INSTALLATION
AND
OPERATING INSTRUCTIONS

FOR

ONAN ELECTRIC GENERATING PLANTS

DZB
Series

Onan®

DIVISION OF STUDEBAKER CORPORATION
MINNEAPOLIS 14, MINNESOTA

Printed

944-2

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. Electrocution 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.

We mean it.....

.....and this certificate with the Onan electric plant you purchased proves we mean it! When this plant left our factory in Minneapolis it took with it our sincere assurance that it will produce exactly as stated on its nameplate.

The name of ONAN is synonymous with satisfactory performance, certified performance.

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.

MANUFACTURER'S WARRANTY

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

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

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

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

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

IMPORTANT

RETURN WARRANTY CARD ATTACHED TO UNIT

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Each Onan generating plant of the DZB series is a complete unit consisting of a diesel type driving engine, a self excited generator, and such controls and accessories as are necessary for a normal installation. Right and left sides of the plant are designated when facing the engine, or front, end of the plant.

The electrical characteristics of the plant vary according to the particular model, and are noted on the Onan nameplate attached to the unit. If it ever becomes necessary to contact a dealer or the factory regarding the plant, be sure to mention the complete Model and Spec. No., and the Serial No. as given on the Onan nameplate. This nameplate information is necessary to properly identify the plant among the many basic types manufactured. Refer to the engine nameplate when requesting engine information from its manufacturer.

Each generating plant is given a complete running test under various load conditions and is carefully checked before leaving the factory. Inspect the plant closely for any damage which may have occured in shipment. Any such damage must be repaired before putting the plant in operation.

ENGINE

Prior to spec D the engine is a Hercules series DD-149, and beginning spec D the engine is a series D-1500, which is described in the Hercules manual. The specific engine used may have variations due to optional features of the generator plant. Basically the engine is a 3 cylinder, water cooled, diesel (compression ignition) type. The cylinder bore is 3-3/4 inches, piston stroke is 4-1/2 inches, and displacement is 149 inches. The standard oil capacity is 6 U. S. quarts. A 12 volt battery is used for starting and control circuits. Accessories, safety devices, indicating gauges, etc vary according to the model or purchased options.

GENERATOR

The alternating current generator is a revolving armature, self excited, inherently regulated type. Close regulation of voltage at all loads is the result of the inherent design, using a saturated shunt wound field. The generator is a 4 pole type, with the armature connected directly to the engine flywheel. Speed is approximately 1800 rpm for 60 cycle plants, and 1500 rpm for 50 cycle plants.

CONTROLS

The engine controls for a standard plant include 12 volt automotive type starting and battery charging circuits with necessary relays, and a charge rate ammeter. A water temperature gauge, lubricating oil pressure gauge, and high water temperature safety shut-off switch are provided. A manually controlled intake manifold heater assists in cold weather starting. The generating plant is adaptable to the use of automatic line transfer control equipment (for emergency standby use) in installations where the ambient temperature will be above $50^{o}F$.

CONTROLS - (Cont'd)

The optional electrical instrument panel equipment varies according to the model. Instruments may include voltmeter, ammeter, circuit breaker, and running time meter. Some models are equipped with output receptacles in addition to the standard terminals.

Installation of the plant involves its location, mounting, connection of fuel lines, exhaust line, starting battery installation, and connection to the load wires. Each installation presents its individual problems. Use these instructions as a general guide.

LOCATION. - In the average installation, the location has been pre-determined. Local codes or other regulations may determine some details. For standby service a warm, indoor site is usually required.

The location should be dry, well ventilated, and reasonably dust free. For standby service, locate near the main line switch box. Provide sufficient clearance on all sides (24 inches recommended) for convenience in servicing.

MOUNTING. - Refer to the installation outline drawing. The plant is mounted on a rigid base that provides proper support and adequate vibration dampening. However, for convenience in draining oil, mount the plant on a raised platform or pedestals 6 inches or more in height. For trailer or other mobile use, bolt securely in place. For permanent installations, bolting in place is optional.

VENTILATION. - The generator plant generates a considerable amount of heat that must be dissipated by proper ventilation. The engine heat is transferred to the cooling water that circulates through the radiator. A pusher fan forces cooling air out through the front of the radiator. The generator is directly air cooled by a blower wheel that draws air through the generator.

