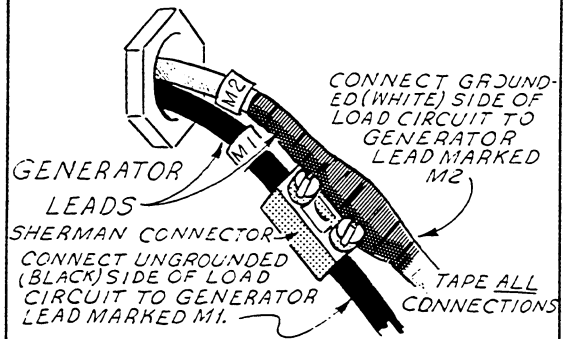
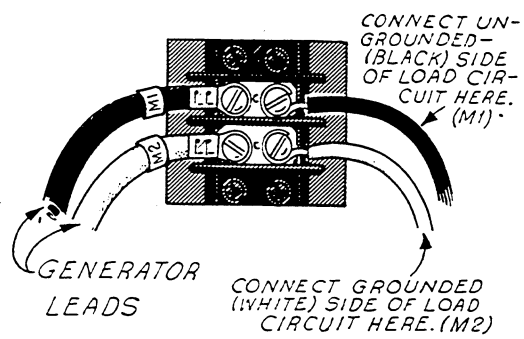
WIRING TABLE

Unity Power Factory. 2% Voltage Drop 120 Volt AC

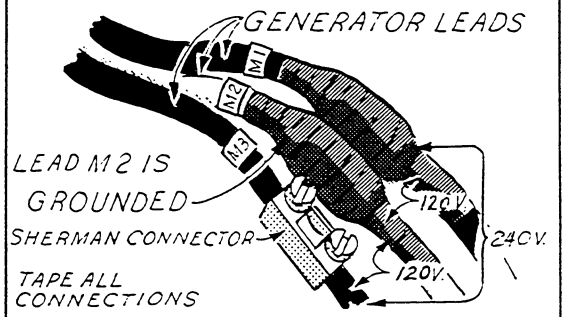
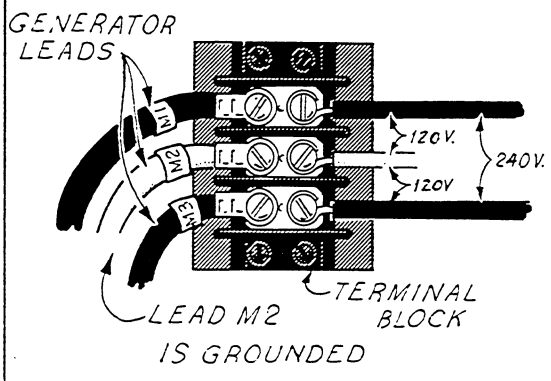
WIRE SIZE NO.	14	12	10	8	6	4	2	
Watts								
Amps.								
		* Distances expressed in feet per wire size						
100	.87	510	810	1280	2040	3250	5300	8200
200	1.74	255	405	640	1020	1625	2650	4100
300	2.61	170	270	430	680	1080	1770	2730
400	3.48	125	200	320	510	810	1325	2050
500	4.35	100	160	255	410	650	1060	1640
750	6.52	65	100	170	275	430	710	1090
1000	8.69	50	80	125	205	325	530	820
1500	13.04	35	55	85	140	215	350	550
2000	17.38	25	40	65	100	160	265	410
2500	21.73	20	35	50	80	130	210	350
3000	26.07	15	25	40	65	110	180	275

* Above figures represent a point to point distance for a 2 wire run. If a 4% voltage drop is permissible, double the distance listed. If only 1% voltage drop is allowable, divide the distances listed by 2.

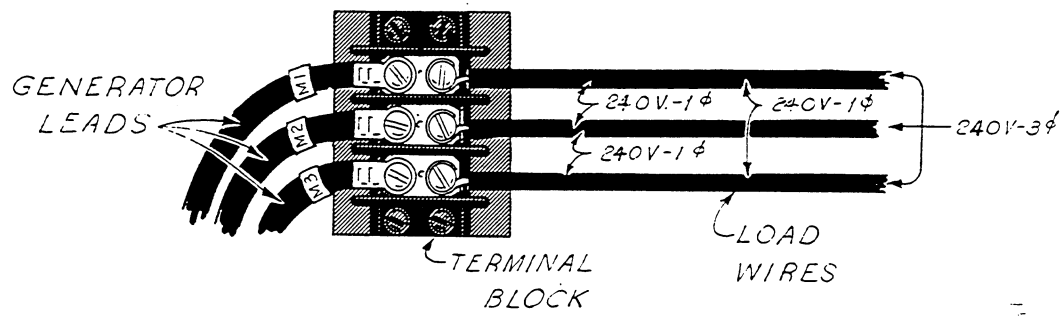
SINGLE PHASE, TWO WIRE CONNECTIONS



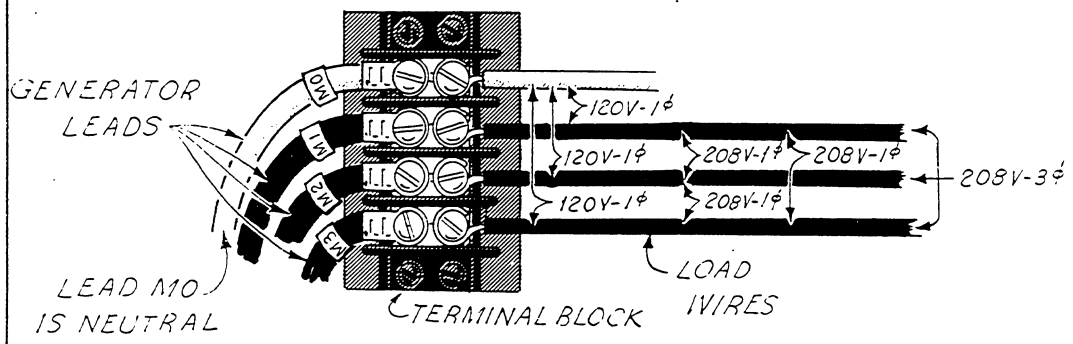
SINGLE PHASE, THREE WIRE CONNECTIONS



THREE PHASE, THREE WIRE CONNECTIONS



THREE PHASE, FOUR WIRE CONNECTIONS



LOAD CONNECTIONS

CONNECTING THE LOAD

CONNECTING THE LOAD (Battery Charging Plants). - Connect the positive side of the main line to the battery positive terminal on the control panel and the negative side to the battery negative terminal on the control panel.

CONNECTING THE LOAD (Direct Service Plants). - Connect the positive side of the main line to the black (positive) lead extending out from the generator. The negative side to the white (ground) lead extending out from the generator.

MANUAL START AND DUAL PURPOSE PLANTS. - All manual start plants are equipped with an outlet box mounted on the generator frame. The leads from the generator are brought into this box. The AC lead wires of the Dual Purpose plants extend out from the chase nipple on the control saddle for 2 wire plants or from the connector on the shield for 3 and 4 wire plants.

SINGLE PHASE, TWO WIRE CONNECTIONS. - The leads of the single phase, two wire plants are marked "M1" and "M2". Connect the HOT side of the main line to the lead marked "M1". Connect the grounded side of the main line to the lead marked "M2". If the main lines are to be run in rigid conduit, install a short length of flexible conduit between the outlet box and the rigid conduit. If rigid conduit is not to be used, install a chase nipple in the knockout used.

SINGLE PHASE, THREE WIRE CONNECTIONS. - The leads of the single phase, 3 wire plants are marked "M1", "M2", and "M3".

If a single 120 volt circuit is to be used, connect the GROUNDED side of the main line to the lead marked "M2" and connect the HOT side of the main line to "M1" or to "M3". If only one 120 volt circuit is used, the total load on the circuit should not be more than 1/2 the capacity of the plant.

If two 120 volt circuits are to be used, connect the HOT lead of one circuit to "M1" and the HOT lead of the other circuit to "M3". Connect the GROUND lead of each circuit to "M2". The load on either circuit should not be more than 1/2 the capacity of the plant.

For a 240 volt circuit, connect one main line wire to "M1" and the other main line wire to "M3". "M2" is not used with a 240 volt circuit. The full rated capacity of the plant is available on the circuit.

REMOTE START PLANTS. - Remote start plant load connections are made at a terminal block inside the control box. If the main line wires are to be enclosed in rigid conduit, always install a length of flexible conduit between the plant and the rigid conduit. Single phase, two wire plants have a 1/2 inch chase nipple in the control saddle. Remove this nipple and install a 1/2 inch Greenfield connector if conduit is to be used. Other plants have a shield at the back of the control box saddle and are equipped with a Greenfield connector.

SINGLE PHASE, TWO WIRE CONNECTION, 120 VOLT AND 240 VOLT PLANTS. - The terminals are marked "M1" and "M2". Connect the HOT side of the main line to the terminal marked "M1". Connect the GROUNDED side of the main line to the terminal marked "M2".

SINGLE PHASE, THREE WIRE CONNECTION, 120/240 VOLT PLANTS. - The terminals are marked "M1", "M2" and "M3".

If a single 120 volt circuit is to be used, connect the GROUNDED side of the main line to the terminal marked "M2" and connect the HOT side of the main line to "M1" or to "M3". If only one of the two 120 volt circuits is used, the total load on the circuit should not be more than 1/2 the capacity of the plant.

If two 120 volt circuits are to be used, connect the HOT lead of one circuit to "M1" and the HOT lead of the other circuit to "M3". Connect the GROUND lead of each circuit to "M2". The load on either circuit should not be more than 1/2 the capacity of the plant.

For a 240 volt circuit, connect one main line wire to "M1" and the other main line wire to "M3". "M2" is not used with a 240 volt circuit. The full rated capacity of the plant is available on this circuit.

THREE PHASE, THREE WIRE CONNECTIONS, 240 VOLT THREE PHASE PLANTS. - The terminals are marked "M1", "M2" and "M3" and no wire is grounded.

For a three phase, 240 volt hookup, connect one main line wire to each load terminal marked "M1", "M2", and "M3". If the connected load rotates in the wrong direction after the plant is started, reversing the connections between any two load terminals will reverse the direction of rotation. To assure in phase connections, use a phase sequence indicator.

Three, single phase, 240 volt circuits may be obtained by connecting the two load wires of each single phase circuit to any two terminals as shown in the illustration. It is not advisable to use only one of the three, 240 volt, single phase circuits. Use all three and connect an equal load to each circuit to prevent unbalancing the generator. The load on any one

of the three single phase circuits must not be more than 1/3 the rated capacity of the plant.

THREE PHASE, FOUR WIRE CONNECTIONS, 120/208 VOLT, THREE PHASE PLANTS. - The terminals are marked "M1", "M2", "M3", and "M0", "M0" being grounded. Three different phase and voltage combinations are available. Single phase, 120 volt; single phase, 208 volt; three phase, 208 volt.

For single phase 120 volt circuits, connect the GROUNDED load wire of each circuit to the terminal marked "M0". Connect the HOT load wire of each circuit to the terminals marked "M1", "M2", and "M3", one wire to each terminal. Use all three available circuits and balance the load as closely as possible between each circuit. The load on each circuit should not be more than 1/3 the rated capacity of the plant.

For single phase, 208 volt circuits, connect the load wires of each circuit across any two of the three terminals marked "M1", "M2", and "M3". One circuit across "M1" and "M2", one across "M2" and "M3", and one across "M1", and "M3". Use all three circuits and balance the load equally between each circuit. The terminal marked "M0" is not used.

For a three phase, 208 volt circuit, connect a load wire to each of the three terminals marked "M1", "M2", and "M3", one wire to each terminal. The terminal marked "M0" is not used. If the connected load rotates in the wrong direction after the plant is started, reversing the connections between any two load terminals will reverse the direction of rotation. To assure in phase connections use a phase sequence indicator.

REMOTE CONTROL CONNECTIONS (Remote Control and Dual Purpose Plants) . - These plants may be started and stopped at distances of up to 250 feet from the plant by installing remote start-stop stations. Use No. 18 wire up to 100 feet, No. 16 up to 160 feet, and No. 14 wire up to 250 feet.

The remote control terminals of the Remote Control plants are marked "REMOTE CONTROL" B +, 1, 2, and 3. The terminal marked B + is to be used only with an automatic control installation.

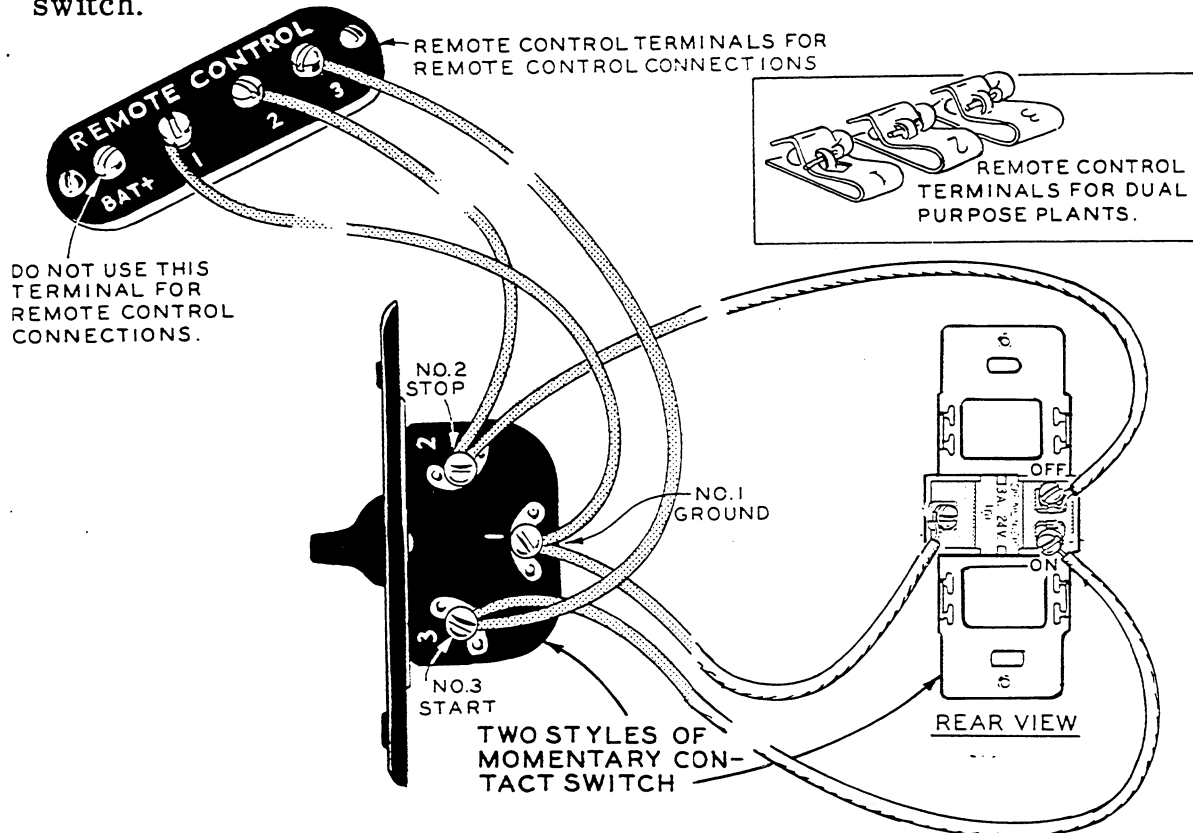
The remote control terminals of the Dual Purpose plants are three Fahnestock clips in a row marked 1, 2, and 3.

Each remote start-stop switch also has three terminals marked 1, 2, and 3.

Use wire of the size recommended for the distance from the plant the remote start-stop station is to be installed and make connections as follows:

Connect plant terminal #1 to the unmarked switch terminal, plant terminal #2 to the OFF switch terminal, and plant terminal #3 to switch terminal ON. Two types of remote control switches are shown, one of which has terminals numbered to correspond to plant terminals.

Additional remote start-stop stations may be connected as desired, either directly at the control panel or in parallel with another remote control switch.



REMOTE CONTROL CONNECTIONS

CONNECTING THE DC LOAD (Dual Purpose Plants Only). - A 32-volt direct current load may be connected directly to the terminals of the battery. In no case should this DC load be connected to the battery terminals on the plant control box saddle. Be sure terminals and connectors are clean. Make sure all connections are electrically secure. Then proceed as follows:

Make sure the wire used for this DC circuit is sufficiently large to carry the entire output of the battery to the main switch or circuit breaker of the DC circuit. Smaller wire may be used for smaller circuits that branch off this main DC circuit.

Connect the hot side of this DC circuit to the positive (+) post on the battery. Connect the GROUNDED side of this DC circuit to the negative (-)

post on the battery. Use approved connectors. The main line should be protected by a fused main switch or a circuit breaker.

BATTERIES. - Batteries shipped "dry charged" must be serviced with electrolyte according to the directions supplied with such batteries. Batteries shipped "wet charged" are fully charged when shipped, but may require a freshening charge before putting them in service. Batteries should always be installed on a suitable rack to provide a free circulation of air around each battery.

Cables for making connections between the plant and the battery are supplied for all remote start plants even though the starting batteries are not. The short jumper cable connects two six volt batteries in series to form a 12 volt battery. The two longer cables connect the battery to the plant. These two long cables are the same. When making the connections at the battery, it may be necessary to spread the cable lug open slightly before it will fit properly. Do not use a hammer to drive the lugs onto the battery posts, the battery may be damaged. The lugs should have full contact on the battery terminal posts to prevent loss of current. Be sure that the contact surfaces of the lugs are clean before connecting them and coat the lug and battery terminal with a thin coating of vaseline.

Connect the battery to the plant as follows:

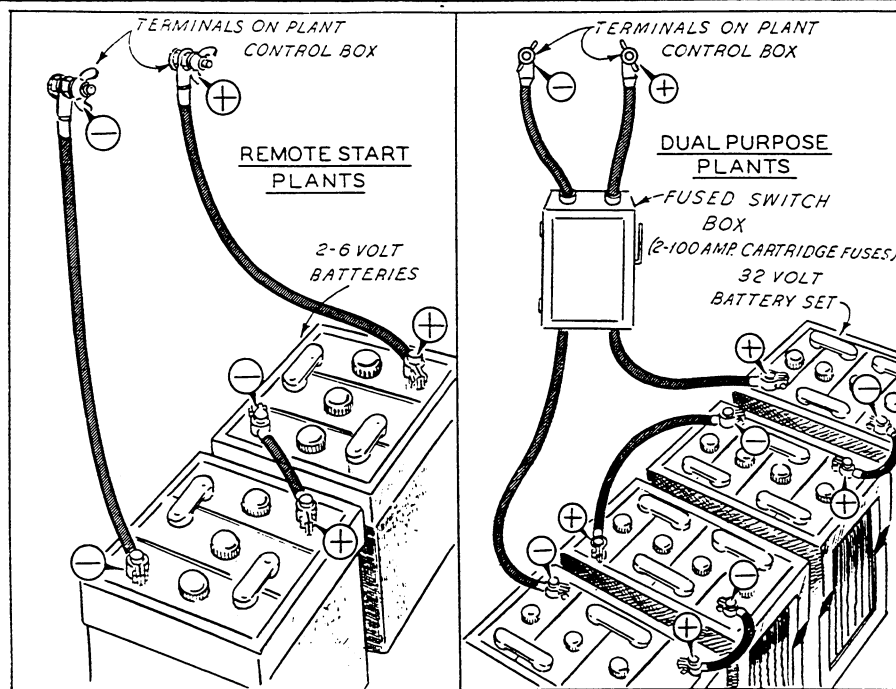
If a 12 volt battery is used, connect one long cable from the positive (+) post on the battery to the POSITIVE terminal on the control saddle. Connect the other long cable from the negative (-) post on the battery to the NEGATIVE post on the control saddle. The short jumper cable is not used. Be sure connections are secure at all points.

If two 6-volt batteries are to be connected in series to form a 12 volt battery, connect the short jumper cable from the negative (-) post of one battery to the positive (+) post of the other battery. Then connect the battery to the plant as described in the foregoing paragraph.

The 32-volt batteries for the Dual Purpose plants should be prepared for use according to the instructions supplied by the battery manufacturer. Several different kinds of the automotive or glass jar type are available on the market. Your dealer can recommend the type best suited for your installation.

Battery cables are not supplied for these units. Your dealer should be able to supply you with the correct size and length of cable necessary for the installation. Both cables should be of the same length and the length should be held to a minimum.

A single throw, double pole, fused switch should be installed in the line between the plant and the battery. See wiring diagram No. 611B16. Be



BATTERY CONNECTIONS

sure to use 100 amp. fuses in the switch. Keep the switch closed at all times.

Connect a short cable from the battery positive (+) post to the HOT side of the switch. Connect another length of cable from the HOT side of the switch to the POSITIVE terminal on the plant control saddle.

Connect another short cable from the battery negative (-) post to the GROUND side of the switch. Connect a second length of cable from the ground side of the switch to the NEGATIVE terminal on the plant control saddle.

INSTALLATION OF PLANTS EQUIPPED FOR NATURAL GAS, BUTANE OR PROPANE GAS. - Follow national and local codes when installing fuel pipes and fuel containers, according to the type of fuel being used. Complete the installation as described for gasoline operated plants.

NOTE: Make sure the line pressure does not exceed 4 to 6 ounces per square inch. If it exceeds this value, a primary regulator will be needed to reduce the pressure before it enters the main regulator by the plant.

The secondary regulator should not be mounted on the plant. It should be mounted near the carburetor, with a rubber hose running from the regulator to the carburetor.

Keep the fuel line as straight as possible.

PREPARATION FOR OPERATION. - Before the plant is operated it is necessary to supply it with proper oil, water (or antifreeze), and fuel. Comply with the following instructions.

CAUTION

Keep the crankcase oil level at or near the proper high level at all times, never above it. Do not allow the engine to run with the oil level below the normal low level.

LUBRICATION. - Fill the crankcase to the "F" mark on the gauge with 6 quarts (U. S. Measure) of oil of the proper SAE number according to the lowest temperature to which the plant will be exposed, as indicated in the following table. Do not overfill. Use a heavy duty (detergent) oil marked for "DG" service. The use of a multi-viscosity oil such as 5W-20 or 10W-30 is not recommended.

LOWEST TEMPERATURE	SAE NUMBER
Above 90°F., 32°C.	No. 30
Between 50° F. and 90°F. Between 10°C. and 32°C.	No. 20 or 20W
Between 0°F. and 50°F. Between -18°C. and 10°C.	No. 10 or 10W
Below 0°F., and -18°C.	No. 5W*

*NOTICE

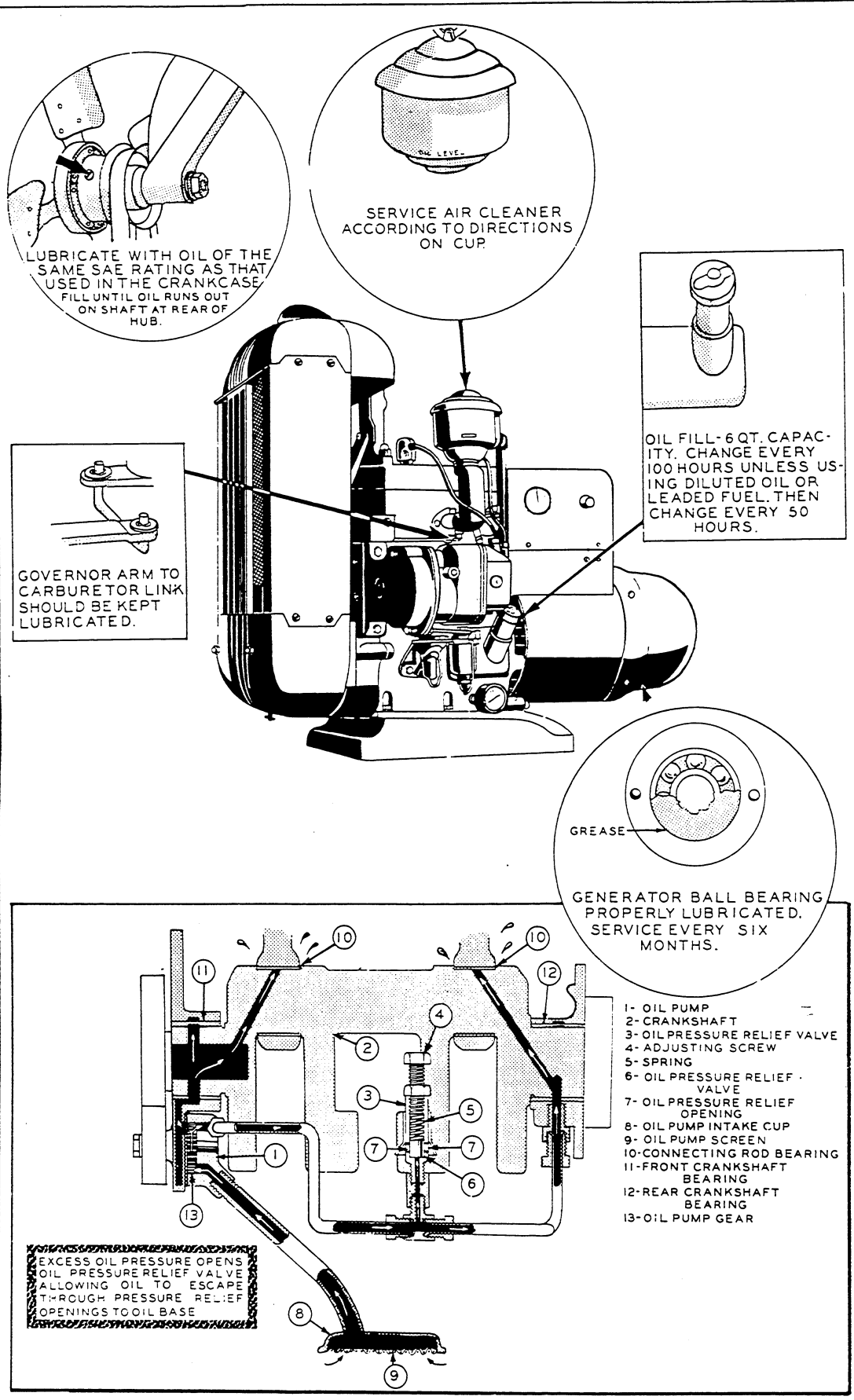
If No. 5W oil is not available, dilute No. 10W oil with 10% of kerosene. Mix thoroughly before pouring into the engine.

Fill the air cleaner to the indicated level with oil of the same SAE number as used in the crankcase.

Fill the fan hub with oil of the same SAE number as used in the crankcase, until oil seeps out on the shaft at the rear of the hub.

Place a drop of oil on each joint of the carburetor throttle to governor arm link. Use a non-gumming oil.