Under normal operating conditions, approximately 2,000 cubic feet of air per minute will provide proper cooling. In a small room installation, this may require installation of an auxiliary fan connected to operate at any time the plant is running. The usual method of exhausting heated air is to construct a duct from the front of the radiator to an outside wall. In cold climates, provision must be made to prevent any back-flow of cold outside air during periods of shut down. This may require automatic shutters for a standby installation. The room air outlet opening should be at least as large as the plant radiator area. A separate room or compartment air inlet opening is necessary, of at least equal area.

EXHAUST. - For indoor installations, pipe the exhaust gases outside the enclosure. Use pipe at least as large as the 1-1/2 inch pipe size outlet of the engine. Increase the pipe diameter one size for each additional 10 feet in length. Use a flexible connection to the engine exhaust manifold. Avoid using sharp elbow turns - use sweeping type elbows to keep back pressure to a minimum. If the exhaust line runs upward at any point, install a vapor trap at the low point, with provision for periodic service. Protect walls, partitions, etc. through which exhaust lines pass with a metal thimble having the dimensions shown in Figure 1. Install a suitable muffler at the end of the line.

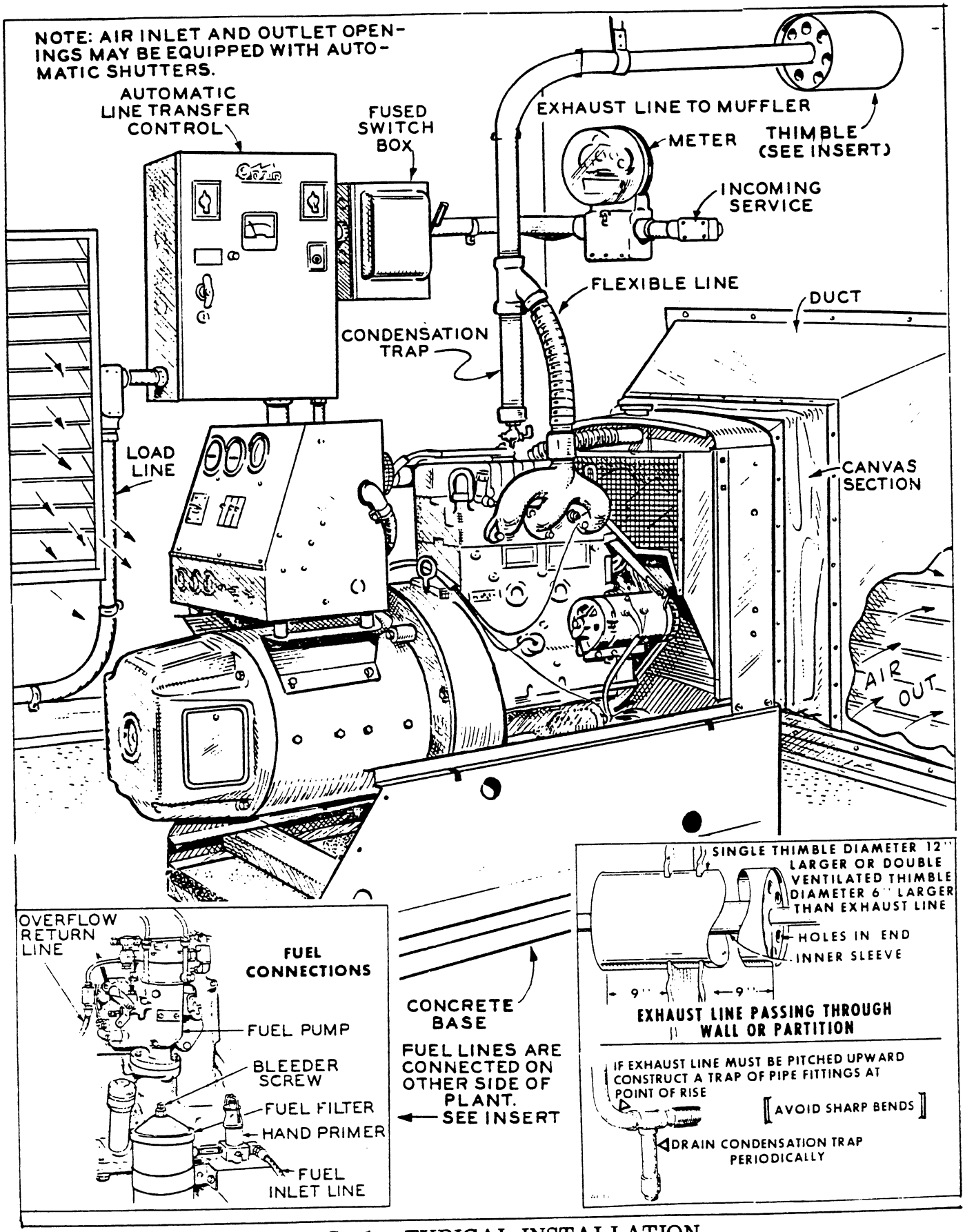

FIG. 1 - TYPICAL INSTALLATION

FUEL CONNECTIONS - If a separate fuel supply tank is to be installed, be sure to comply with any local regulations regarding such installations. The tank must have a supply line for fuel flow to the plant, and a second line for excess fuel to return to the supply tank.

NOTE

In any diesel engine installation, fuel system cleanliness is of utmost importance, and can not be over emphasized. Make every effort to prevent entrance of any contaminating matter of any kind. Do not use lines or fittings of galvanized material.

The maximum lift of fuel, without any horizontal run, should not exceed 3 feet. Horizontal run, if the fuel supply tank is level with the engine pump, should not exceed 25 feet. If the installation requires a considerable lift combined with a lengthy horizontal run, an auxiliary electrically operated booster pump should be installed. Use 1/2 inch tubing for the supply line, 3/8 inch tubing for the return.

The fuel supply inlet on the engine is threaded for a 1/4 inch pipe fitting, and the over flow or return opening is threaded for a 1/8 inch pipe fitting. Use care to see that there is no possibility of an air leak in the supply line connections.

BATTERY. - A 12-volt heavy duty battery (at least 72 amp. hr. rating) is recommended. Connect the battery positive post to the start solenoid cable on the engine starter, and the battery negative post to the grounded plant cable. Service the battery as necessary.

Infrequent use of the plant (as in emergency standby service) may allow the battery to self discharge to the point where the battery will not start the plant in an emergency. If a line transfer switch assembly that does not include a trickle charge circuit is used, a separate trickle charger should be connected.

CONNECTING THE LOAD WIRES. - The plant AC output terminals are located inside the control box, at the generator end of the plant. Knock out openings are provided for convenience in bringing the load wires into the control box.

All connections, wire size, etc. must conform to requirements of electrical codes in effect at the installation location. Most local regulations require that the installation be inspected and approved before operation. If the installation is for standby service, a double throw switch must always be used. This switch (either manual or automatic type) must be connected so that there is no possibility for the generator current to be fed into the commercial (normal source of power) lines, nor for the normal source and generator current to be connected at the same time. Instructions for connecting an automatic switch (line transfer control), or an automatic (demand type) control, are included with such equipment. It is assumed that personnel connecting the generator, and any such auxiliary equipment, are