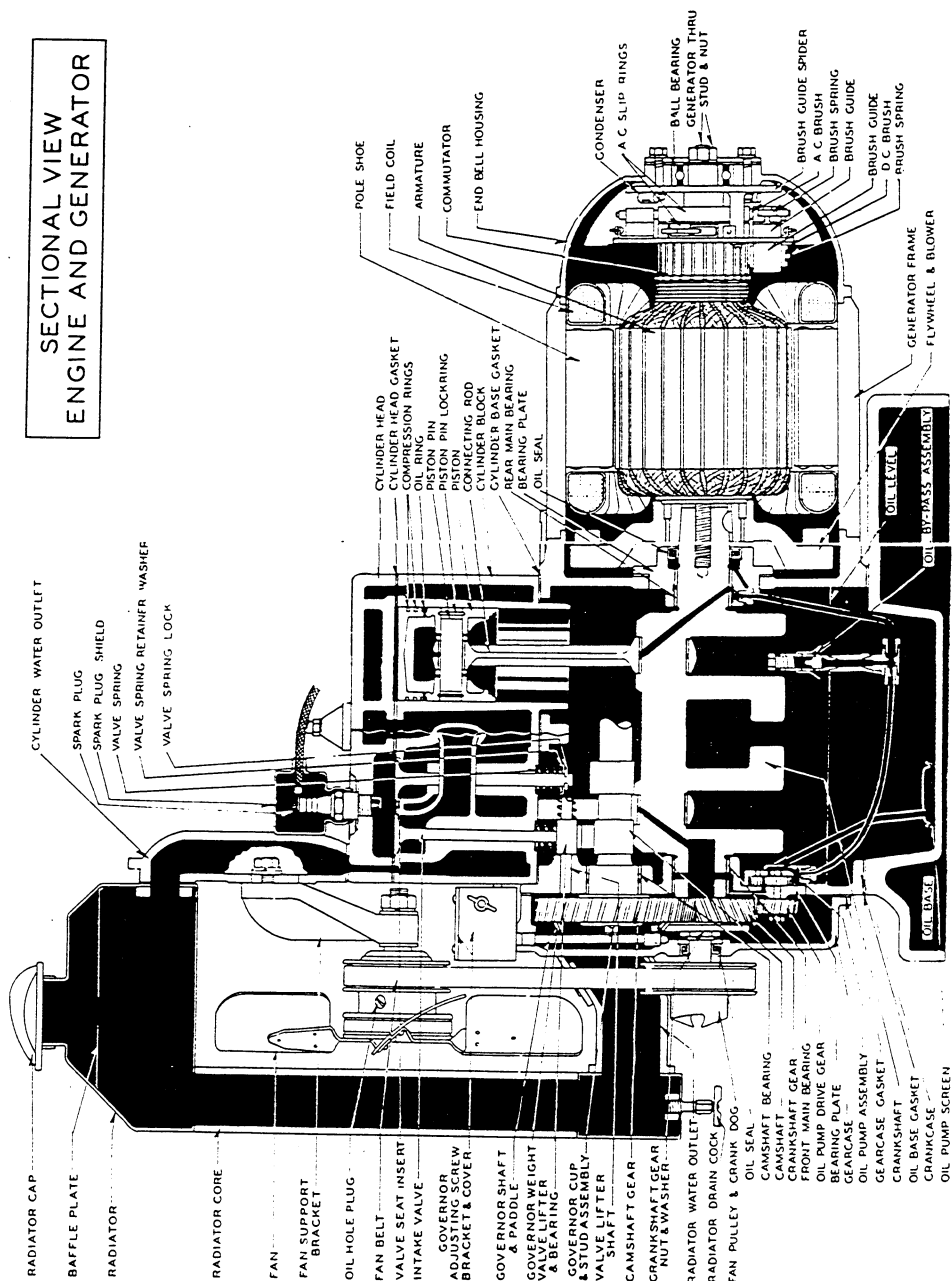
RADIATOR. - Fill the radiator to the top of the baffle plate with 9 quarts of clean, alkali-free, water. Distilled or rain water may be used. If there is danger of freezing, use a standard antifreeze in proper proportion.



LUBRICATION

FUEL. - Fill the fuel tank nearly full with clean, fresh, regular gasoline of 68 to 74 octane. Do not use premium grade gasoline. Engine life will be greatest when fuel containing the smallest amount of lead is used. NEVER FILL THE FUEL TANK WITH THE ENGINE RUNNING.

After all the foregoing instructions have been carefully complied with, the plant is ready to be started. However, before starting the plant study the paragraphs under the headings OPERATION and ABNORMAL OPERATING CONDITIONS.



PRELIMINARY. - Before starting the plant, make a final check to see that the plant has been properly installed and that the plant has been properly serviced with oil, gasoline, and water. If the preparation has been made for cold weather operation, refer to the section on ABNORMAL OPERATING CONDITIONS to see that all necessary precautions have been taken.

STARTING GENERATING PLANTS. - Before starting a new plant or a plant that has run out of fuel, open the shutoff valve on the fuel tank and operate the manual lever on the fuel pump until the carburetor bowl is full of gasoline. Check to see that the IGNITION SWITCH on the control panel is at the ELECTRIC START position. Then simply press the START button in firmly. Choking is automatic and the plant should start at the first attempt. If it does not start, do not continue to press the START button in. Instead, press in for periods of five seconds at a time with a five second wait between each attempt. If the plant does not start after a few attempts, check the fuel and ignition systems and repeat the starting procedure after correcting any trouble found.

NOTE: Oil was placed in the cylinders before the plant was shipped and it may be necessary to remove the spark plugs and clean them in gasoline before the plant will start the first time.

If the charged condition of the battery is so low that it does not have power to crank the plant, it may be started manually as follows:

1. Throw the IGNITION SWITCH to the HAND CRANK position.
2. Insert the crank into the opening below the radiator and securely engage it with the crankdog.
3. Crank the plant with a quick upward pull, using the right hand. Keep the thumb on the same side as the fingers. Do not spin the crank. Repeat if necessary.
4. If the plant does not start, check the fuel and ignition system and repeat the cranking procedure after correcting any trouble found. Return the IGNITION SWITCH to the ELECTRIC START position as soon as the plant starts.

NOTE: Keep the IGNITION SWITCH at the ELECTRIC START position at all times except while actually starting the plant by hand cranking. If this switch is left at HAND CRANK position, the battery may be discharged.

ADJUSTING THE CHARGING RATE, REMOTE CONTROL AND DUAL PURPOSE PLANTS. - The charging rate to the battery is controlled by a HIGH-LOW charge switch located near the ammeter on the plant control box.

When the switch is at the HIGH position, the charging rate is about 7 to 10 amperes for the Remote Control plants and about 18 to 20 amperes for the Dual Purpose plants.

When the switch is at the LOW position, the charging rate is about 2 to 3 amperes for both types of plants.

If the plant is to be run for long periods of time, keep the switch at the LOW position.

BATTERY CHARGING PLANTS. - The speed and the charge rate may be adjusted by loosening the wing nut and turning the governor knob to the right (clockwise) to increase the charge rate. Turn to the left (counterclockwise) to decrease the charge rate. Lock the wing nut tightly against the side after making any adjustment.

DIRECT SERVICE PLANTS. - The charging rate to the starting battery is controlled by fixed resistors and no adjustment is necessary.

WHEN TO OPERATE. - The Battery charging (DC) plant is operated to generate electricity for the storage battery.

When the battery is charged, electricity may be taken from the battery (without the engine running) until it is discharged.

The plant must be run to recharge the battery.

If an external load, other than the battery, is connected to the plant, it is recommended that a separate control panel containing the necessary equipment be installed to protect the plant from overloading. This will enable the operator to determine the amperage of the battery charge or discharge current.

The electrical load should not be greater than the plant capacity.

AC and DC PLANTS. - Must operate whenever electricity is needed.

ADJUSTING ENGINE SPEED, ALL PLANTS. - AC plants - 1800 rpm-60 cycle; AC plants - 1500 rpm - 50 cycle; Battery Charging Plants - 2200 rpm; Direct Service Plants - 2000 rpm. Adjustments are made by increasing or decreasing governor spring tension. Loosen the lock nut on the governor speed adjusting stud and turn the adjusting nut in to increase spring ten-

sion (also engine speed and generator voltage) or out to decrease it. Tighten the lock nut securely after making an adjustment.

STOPPING THE PLANT, ALL PLANTS. - Disconnect the load by throwing the circuit breaker or main line (AC) switch to the OFF position. Then press the STOP button firmly until the plant has completely stopped running. The STOP button of the manual plants is located on the magneto. The STOP button of the remote control and dual purpose plants is located on the plant control panel.

STARTING THE MANUAL START PLANTS. - Before starting a new plant or a plant that has run out of fuel, open the fuel tank shut-off valve and work the primer lever on the fuel pump until the carburetor bowl is full of fuel. Then pull the choke control knob out as far as it will go. Insert the crank into the opening below the radiator and securely engage it with the crank-dog. Crank the plant with a quick upward pull, using the right hand. Keep the thumb on the same side of the crank as the fingers. Do not spin the crank. If necessary to repeat the cranking, push the choke control knob in part way. As soon as the plant starts, push the choke control knob in until the plant runs smoothly. As the plant warms up, slowly push the choke control knob in until it is at its closed position. If the plant does not start, check the fuel and ignition systems and repeat the cranking procedure after correcting any trouble found.

INSTRUCTIONS FOR OPERATING PLANTS EQUIPPED TO RUN ON NATURAL, BUTANE, OR PROPANE GAS.

1. Turn on the supply of natural gas or fuel vapor and start the engine. The priming button on the regulator may have to be pushed to get the engine started. Do not hold the button in, just touch it lightly to avoid overchoking.
2. Allow the engine to run until it reaches operating temperature. Then adjust the carburetor main adjustment screw to give the smoothest operation at full load. Turn the main adjusting screw in until the engine loses speed from lack of fuel. Slowly turn the adjusting screw out until the engine will carry the load smoothly. Disconnect all load and adjust the small idle adjusting screw, in the same manner. If the engine tends to surge, turn the main adjusting screw out not more than 1/2 additional turn.
3. If the engine speed is unusually high, it will be necessary to adjust the tension on the governor spring to get the correct speed. See ADJUSTING ENGINE SPEED in this section. If the governor is operating properly, the engine speed should be slightly above recommended speed when there is no load on the plant and slightly below this speed when there is a full load on the plant.

4. Make final adjustments of the governor and carburetor after the engine reaches normal operating temperature.

If the line pressure exceeds 4 to 6 ounces, a primary type regulator must be installed ahead of the secondary regulator supplied.

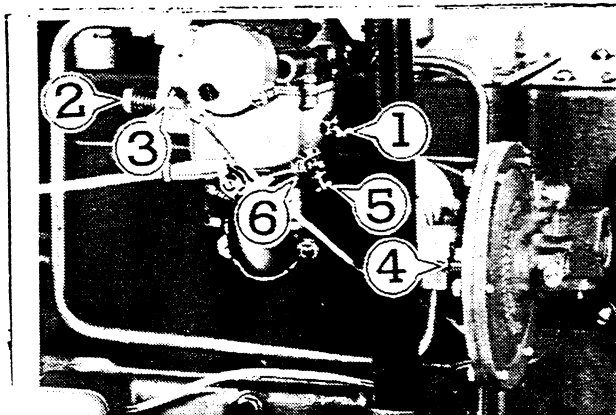
Set the spark plug gaps at .015" - .018" for use of gaseous fuel.

If it is desired to return to gasoline fuel use, proceed as follows:

1. Close the gas fuel supply valve, so no air will enter.
2. Be sure the gasoline supply shut-off valve is turned on.
3. Release the carburetor float lock (1). Be sure it back seats fully.
4. Release the lock on the choke shaft so that it is free to operate.
5. Adjust the main (5) and idle (6) gasoline adjusting screws.

CAUTION - DUAL (AC/DC) PLANT

THE TOTAL AC LOAD ON THESE PLANTS SHOULD NOT EXCEED 2250 WATTS WHEN THE CHARGE SWITCH IS AT ITS HIGH POSITION. WHEN THE CHARGE SWITCH IS AT THE LOW POSITION, THE FULL AC CAPACITY OF 3000 WATTS MAY BE USED.



- 1- CARBURETOR FLOAT LOCK SCREW.
- 2- MAIN GAS ADJUSTMENT SCREW
- 3- IDLE ADJUSTMENT SCREW.
- 4- REGULATOR PRIMING BUTTON.
- 5- MAIN GASOLINE ADJUSTMENT SCREW.
- 6- GASOLINE IDLE ADJUSTMENT SCREW.

HIGH ALTITUDE OPERATION. - If the unit is to be operated at an altitude of 2500 feet or more above sea level, the carburetor main jet adjustment should be "leaned" slightly to obtain maximum possible power. The carburetor was adjusted for best performance at the factory altitude: approximately 860 feet.

Because the air becomes less dense as the altitude increases, less fuel is required to maintain the proper air-to-fuel ratio. Consequently, any engine will develop less power at higher altitudes. The usual altitude de-rating amount is approximately 4 per cent for each 1000 feet above sea level.

COLD TEMPERATURES. - Special precautions should be taken at cold temperatures as outlined below.

LUBRICATION. - For temperatures below 0°F. (-18°C.), drain the oil base while the engine is warm or run until warm before draining and refill the crankcase to the "F" mark on the gauge with 6 qts. (U.S. Measure) of SAE No. 5 oil. Then run the engine 10 minutes to circulate the oil.

If No. 5 oil is not available, drain the oil base while the engine is warm or run until thoroughly warmed up before draining. Then thoroughly mix 1 pint of kerosene with 5-1/2 qts. of SAE No. 10 or 10W oil and refill the crankcase to the "F" mark on the gauge. Run the engine for 10 minutes to circulate the mixture. NEVER ADD KEROSENE ALONE TO THIN THE OIL. When using oil diluted with kerosene, change every 50 operating hours and check the level at least once every 8 operating hours.

Do not dilute oil heavier than SAE No. 10 as the mixture may separate when the engine is stopped.

AIR CLEANER. - If congealed SAE No. 10 or No. 5 oil or frost formation within the air cleaner restricts the flow of air, remove and clean the air cleaner. Reassemble and use without oil until temperature conditions permit use of oil in the normal manner.

COOLING SYSTEM. - The liquid in the cooling system must be protected if there is any possibility of its freezing. Use a good permanent type of antifreeze in the proportion recommended by the manufacturer. The use of an alcohol base antifreeze is not recommended because the engine is designed to operate at a temperature above the boiling point of alcohol. If necessary, a portion of the radiator surface may be covered in order to raise the coolant temperature to normal. Avoid overheating.

FUEL. - Fresh, high test fuel is an aid to starting in cold weather. Never fill the fuel tank entirely full with cold gasoline, as expansion as it warms up may cause it to overflow.

HOT TEMPERATURES. - Under extremely warm operating conditions, provide ample ventilation, keep the radiator well filled, the fan belt properly adjusted, and the crankcase oil level near the "F" mark. Keep the cooling system clean and unobstructed. Change oil every 100 operating hours.

DUST AND DIRT. - Keep the plant as clean as practicable. Check the operation oftener and service as needed. Clean the air cleaner often. Clean the commutator and brushes often and see that the brushes ride freely in their holders. Keep supplies of fuel and oil in airtight containers.

PRELIMINARY. - Follow a definite schedule of inspection and service.

Lubrication is an important part of periodic service and reference should be made to the illustration on lubrication. Service periods indicated are for normal service. For extreme conditions of load, temperature, frequent starts, dust, and dirt, service more often. If the plant is to be operated more than 8 hours a day, check every 8 hours; more than 50 hours a week, check every 50 hours; more than 200 hours a month, check every 200 hours; more than 1200 hours each six months, check every 1200 hours.