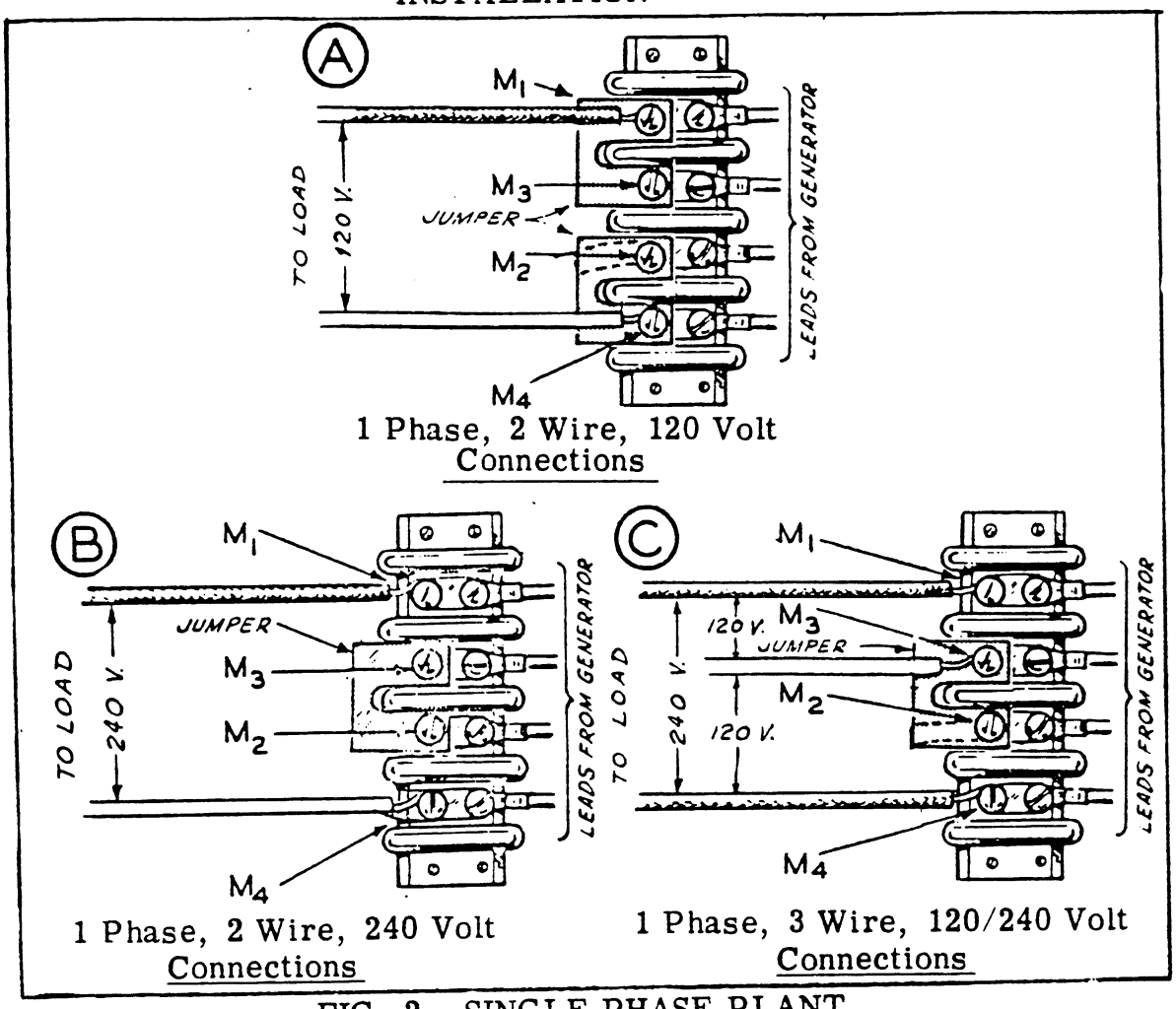

FIG. 2 - SINGLE PHASE PLANT

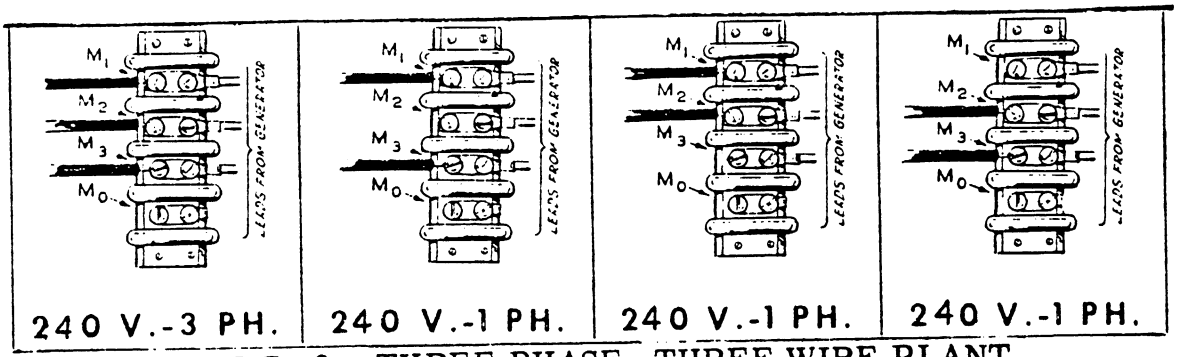

FIG. 3 - THREE PHASE, THREE WIRE PLANT

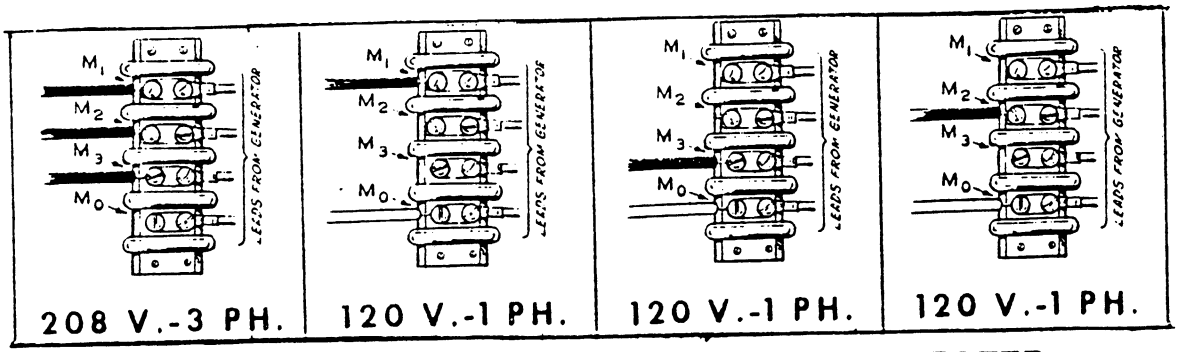

FIG. 4 - THREE PHASE, FOUR WIRE WYE CONNECTED

fully qualified and understand the problems of balancing the circuits, grounding - etc.

SINGLE PHASE PLANT

Some single phase plants are not equipped with circuit breakers, or electrical meters. Such single phase plants can be reconnected for either 120 volt 2 wire service, 240 volt 2 wire 1 side grounded service, or 120/240 volt 3 wire service. Install jumpers according to the type service desired. DO NOT CHANGE THE FACTORY JUMPER CONNECTIONS IF THE PLANT HAS A CIRCUIT BREAKER OR AC OUTPUT METERS, ETC.

For 120 volt 2 wire service, see that a jumper bar is installed between the plant output terminals M1 and M3, and a second jumper bar between terminals M2 and M4. Connect the "hot" (black) load wire to the M1 plant terminal. Connect the neutral (white) load wire to the M4 terminal. See Fig. 2, detail A.

For 240 volt 2 wire (1 side grounded) service, leave the jumper connected across terminals M3 and M2. Connect the (hot) black load wire to terminal M1. Connect the neutral (ground) white load wire to terminal M4. See Fig 2, detail B.

For 120/240 volt 3 wire service see that a jumper bar is installed between terminals M3 and M2. Connect the "hot" (black) load wires to terminals M1 and M4. Connect the neutral (white) load wire to the M3 or M2 terminal. Two separate 120 volt circuits are available, and one 240 volt ungrounded circuit. See Fig. 2, detail C.

3 PHASE, 3 WIRE PLANT

For 3 phase, 3 wire service, connect the load wires to the plant terminals M1, M2 and M3. The M0 plant terminal is not used. Refer to Fig. 3. Reversing the connections between any two terminals will reverse the direction of rotation of 3 phase motors.

If part of the load on a 3 phase generator is single phase, use care not to overload any one circuit. Remember that not more than 1/3 the rated capacity of the plant is available on any one circuit. For example, a 4000 watt, 3 phase load is connected to a 10,000 watt plant. This leaves a reserve of 6,000 watts. However, 1/3 of this 6000 watts (2,000 watts) is the limit of single phase load that can be connected to any one circuit. Three 2,000 watt single phase loads could be connected in this example.

3 PHASE, 4 WIRE PLANT (WYE CONNECTED)

The 4 wire plant supplies single phase current of one voltage, and 3 phase current of another voltage. The 3 phase current is the higher voltage shown on the plant nameplate.