DAILY SERVICE

FUEL. - The five gallon tank holds enough fuel for approximately 7 hours operation at full load. The two gallon tank holds enough fuel for approximately 3 hours at full load. Check the fuel supply often enough to assure a continuous supply of fuel.

RADIATOR. - Check the cooling liquid level and add sufficient liquid to bring the level up to the top of the baffle plates.

CRANKCASE OIL LEVEL. - Check the oil level as indicated on the bayonet type gauge. Add the proper grade of oil to bring the level of the oil to the "F" mark on the gauge.

AIR CLEANER. - Check the oil level in the cup and refill to the proper level indicated thereon.

CLEANING. - Keep all external surfaces of the engine and generator clean and free of dirt and grease.

WEEKLY SERVICE

LUBRICATION. - Check the oil level. Add sufficient oil to bring the oil level to the "F" mark on the gauge. Change the oil every 100 operating hours unless the plant is operated with diluted oil or leaded fuel, then change every 50 operating hours.

AIR CLEANER. - Clean the element thoroughly in gasoline or other suitable solvent. Allow to dry or dry by using an air hose. Refill the cup to the level indicated thereon with oil of the same SAE number as used in the crankcase, except as noted under ABNORMAL OPERATING CONDITIONS.

CRANKCASE BREATHER CAP. - Remove and clean thoroughly in gasoline or other suitable solvent.

FAN. - Fill the fan hub with oil of the same SAE number as used in the crankcase, until oil seeps out on the shaft at the rear of the hub.

GENERAL. - Lubricate the governor arm to throttle shaft link and the choke shaft bearings.

FAN BELT. - Inspect the fan belt. Adjust the tension to permit about 1/2 inch play when pressure is applied midway between pulleys.

SPARK PLUGS. - Clean and reset the gap between electrodes to 0.033 to 0.035 inch for plants having battery ignition and 0.024 to 0.026 inch for plants having magneto ignition. More frequent service may be required if leaded fuels are used. Set spark plugs at .015 to .018 for plants using gaseous fuel.

BREAKER POINTS. - Contact points can be resurfaced by using a fine stone. If necessary, they may be replaced. After either resurfacing or replacing, adjust the gap to 0.018 to 0.022 inch for plants having battery ignition and 0.019 to 0.021 inch (0.015 for Wico magneto) for plants having magneto ignition. See the ACCESSORY SERVICE illustration. If excessive arcing occurs at the breaker points, a defective condenser is indicated and it should be replaced.

BATTERIES. - For plants having batteries, make certain all connections are clean and tight and keep the electrolyte level above the plates by adding clean, distilled water. Do not fill to overflowing. Follow the instructions furnished by the battery manufacturer or supplier regarding proper level. 3/8" above the separators is a safe level to use where no other level is given.

MONTHLY SERVICE

FUEL SEDIMENT BOWL. - Clean the bowl and screen. Be sure the gasket is in good order before replacing. Inspect for leaks and correct any found.

CARBURETOR. - Drain the carburetor bowl.

EXHAUST SYSTEM. - Inspect all exhaust connections. Tighten or replace all parts requiring it.

ENGINE COMPRESSION. - Check the compression of the cylinders by means of the hand crank. Loss of compression may be due to leaking spark plugs, spark plug gaskets, valves, cylinder head gasket, or piston rings. Repair or replace, as needed.

GENERATOR. - Examine the commutator and brushes. Clean, adjust, or replace as needed. Brushes worn to 5/8 inch should be replaced.

GENERAL. - Inspect the plant thoroughly for leaks, loose electrical connections, and other external items that may need attention.

SEMI-YEARLY SERVICE

CRANKCASE BREATHER VALVE. - Remove crankcase breather adapter and unthread valve assembly.

Check the bakelite valve disc for possible damage. If cracked or otherwise damaged, replace with a new one. Immerse the entire valve assembly in gasoline or other suitable solvent and clean thoroughly.

Thread valve into adapter and install to engine.

GENERATOR ARMATURE BEARING.

NOTE: Sealed bearings do not require servicing.

In addition to the other periodic services, the armature ball bearing will require servicing every six months. Clean all dirt from around the bearing cover and remove the cover and gasket. Clean out the old lubricant with a finger and work about a tablespoon of new bearing lubricant well into the bearing and again clean the bearing. Then refill the bearing housing 1/2 full of bearing lubricant, packing well into the lower half of the bearing. See the illustration on lubrication. Keep dirt out of the bearing housing. Reassemble, use a new gasket if necessary.

Check the brush rig for proper alignment of the witness mark on the brush rig and bearing support.

**BREAKER POINTS
BATTERY IGNITION**

SET BREAKER POINT GAP AT .018" TO .022" CLEARANCE. REPLACE POINTS IF PITTED OR BURNED.

ELECTRIC CHOKE

ELECTRIC CHOKE
ELECTRIC CHOKE
CHOKE BUTTERFLY VALVE
CLOSURES PASSAGE WHEN ENGINE IS COLD. OPENS AT OPERATING TEMPERATURE.
MANUAL CHOKE KNOB
CHOKE

WICO MAGNETO

BREAKER POINT GAP, INDICATED BY SPACE BETWEEN ARROW HEADS, SHOULD BE .015".

SPARK PLUG

FOR MAGNETO IGNITION SET GAP .024 TO .026

FOR BATTERY IGNITION SET GAP .033 TO .035

KEEP PLUGS CLEAN

WATER FILL
SPARK PLUG
AIR CLEANER
CONTROL BOX
GOVERNOR ARM
MAGNETO
CARBURETOR
GENERATOR FRAME
OIL BASE
FUEL PUMP

**BREAKER POINTS
MAGNETO IGNITION
FAIRBANKS-MORSE MAGNETO**

SET BREAKER POINT GAP AT .019" TO .021" CLEARANCE. REPLACE POINTS IF PITTED OR BURNED.

ADJUSTING CARBURETOR FLOAT LEVEL

FLOAT IF NECESSARY BEND HERE
COVER WITH GASKET REMOVED
GASKET
THIS DIMENSION SHOULD BE 5/16

ACCESSORY SERVICE

GENERAL. - This section includes instructions for servicing which are not of an accessory nature, but which the operator should be able to make when needed. If trouble develops, the operator should follow an orderly procedure in determining the cause before attempting adjustments. For assistance, refer to the SERVICE DIAGNOSIS section.

CARBURETOR ADJUSTMENT. - With the plant running at normal operating temperature and carrying a full load, turn the main adjusting needle in (clockwise) until the engine begins to lose power and speed. Next, turn the needle out very slowly until the engine regains maximum power and speed. The correct adjustment is the one which provides maximum power and voltage as indicated by use of a voltmeter. If a voltmeter is not available, turn the needle in (clockwise) until the governor just starts to react to the loss of power, then turn out (counterclockwise) 1/2 turn. However, if there is a tendency of the engine to hunt (alternately gain and lose speed), it may be necessary to turn the needle out a little further. Do not turn it out more than 1/2 turn beyond the maximum point of power. To adjust the idle jet needle, the plant should be running at normal operating temperature and carrying no load. Turn the needle in (clockwise) until the engine loses considerable speed, then turn it out (counterclockwise) until the engine runs smoothly. The correct setting is approximately 1/2 to 1-1/4 turns open. If the carburetor is entirely out of adjustment, open both needles approximately 2-1/2 turns to permit starting. Make final adjustment after the engine reaches normal operating temperature.

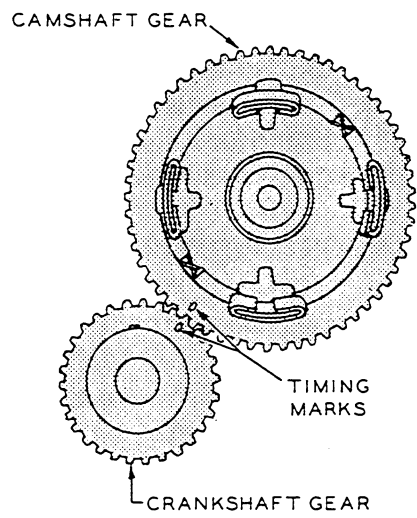
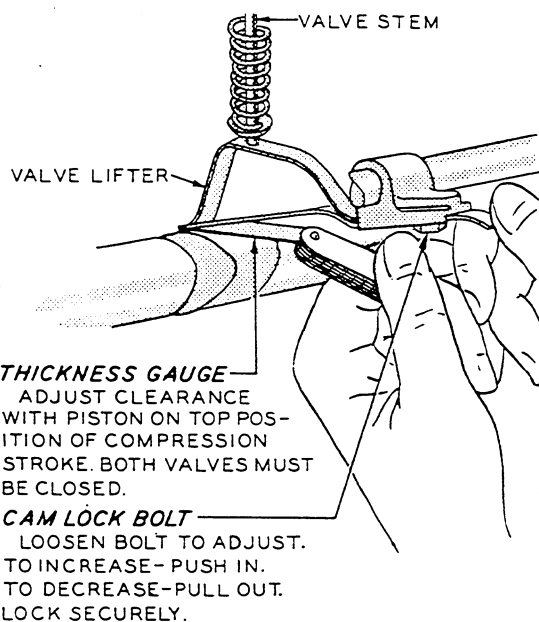
When cleaning jets and passages use compressed air or a fine, soft copper wire. Be sure a small fiber gasket is in place below the head of each jet, when reassembling.

Changes in the type of fuel or in operating conditions may necessitate an adjustment of the carburetor.

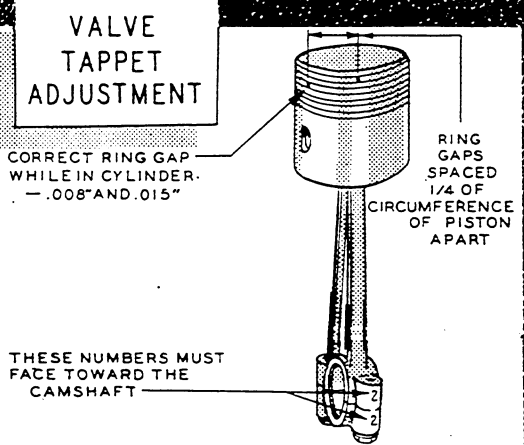
FUEL PUMP. - An automotive type fuel pump is used. If fuel does not reach the carburetor, check the fuel supply, fuel lines, and strainer before dismantling the pump. The pump can be checked by disconnecting the line at the carburetor and working the primer lever. If there is enough fuel in the tank, and the line between the tank and pump is unobstructed, but the pump will not operate, repair or replace it. Failure of the pump to operate is usually due to a leaking diaphragm, valve, or gasket; a weak or broken spring; or wear in the driving linkage.

SEDIMENT BOWL. - Remove the sediment bowl and screen, clean and replace. Before replacing the screen and bowl examine the bowl gaskets. A faulty gasket will leak and may cause the fuel pump to fail to operate.

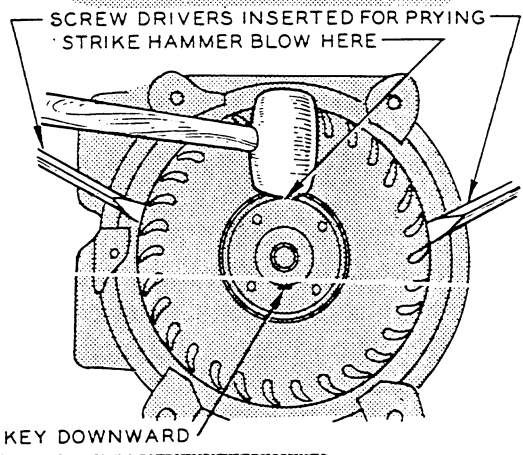
ELECTRIC CHOKE ADJUSTMENT. - Improper operation of the choke assembly will be indicated by hard



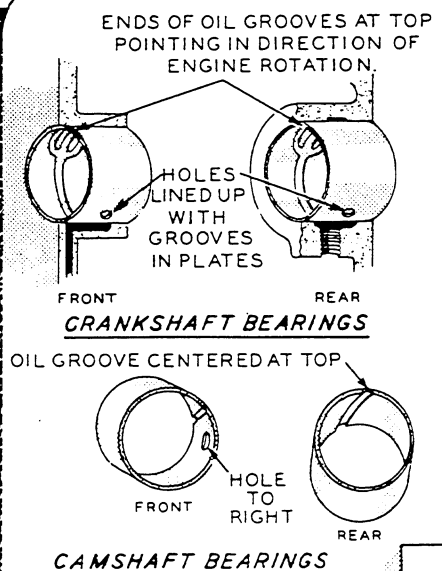
TIMING GEAR MARKS



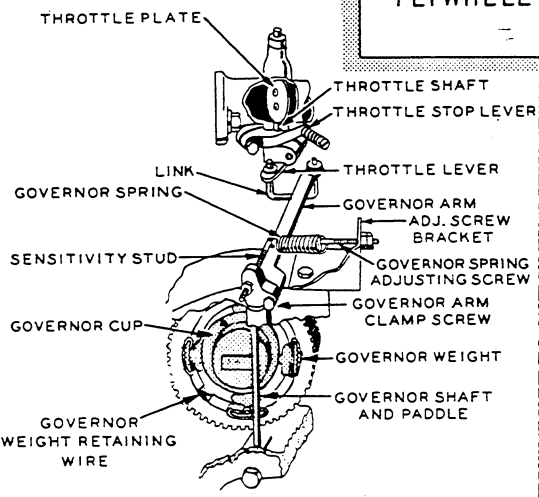
PISTON AND CONNECTING ROD



REMOVING FLYWHEEL



INSTALLATION OF BEARINGS



CUTAWAY VIEW GOVERNOR MECHANISM

starting or irregular running during the warm-up period. Proper adjustment can be made by rotating the housing in a counterclockwise direction, when looking at the thermostat end of the shaft, for a leaner mixture, and in a clockwise direction for a richer mixture. At 70°F. the choke plate should be nearly closed, approximately 1/16 inch from its fully closed position. At normal operating temperature the plate should be in a wide open position.