The plant M0 terminal is grounded, and is the "neutral" single phase terminal. Connect the grounded load wire to the M0 terminal, and the "hot"load wire to any one of the plant terminals M1, M2, or M3. Three single phase circuits are thus available. The same load limitations apply as given for the 3 phase, 3 wire plant.

For 3 phase current, connect the load wires to the three terminals M1, M2, and M3. Refer to Fig. 4. Reversing the connections between any two terminals will reverse the direction of rotation of 3 phase motors.

3 PHASE, 4 WIRE PLANT (DELTA CONNECTED)

The 3 phase, 4 wire delta connected plant is designed to supply 120 volt, 1 phase current and 240 volt, 3 phase current. The M0 terminal is the generator center tap between M1 and M2; it normally is not grounded.

For 240 volt, 3 phase operation connect the three load wires to terminals M1, M2 and M3 — one wire to each terminal. The M0 terminal is not used for 3 phase.

For 120/240 volt, 1 phase, 3 wire operation, terminals M1 and M2 are the "hot" terminals. The M0 terminal is the neutral, which can be grounded if required. For 120 volt service, connect the "hot" (black) load wire to either the M1 or M2 terminal. Connect the neutral (white) wire to the M0 terminal. Two 120 volt. circuits are available. Any combination of single phase and three phase loading can be used at the same time as long as no terminal current exceeds the Nameplate rating of the generator.