GOVERNOR ADJUSTMENT. - If there is a tendency of the governor to hunt (alternately increase and decrease speed) it may be necessary to adjust the sensitivity stud so that the inner end of the spring is held farther from the governor shaft. Regulation is better with the inner end of the spring closer to the shaft, but the tendency to hunt is increased also. The correct position is the one giving the best regulation with no hunting. Check periodically to assure freedom of action. If it does not respond to the slightest variation of the load, correct the trouble and adjust after the plant reaches normal operating temperature and speed.

If any change is made in the sensitivity stud adjustment, it will be necessary to readjust the spring tension to correct the speed as directed under OPERATION.

SPARK PLUGS. - Clean the carbon from the spark plugs by using a stiff wire brush or a regular plug cleaning machine. Reset the electrode gap to 0.033 to 0.035 inch for plants having battery ignition and to 0.024 to 0.026 inch for plants having magneto ignition. When necessary to replace the spark plugs, use a Champion No. 5 COM or an equivalent type plug. Set spark plug gap at .015 to .018 on plants using gaseous fuel.

RADIATOR. - Keep the radiator filled with water or permanent type antifreeze. Use alkali free water such as rain water. The use of a good rust inhibitor is recommended. The radiator must be kept clean inside and outside. Keep the hose connections tight and correct any leaks that may occur.

HIGH TEMPERATURE SWITCH. - The high temperature switch operates automatically, grounding out the ignition system and stopping the engine if the engine temperature rises to a dangerous point. This prevents overheating, which could cause serious damage to the engine parts. The engine may be started again when the bi-metal element and engine have cooled approximately 40°F.

Should the switch prove defective at any time, the plant may be operated by disconnecting the lead at the switch and taping the end. A new switch should be ordered immediately and installed as soon as possible as there is no protection from overheating while the switch is disconnected. Keep a close check of the water level in the radiator while the switch is disconnected.

GENERAL. - Certain new engines when leaving the factory have an oversize cylinder bore. This oversize is indicated by the addition of a letter to the plant serial number. For example: Serial No. 47.382425E, the letter E indicating .005" oversize. Also the oversize is stamped on the cylinder block between the cylinder bores. The piston oversize is stamped on top of the piston.

Pistons and rings are available in .010", .020", .030" oversize for re-bore jobs. Piston pins are also available in .002" and .005" oversizes. Before ordering any repair parts that may be required in an oversize, check the serial number of the plant and the positions of the oversize stampings as noted above.

ENGINE

CRANKCASE INSPECTION. - A competent mechanic can determine the need for major repairs by removing the inspection plates from the crankcase, inserting a trouble lamp inside the crankcase, and checking the clearances of the working parts of the engine. Drain the oil and remove the oil base whenever servicing connecting rods or pistons.

VALVE SERVICE. - Compression readings for the cylinders should be within 10 pounds of each other and not less than 60 pounds at sea level when cranked by hand. A compression loss past an exhaust valve may be heard at the exhaust outlet. A compression loss past an intake valve may be heard through the carburetor. Compressed gasses leaking past the piston rings may be heard at the oil fill opening. If any one valve is leaking, all should be serviced at the same time.

When removing the cast iron cylinder block or head do not use a pry, rap sharply with a soft hammer to loosen. Do not let the pistons fall against the crankcase. Valves are of the poppet type. Clean all carbon from the valves, valve stems, valve faces, and valve ports. Replace badly burned valves. Reface to a 44° angle the old valves to be retained. Reface the valve seats to a 45° angle, if necessary. The finished seat should be between 3/64 and 5/64 of an inch wide. Grind each valve to its seat just enough to assure correct seating between valve and seat. Be sure to clean all grinding compound from engine parts. When reassembling, lubricate the valve stems and faces. Be sure to place each valve in its proper location.

PISTON RING SERVICE. - Each of the two cast aluminum pistons has three compression rings and one oil control ring. Inspect the piston rings carefully for fit in grooves, for tension, and for seating on cylinder walls. If there is any doubt about the serviceability of the old piston rings, install new ones. Fit each ring individually to its cylinder from the crankcase end. The correct ring gap, while in the cylinder, is between 0.010 and 0.015 of an inch. If the ring

is not too large, the ends may be filed slightly to obtain the correct gap. Rings so large as to require too much filing should not be used. Each ring gap should be 1/4 of the way around the piston from the preceding one. Rings of the tapered type will be marked "Top", or identified in some other manner, and this mark must be placed nearer the top of the piston. Install all rings on the pistons. NOTE: Expander type rings are recommended if oil consumption is excessive due to ring trouble.

CONNECTING RODS. - The aluminum connecting rods and bearing caps are numbered. If replacement of the connecting rods becomes necessary, these numbers must face the camshaft when reassembling. The split in the piston skirt must face the camshaft.

VALVE TAPPET ADJUSTMENT. - When it is necessary to readjust the tappet clearance proceed in the following manner. Tighten all cylinder head nuts to a tension of 50 pounds foot. Remove the valve chamber inspection plate. On the battery ignition plant, take care not to lose or damage the breaker plunger. On the magneto ignition plant it will be necessary to remove the magneto to reach the front valves. Crank the engine slowly until the No. 1 valve (nearest the radiator) closes and continue until the "TC" marks on the flywheel and right side of the crankcase coincide. The No. 1 piston should then be at the top of its compression stroke. Adjust tappets No. 1 (intake) and No. 2 (exhaust) by loosening the lock bolt (see illustration) and pushing the valve lifter in to increase the clearance, or pulling the lifter out to decrease the clearance. Use a 0.008" and a .010" feeler gauge for the intake valve, and a 0.010" and a 0.012" feeler gauge for the exhaust valve. In each case the smaller gauge should pass freely between the cam surface and the valve lifter, but the larger gauge should not. Crank the engine over one complete revolution and align the "TC" marks for the correct position of the No. 2 piston. Adjust tappets #3 (exhaust) and No. 4 (intake) in the same manner. Be sure that all lock bolts are securely tightened as adjustments are completed. The clearances given are for a "cold" engine (not at operating temperature).

NOTE

"TC" marks on crankcase and flywheel should be in line when each piston is at the top of its compression stroke.

FLYWHEEL. - To remove, turn the flywheel until the keyway is downward and insert a heavy screwdriver between the flywheel and crankcase on each side. Then strike a sharp downward blow on the hub with a heavy lead hammer. Avoid dropping the flywheel.

CRANKSHAFT GEAR. - The steel crankshaft gear may be pulled from the crankshaft by means of a suitable gear puller, after first removing the gear nut and special washer. If the gear is to be used again, apply the puller carefully to avoid damage to the teeth.

CAMSHAFT GEAR. - Remove the cast iron camshaft gear and camshaft as an assembly, sliding it out while raising the valve lifters and the fuel pump eccentric follower arm so they will clear the cams and rear journal. The gear should be removed and replaced by means of an arbor press.

GOVERNOR ARM. - When replacing the governor arm, be sure the felt washer is in place on the governor shaft, then set the arm at such height that the carburetor end is approximately level with the forward end of the throttle lever. Do not tighten the governor arm clamp screw until the carburetor link, spring bracket, and spring have been installed. Then, with the governor spring holding the arm in the open-throttle position, insert a screwdriver into the slot at the top end of the shaft and turn the shaft clockwise as far as it will go. Hold in this position and tighten securely. Do not force the arm down on the shaft so far as to cause a binding condition. After the engine reaches normal operating temperature, adjust the engine speed to approximately 1800 rpm for the 60 cycle plants and 1500 rpm for the 50 cycle plants.

GOVERNOR. - Refer to the ACCESSORY SERVICE section for adjustment of the enclosed, centrifugal weight type, governor.

REPLACING GOVERNOR WEIGHTS. - Before removing the retaining wire, examine the ends of the wire and note exactly how they are inserted in small holes in the gear, and how the wire has been bent outward. Hold the retaining wire with pliers while removing. Then install new weights and place the new retaining wire in position in the groove. Be sure the ends of the wires enter the small holes in the gear. Then, using a small punch and a light hammer, strike a blow near each end of the wire at the center of the recess so that each wire will bow slightly outward (toward the teeth) instead of inward. It is important that the ends of the wires seat securely in the holes and expand the wire outward tightly in the groove. If not so expanded, it may become loosened, release the weights, and cause extensive damage. When ordering a new gear always order a complete assembly with weights assembled.

GEAR COVER. - When installing the gear cover, turn the shaft counterclockwise (looking at the top of the shaft) as far as it will go and hold in this position until the cover is located on the dowel pins.

CYLINDERS. - The cylinder bore is 3 inches; stroke, 2-3/4 inches; piston displacement, 38.8 cubic inches; compression ratio, 5.5 to 1. If cylinder walls are worn more than 0.005 inch out of true, it is advisable to install a new cylinder block with new standard size pistons, or to refinish the cylinders to accommodate new pistons of one of the available oversizes. Pistons are available in .010", .020" and .030" oversize.

CRANKSHAFT. - The counterbalanced crankshaft is drilled for pressure lubrication of the connecting rods. When making major repairs, these drilled passages should be inspected and thoroughly cleaned to assure proper lubrication of the connecting rods.

BEARINGS. - The split sleeve type, steel-backed, babbitt-lined crankshaft bearings must be installed with the oil grooves at the top, the ends of the outer grooves pointing in the direction of the crankshaft rotation, and the oil holes in line with the depressions in the bearing plates. See the illustrations in this section. Press both bearings in until the ends are flush with the inner ends of the bearing plates.

The cast iron camshaft is supported by sleeve type, steel-backed, babbitt-lined bearings. The oil groove of the rear camshaft bearing should be centered at the top. The hole in the front camshaft bearing should be to the right, when facing the front of the crankcase, and centered with the hole in the bearing boss. Press the front cam bearing in flush with the bearing boss. Press the rear bearing in flush with the welch plug groove.

Both the crankshaft and camshaft bearings must be line reamed in the crankcase after being installed.

TIMING GEAR MARKS. - The timing mark on the crankshaft gear must coincide with the timing mark on the camshaft gear when the gears are installed. See the illustration in this section. It is advisable to install both gears when either is required.

IGNITION SYSTEM. - Refer to the PERIODIC SERVICE and ACCESSORY SERVICE sections for instructions on servicing the ignition system and to the next two paragraphs for instructions on timing.

TIMING THE IGNITION (BATTERY IGNITION) . - With the timing gears properly meshed, the No. 1 piston at the top of its compression stroke, and the "TC" marks exactly in line, the only other adjustment is the setting of the breaker point gap to 0.018 to 0.022 inch at full separation. The spark should occur approximately 20° before top center.

TIMING THE IGNITION (MAGNETO IGNITION). - The No. 1 piston must be at the top of its compression stroke and the "TC" marks exactly in line when timing the ignition for plants having magneto ignition. Set the breaker points to 0.020 inch (0.015 for Wico magneto) at full separation. Then turn the magneto gear in the normal direction of rotation until the impulse coupling just trips with the distributor arm pointing toward the No. 1 tower of the distributor. Install the magneto without turning the gear from this position. Then crank the engine very slowly and note whether the impulse

coupling just trips when the "TC" marks are exactly in line. If not, timing is incorrect. If not too far off, it may be corrected by turning the magneto frame slightly. If too far off, remove the magneto and turn the gear one or more teeth to advance, or to retard the timing. Install and again note whether the impulse coupling just trips when the "TC" marks are exactly in line. The spark advance should be 20° to 22° at running speed.

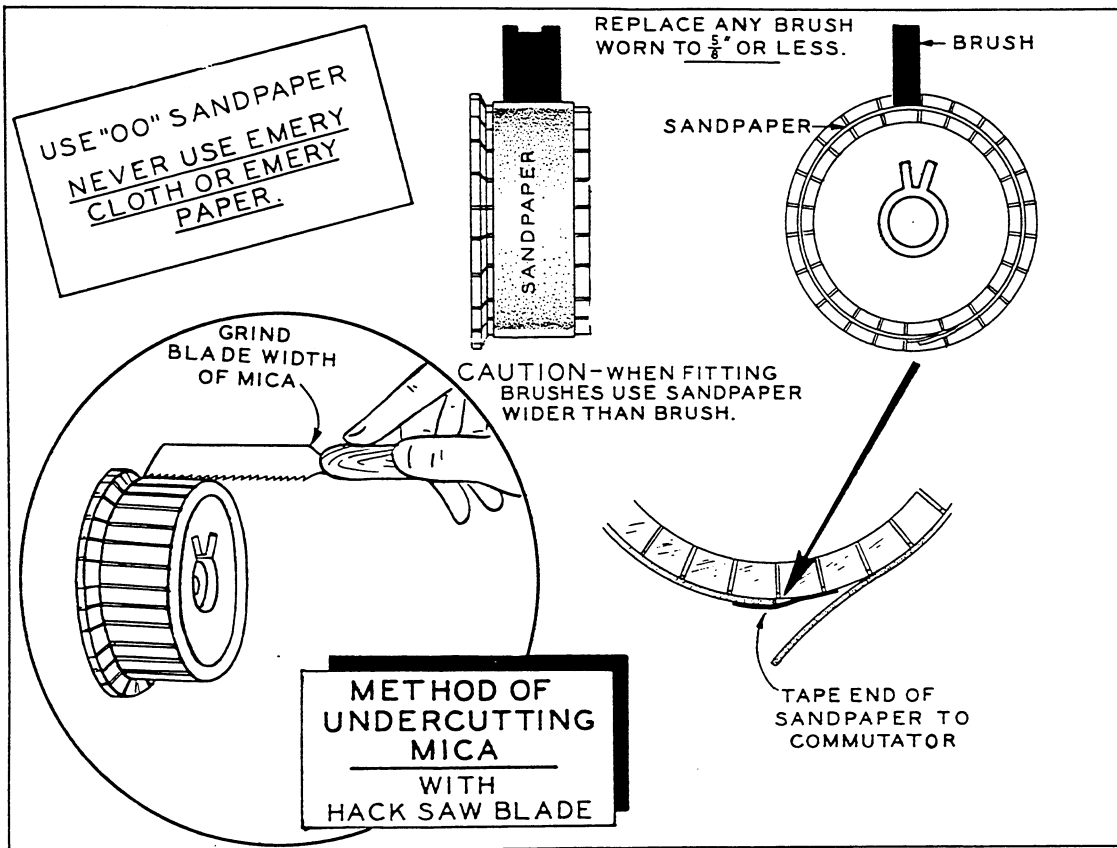
LUBRICATING SYSTEM. - A gear type oil pump provides for pressure lubrication of the main bearings and the connecting rods and spray lubrication of the other internal parts of the engine. Check the oil pump thoroughly for worn parts. If replacement of parts is necessary, be sure to use the correct gasket when reassembling to allow about 0.002 inch endwise movement in the shaft. Make sure all oil passages are unobstructed.

OIL PRESSURE RELIEF VALVE. - A by-pass valve in the oil pressure line controls the amount of oil delivered to the main bearings and connecting rods. This valve is properly set at the factory to maintain the correct oil pressure within the plant. This adjustment should not be disturbed. If for any reason the adjustment of the valve has been changed, a new by-pass valve assembly should be installed. Any change in the adjustment other than a factory setting might cause serious trouble.

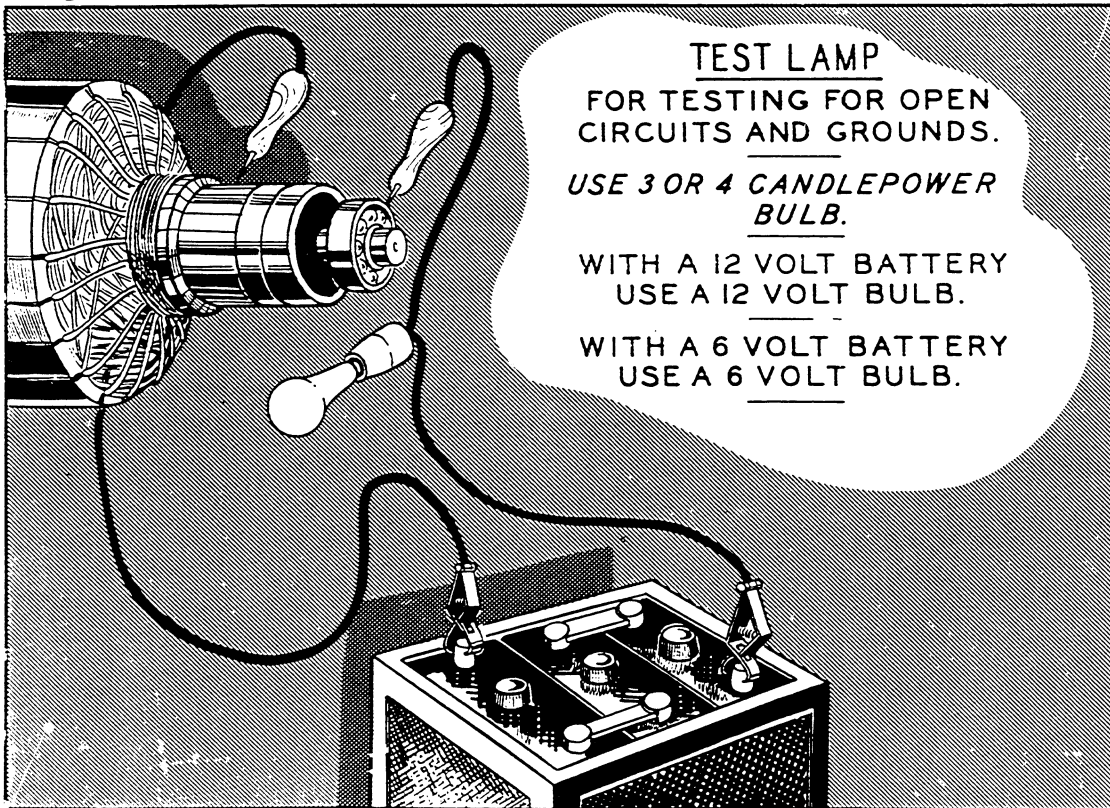
FUEL SYSTEM. - The fuel system includes fuel lines, fuel pump, fuel tank, electric or manual choke, carburetor, and an air cleaner. Refer to PERIODIC SERVICE and ACCESSORY SERVICE for instructions on service and adjustment.

COOLING SYSTEM. - The thermo-siphon cooling system includes the radiator, fan, and fan belt. Refer to PERIODIC SERVICE and ACCESSORY SERVICE for instructions on service and adjustment.

GASKETS. - Check all gasket surfaces to see that they are clean before installing new gaskets. Be sure to replace with new gaskets those that have been disturbed.



CARE OF COMMUTATOR AND BRUSHES



MAINTENANCE AND REPAIR - GENERATOR

TABLE OF CLEARANCES

	MINIMUM	MAXIMUM
Valve Tappet Clearance (Intake) at 72°F.	0.008"	0.010"
Valve Tappet Clearance (Exhaust) at 72°F.	0.010"	0.012"
Valve Seat Width	3/64"	5/64"
Valve Stem Clearance in Guide (All)	0.002"	0.0035"
Crankshaft Main Bearing (Diameter)	0.002"	0.003"
Crankshaft End Play	0.008"	0.010"
Connecting Rod Bearing (Diameter)	0.0025"	0.0035"
Connecting Rod End Play	0.004"	0.006"
Camshaft Bearing (Diameter)	0.0015"	0.0025"
Timing Gear Backlash	0.003"	0.005"
Piston (Clearance in Cylinder)	0.002"	0.004"
Piston Pin (In Piston) at 72°F.		Hand Push Fit
Piston Pin (In Connecting Rod) at 72°F.		Thumb Push Fit
Piston Ring Gap (In Cylinder)	0.010"	0.015"
Piston Ring to Groove Clearance	0.001"	0.0015"
Cylinder Bore (Actual Diameter)	3.003"	3.004"
Breaker Points (Magneto Ignition)	0.019"	0.021"
Breaker Points (Battery Ignition)	0.018"	0.022"
Spark Plugs (Magneto Ignition)	0.024"	0.026"
Spark Plugs (Battery Ignition)	0.033"	0.035"
Spark Plugs (Gaseous Fuel)	0.015"	0.018"

GENERATOR

GENERAL. - The generator normally requires little servicing other than periodic attention to brushes, commutator, and ball bearing. If both the engine and generator require major servicing, combine the work in one job. Only those operations necessary to make the required repairs need be done.

ARMATURE. - Reassembly is accomplished by reversing the procedure used in disassembling. See that all surfaces of the flange joint between generator armature and flywheel are clean. The four dowel pins will permit the armature to be installed in any one of four different positions. Install in whichever position assembly is easiest. After tightening the armature through stud nut, observe the run-out at the bearing. If more than a few thousandths of an inch, it may be due to dirt between the flanges of the joint or a nick on one of the flange surfaces. This condition should be corrected. The run-out might be reduced by changing to another of the four positions permitted by the four dowel pins.

The bearing may be removed from the shaft by means of a bearing puller. Avoid injury to the shaft. The center must remain true to serve as a turning center in refinishing the commutator. Install the bearing with the sealed side toward the armature. Drive the bearing onto the shaft

to the shoulder. The bearing must be packed with lubricant before operating the plant.

COMMUTATOR. - When the commutator becomes grooved, out of round, or the surface becomes pitted or rough so that good brush seating cannot be maintained, it will be necessary to remove the armature and to refinish in a lathe. Undercut the mica $1/32$ of an inch after turning down the commutator. Avoid injury to the commutator bars. Leave no burrs along the edges of the bars.

BRUSHES. - When replacing, sand new brushes to a good seating contact. See the illustration on sanding of brushes in this section.

TESTING WINDINGS. - A test lamp set or an armature growler is required for the various tests. Before making any tests, lift all brushes in their holders and disconnect the load wires. Test prods must make good electrical connections at points of contact.

If the armature winding tests open-circuited, short-circuited, or grounded, the practical repair is to install a new one. To test for open or short circuits, use an armature growler and follow the manufacturer's instructions. To test for a ground, use a test lamp.

If the field winding tests open-circuited, short-circuited, or grounded, the practical repair is to install new field coils unless the trouble is in the leads outside the winding proper.

If a winding having external leads test defective, check the leads carefully. If the trouble is in a lead it can be repaired as the nature of the trouble requires.

CONTROLS

CONTROL PANEL EQUIPMENT. - If any of the control panel equipment fails to function properly it should be replaced by a corresponding new unit rather than to attempt repairs on the old one. No attempt should be made to repair such units as meters, fuses, switches, and receptacles.

POSSIBLE CAUSE

REMEDY

ENGINE CRANKS TOO STIFFLY

Too heavy oil in crankcase. Drain, refill with lighter oil.

Engine stuck. Disassemble and repair.

ENGINE WILL NOT START WHEN CRANKED

Faulty ignition. Clean, adjust, or replace breaker points, plugs, condenser, coil, etc., or retime magneto.

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. Reset breaker points or retime magneto.

ENGINE RUNS BUT VOLTAGE DOES NOT BUILD UP

Poor commutation. See that brushes seat well on commutator, are free in holders, are not worn shorter than 5/8 inch, and have good spring tension.

Speed too low. Adjust governor to correct speed.

Open circuit, short circuit, or ground in generator. See GENERATOR, replace part necessary.

VOLTAGE UNSTEADY BUT ENGINE NOT MISFIRING

Speed too low. Adjust governor to correct speed.

POSSIBLE CAUSE

REMEDY

VOLTAGE UNSTEADY BUT ENGINE NOT MISFIRING (Cont.)

Poor commutation or brush contact.	See that brushes seat well on commutator, are free in holders, are not worn shorter than 5/8", and have good spring tension.
Loose connections.	Tighten connections.
Fluctuating load.	Correct any abnormal load condition causing trouble.

GENERATOR OVERHEATING

Overloaded.	Reduce load.
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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.
Carburetor air cleaner.	Clean and refill.
Choke	See that it opens wide enough.
Carbon in cylinders.	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.

POSSIBLE CAUSE

REMEDY

ENGINE MISFIRES AT LIGHT LOAD (Cont.)

Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, coils, etc., or retime magneto.
Uneven compression.	Tighten cylinder head and spark plugs. If still not corrected, grind valves. Replace piston rings, if necessary.
Worn intake valve stems.	Replace valves.

ENGINE MISFIRES AT HEAVY LOAD

Spark plugs defective.	Replace.
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, coil, etc., or retime magneto.
Clogged carburetor.	Clean jets.
Clogged fuel screen.	Clean.
Defective spark plug cables.	Replace.

ENGINE MISFIRES AT ALL SPEEDS

Fouled spark plug.	Clean and adjust.
Defective or wrong spark plug.	Replace.
Sticking valves.	Grind, or replace.
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.

POSSIBLE CAUSE

REMEDY

LOW OIL PRESSURE (Cont.)

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.	Replace.
Defective oil pressure gauge.	Replace.

ENGINE BACKFIRES AT CARBURETOR

Lean fuel mixture.	Clean or adjust carburetor.
Clogged fuel screen.	Clean screen.
Intake air leak.	Replace flange gaskets, tighten carburetor.
Poor fuel.	Refill with good, fresh fuel.
Spark too late.	Adjust breaker points or retime magneto.
Spark plug wires crossed.	Install wires correctly.
Intake valves leaking.	Grind or replace.

EXCESSIVE OIL CONSUMPTION, LIGHT BLUE SMOKY EXHAUST

Oil leaks from oil base or connections. This does not cause smoky exhaust.	Replace gaskets and leaking tubing. Tighten screws and connections.
Oil too light or diluted.	Drain, refill with correct oil.

POSSIBLE CAUSE

REMEDY

EXCESSIVE OIL CONSUMPTION, LIGHT BLUE SMOKY EXHAUST (Cont.)

Too large bearing clearance.	Replace.
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, coil, etc., or retime magneto.
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 carburetor or choke. Install needed carburetor parts, adjust float level.
Choke not open.	See that choke opens properly.
Dirty air cleaner.	Clean, refill to proper level.

LIGHT POUNDING KNOCK

Loose connecting rod bearing.	Adjust or 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.
Defective ignition.	Check the ignition system. Repair or replace parts necessary.
High water temperature switch.	Check cooling system.

POSSIBLE CAUSE

REMEDY

DULL METALLIC THUD. IF NOT BAD, MAY DISAPPEAR AFTER FEW MINUTES OPERATION. IF BAD, INCREASES WITH LOAD.

Loose crankshaft.

Replace, unless one of the next three remedies permanently corrects the trouble.

SHARP METALLIC THUD, ESPECIALLY WHEN COLD ENGINE FIRST STARTED

Low oil supply.

Add oil.

Low oil pressure.

Refer to symptom of low pressure for remedies.

Oil badly diluted.

Change oil.

PINGING SOUND WHEN ENGINE IS RAPIDLY ACCELERATED OR HEAVILY LOADED

Carbon in cylinders.

Remove carbon.

Spark too early.

Adjust breaker points or retime magnetos.

Wrong spark plugs.

Install Champion 6-M plugs.

Spark plugs burned or carboned.

Install new plugs.

Valves hot.

Adjust tappet clearance.

Fuel stale or low octane.

Use good fresh fuel.

Lean fuel mixture.

Clean and adjust carburetor.

TAPPING SOUND

Tappet clearance too great.

Adjust or replace tappets.

Broken valve spring.

Install new spring.

HOLLOW CLICKING SOUND WITH COOL ENGINE UNDER LOAD

Loose pistons.

If noise only slight and disappears when engine warms up, no immediate attention needed. Otherwise replace worn parts.