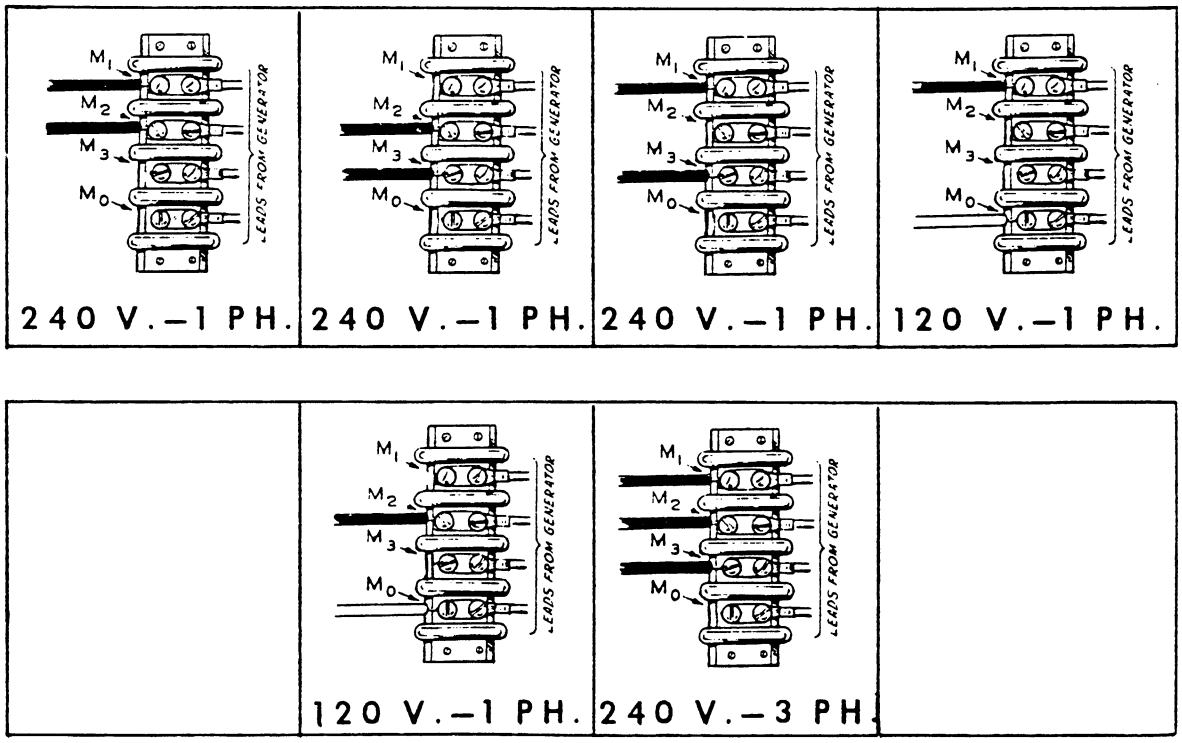

FIG. 4A - THREE PHASE, FOUR WIRE DELTA CONNECTED

REMOTE CONTROL CONNECTIONS. - A small 5 place terminal block, marked B+, 1, 2, 3, and H is located inside the control box. The B+ terminal is used only with automatic or line transfer equipment. Follow instructions supplied with such equipment. Terminals 1, 2, and 3 serve as extensions of the start and stop circuits. Connect terminal #1 to the unmarked remote control switch terminal. Connect terminal #2 to the "OFF" switch terminal, and terminal #3 to the switch terminal marked "ON". The distance between the plant