POSSIBLE CAUSE

REMEDY

LIGHT DIM AT FAR END OF LINE BUT BRIGHT NEAR POWER PLANT

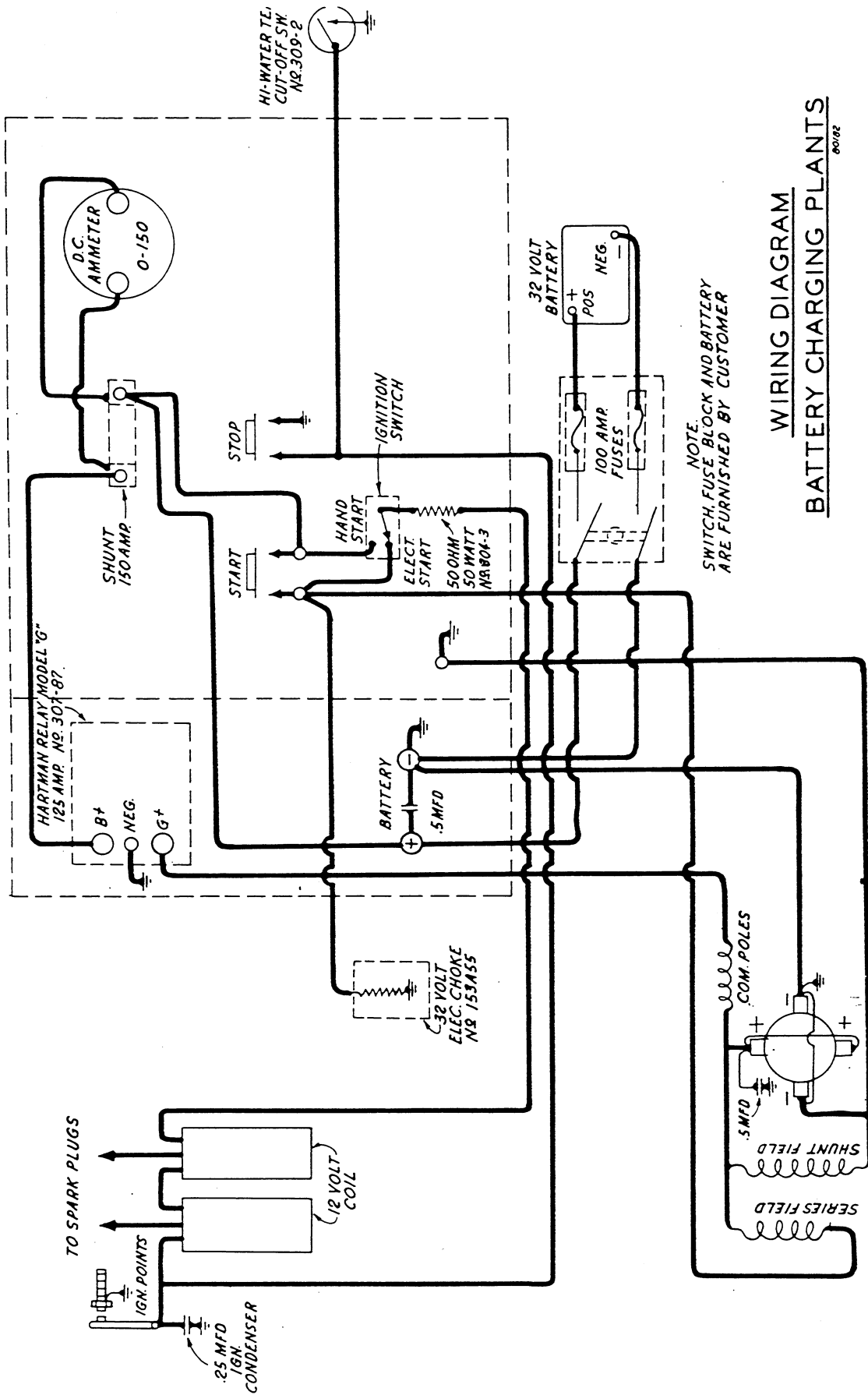
Too small line wire for load
and distance.

Install larger or extra wires or re-
duce 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.

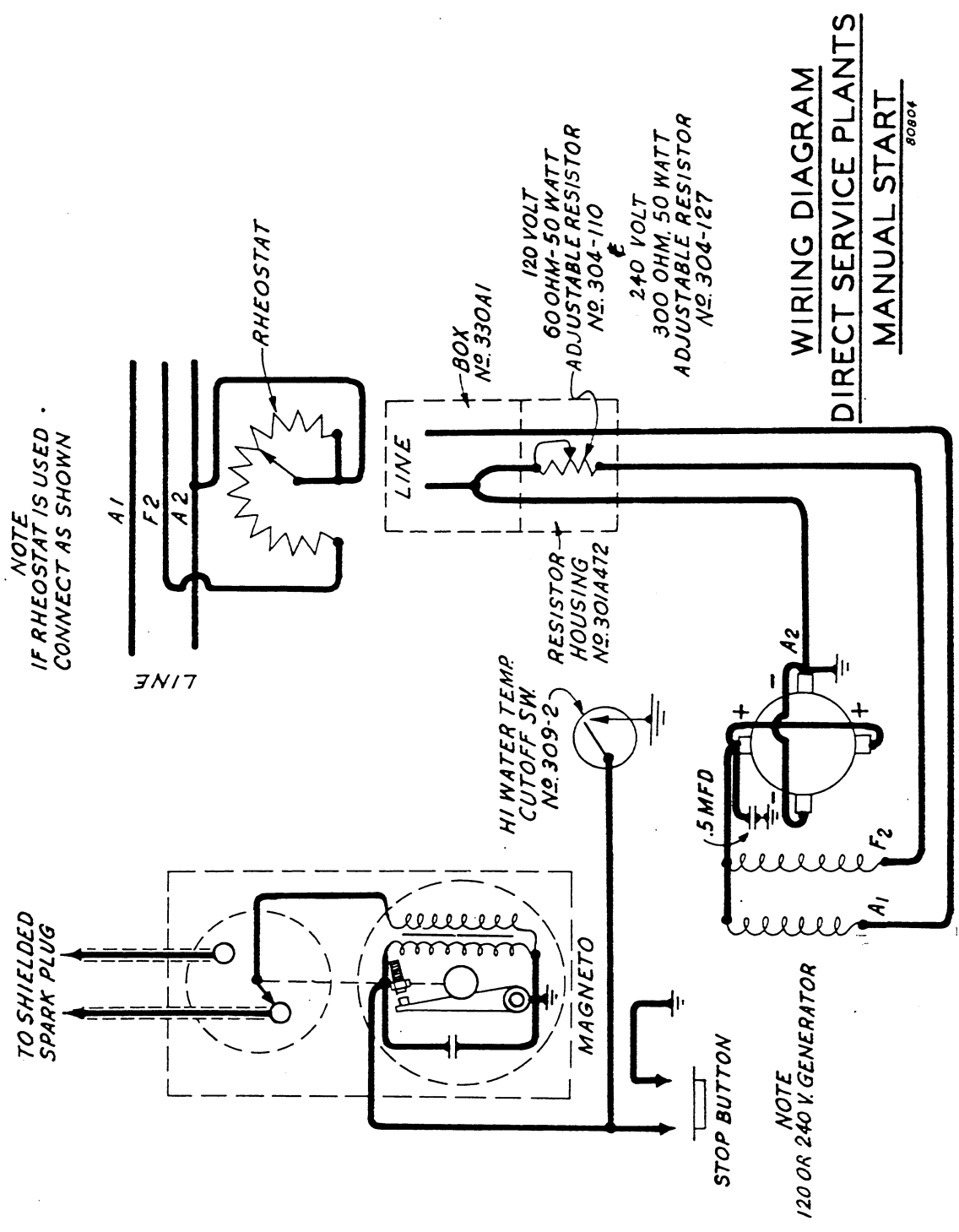
Install larger or extra wires, or re-
duce load.