and the remote control switch determines the size wire necessary. Use #18 wire up to 75 feet, #16 wire up to 135 feet, or #14 wire up to 215 feet. Plant terminal "H" serves as an extension of the manifold heater switch circuit. Use a momentary contact type switch, connecting one switch terminal to the plant "H" terminal, and the other switch terminal to the plant #1 terminal.

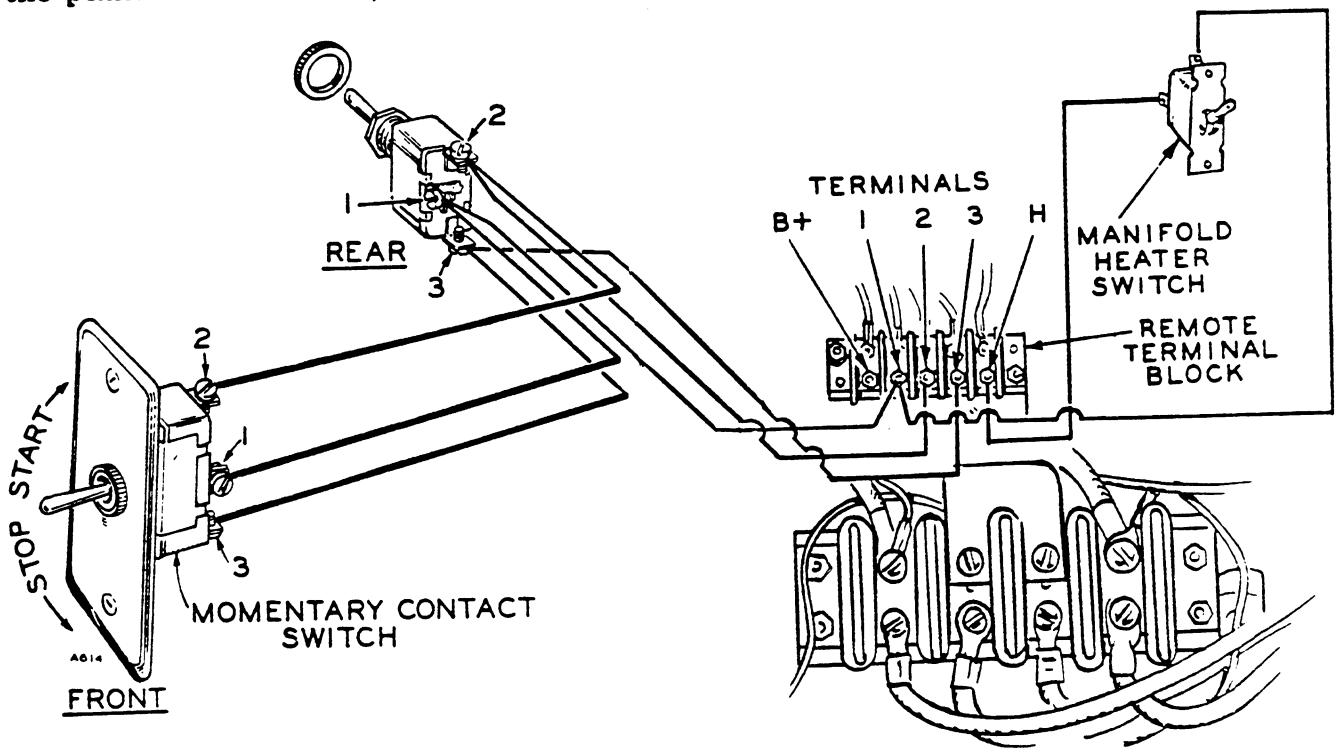

FIG. 5 - REMOTE CONTROL CONNECTIONS

CRANKCASE OIL. - Fill the crankcase with 6 quarts (U.S. measure) of a good quality, heavy duty oil designated by its manufacturer for "type DS" service.