NOTE:
SWITCH, FUSE BLOCK AND BATTERY
ARE FURNISHED BY CUSTOMER

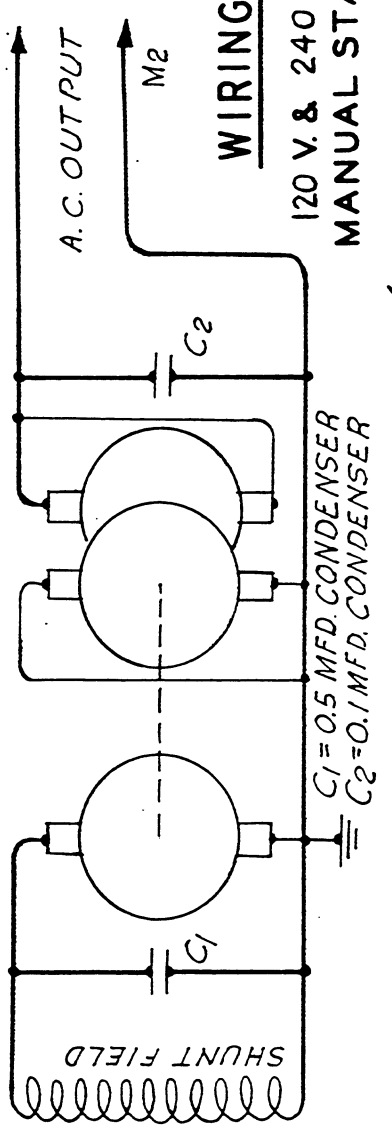
WIRING DIAGRAM
BATTERY CHARGING PLANTS

80/02

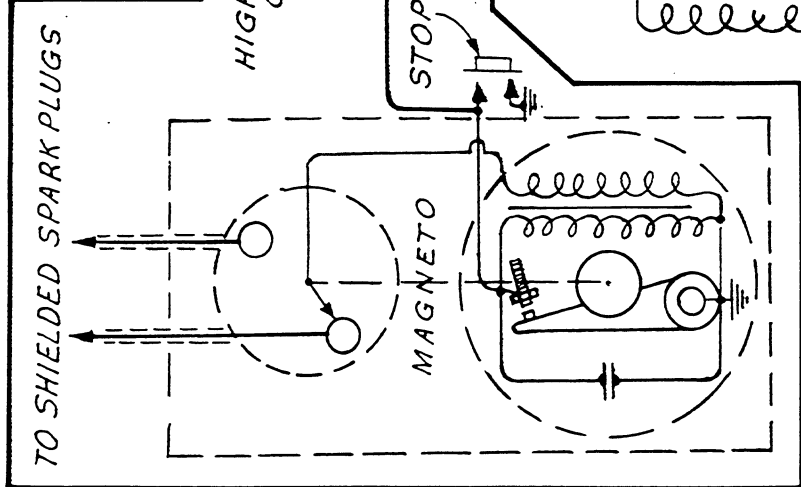


WIRING DIAGRAM
DIRECT SERVICE PLANTS
MANUAL START
60804

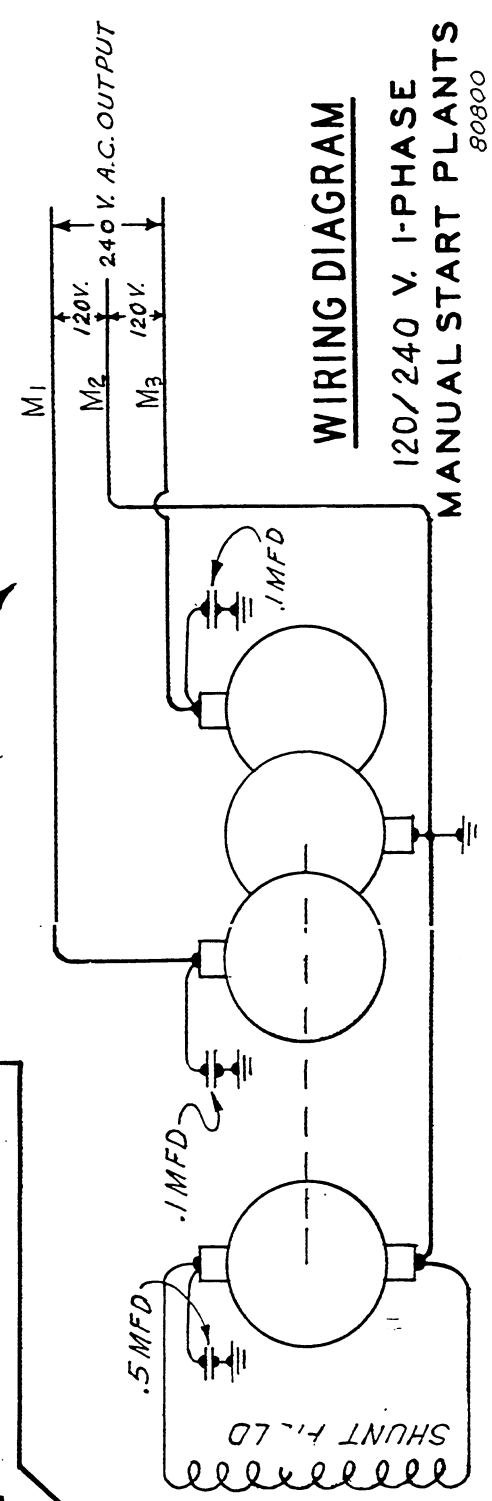
WIRING DIAGRAM
 120 V. & 240 V.-1 PHASE
 MANUAL START PLANTS
 81205

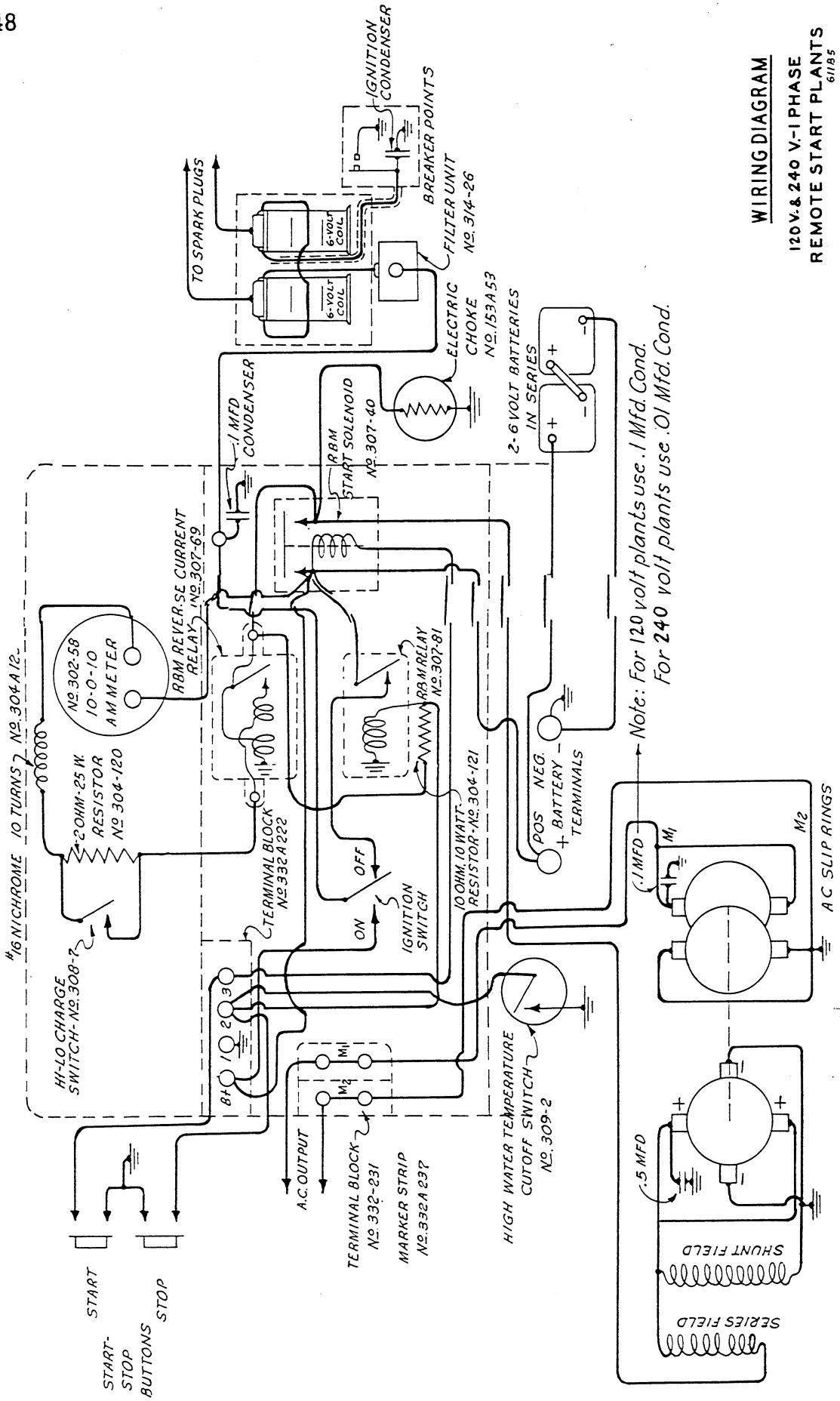


MAGNETO USED WITH
 EITHER DIAGRAM



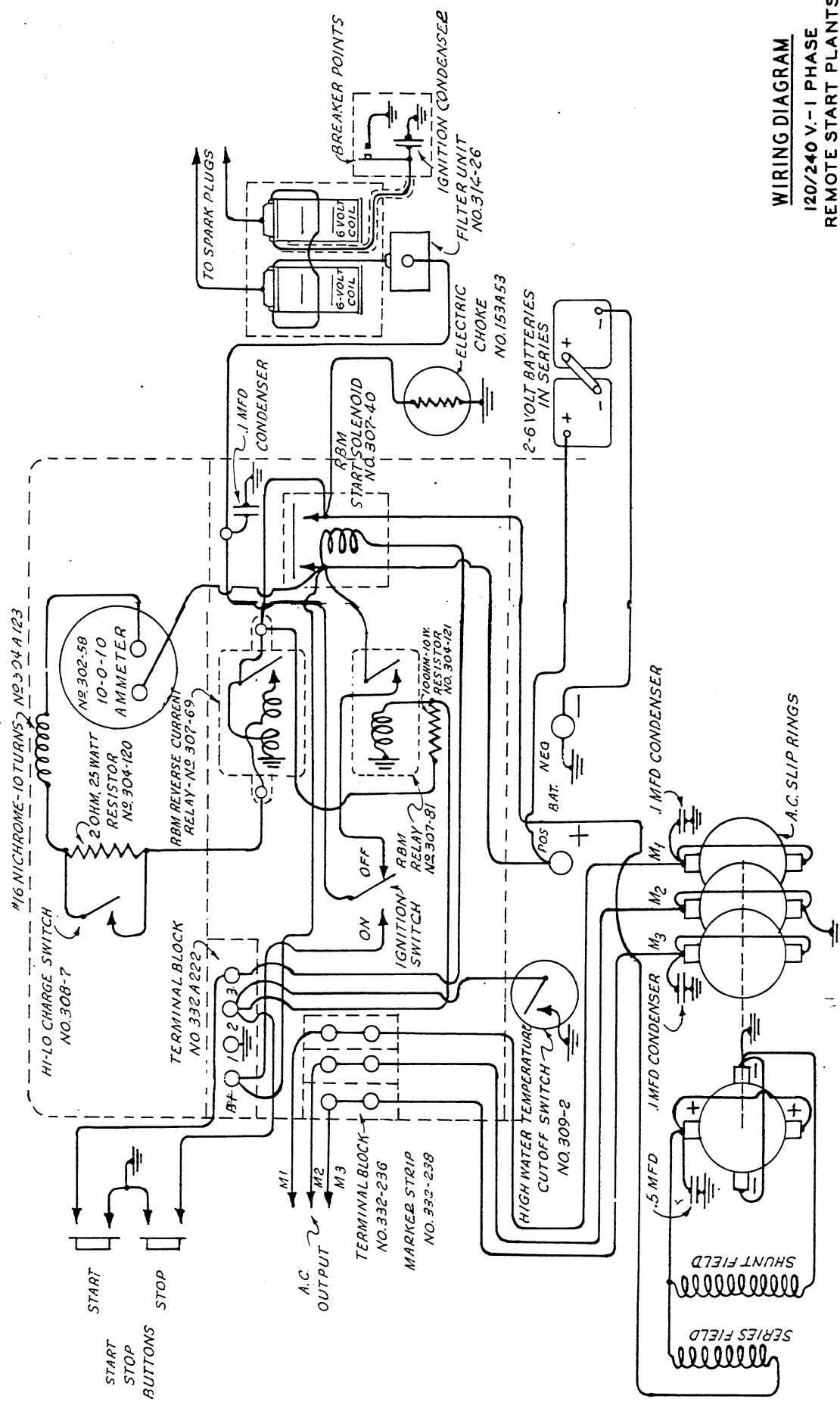
WIRING DIAGRAM
 120/240 V. 1-PHASE
 MANUAL START PLANTS
 80800



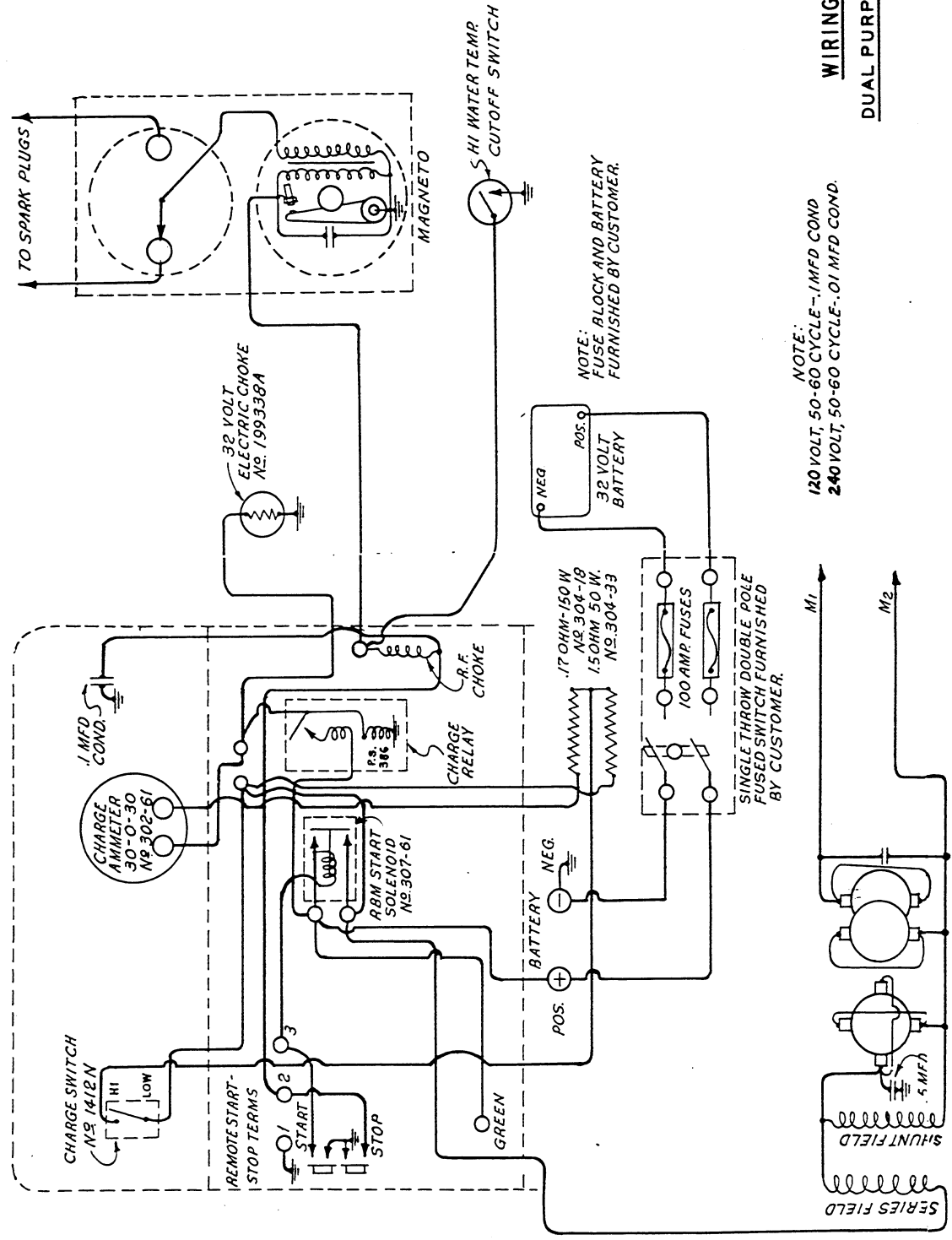


Note: For 120 volt plants use .1 Mfd. Cond.
For 240 volt plants use .01 Mfd. Cond.

WIRING DIAGRAM
120 V. & 240 V.-1 PHASE
REMOTE START PLANTS
6/1/85



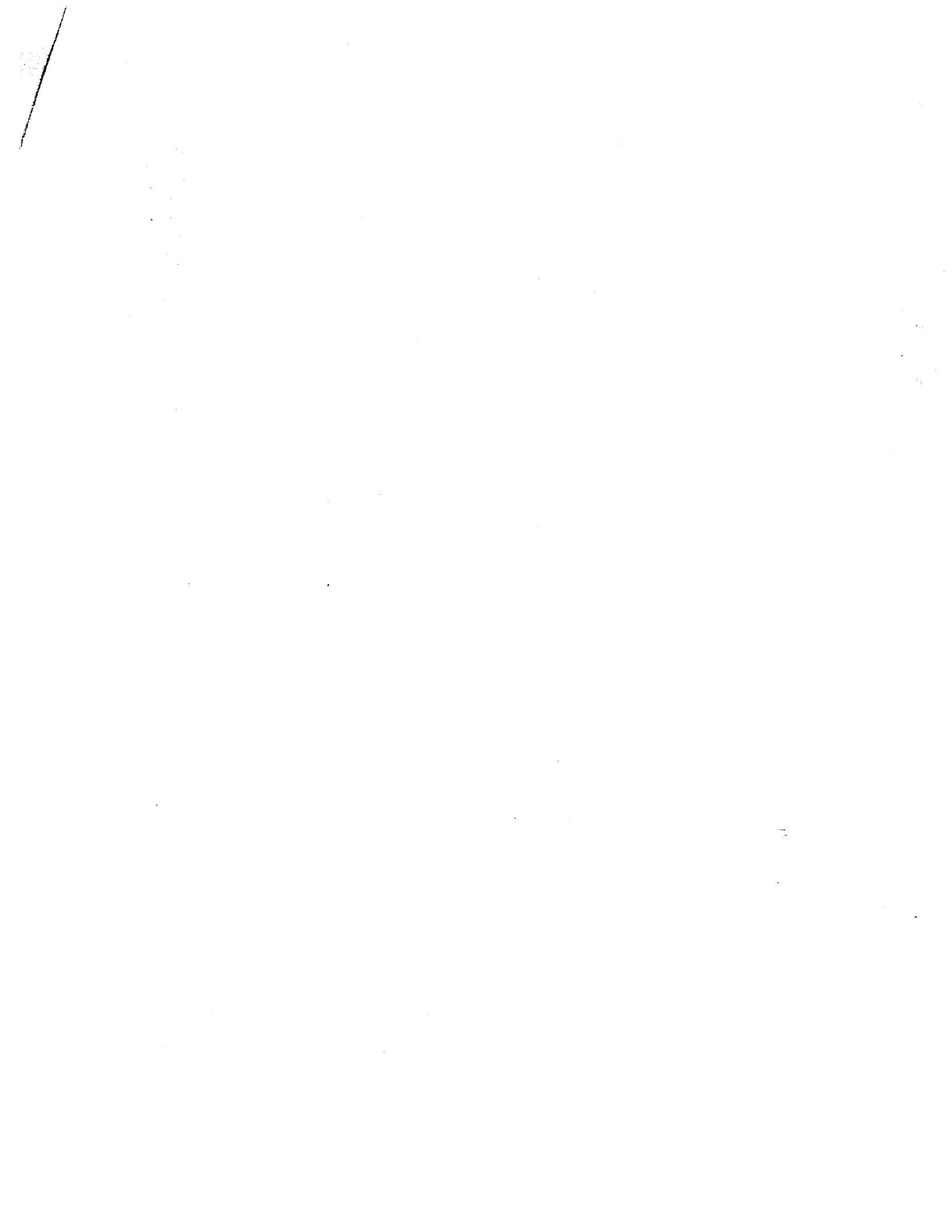
WIRING DIAGRAM
120/240 V.- 1 PHASE
REMOTE START PLANTS
61176 **49**



NOTE:
FUSE BLOCK AND BATTERY
FURNISHED BY CUSTOMER.

NOTE:
120 VOLT, 50-60 CYCLE-.1MFD COND
240 VOLT, 50-60 CYCLE-.01 MFD COND.

WIRING DIAGRAM
DUAL PURPOSE PLANTS
611816





Onan Corporation
1400 73rd Avenue N.E.
Minneapolis, MN 55432
1-800-888-ONAN
612-574-5000 International Use
Telex: 275477
Fax: 612-574-8087

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