Refer to the LUBRICATION section of the HERCULES engine manual for recommendations as to the SAE number of oil, when to change, etc. Approximately 1 quart of oil drains from the oil filter into the crankcase during shut down, so a level reading is accurate only if taken immediately upon stopping.

AIR CLEANER. - Service the air cleaner with oil, filling to the recommended level with oil of the same SAE number as used in the crankcase.

RADIATOR. - Fill the radiator with clean, soft water. Use a good rust and scale inhibitor. If there is any possibility of exposure to freezing, use a standard antifreeze in the recommended proportion. On the initial run, check the coolant level several times and add liquid as necessary to compensate for any air pockets which may have formed during the original filling. The approximate capacity is 10 U.S. quarts.

FUEL. - Refer to the Hercules manual for fuel oil specifications. Before the initial start, the fuel system must be properly primed and all air bled out of the fuel system.

1. Loosen the bleeder screw at the top of the fuel filter.

2. Operate the hand primer until the fuel flows from the bleeder. Tighten the bleeder screw securely.

3. Temporarily disconnect the overflow (return) fuel line. Continue to operate the hand primer pump until at least one pint of fuel has been pumped from the overflow opening. Failure to hand prime long enough will result in an air lock condition and cause the engine to stop soon after starting.

4. Tighten the primer pump clamp securely.

5. Reconnect the overflow line.

STARTING. - Always be sure the fuel system is air free, as directed under PREPARATION, if fuel lines have been disconnected, or if fuel has been exhausted. For normal starts, no further priming is necessary.

For starting in temperatures above 50° F., press the START-STOP switch to its START position, holding in contact to crank the engine. The engine should start with a few seconds of cranking. Investigate any failure to start - do not crank for more than 30 seconds.

If the ambient temperature is between 50° F. and -10° F., hold the MANIFOLD HEATER switch in contact for from 30 to 60 seconds, depending upon the temperature. Continue to hold the heater switch in contact while cranking. Experience will soon indicate how much preheating is necessary.

For starting in temperatures below -10° F., be sure the fuel has a pour point well below the prevailing temperature. The fuel supplier is responsible for providing a fuel suitable for the temperature conditions - free of wax, etc. Drain, preheat, and refill the engine coolant and crankcase oil. If practicable, keep the battery in a warm location during shut down and reconnect just before starting.

CHECKING OPERATION. - As soon as the engine starts, always check the oil pressure. Normal oil pressure is 30 to 45 lbs. at operating temperature, but will be considerably higher until the engine warms up.

The water temperature gauge indicates the coolant temperature during operation. Normal operating temperature is approximately 190° F.

The small DC ammeter indicates the battery charging current. An automatic regulator controls the charging rate, and it will vary according to the charge condition of the battery. Normal charge rate is 5 to 10 amperes when the plant first starts. The rate should fall to almost zero as the battery becomes fully charged.

STOPPING. - If conditions permit, disconnect electrical load and allow the plant to run a few minutes at no load. This will allow the plant to cool off slightly and may prevent an excessive temperature rise when the plant stops and ventilation ceases. Press the START-STOP switch to its STOP position to stop the plant.

HIGH WATER TEMPERATURE. - If the engine coolant temperature rises to a dangerously high point, a thermostatic switch actuates the stop circuit and stops the plant. Correct the condition that caused the high temperature. The coolant temperature must drop approximately 10° F. before the plant can be started again. The high water temperature switch acts through the EMERGENCY STOP RELAY, and the PUSH TO RESET button must be pressed to restore normal operation.

OPTIONAL EQUIPMENT

Some plant models are equipped with electrical indicating meters, running time meter, circuit breakers, low oil pressure stop switch, etc. Such equipment varies according to purchaser options, or plant model.

AC AMMETER. - The ac ammeter indicates the amount of load connected to the generator circuit. On three phase models, the current shown will be for one phase only, according to the position of the selector switch.

AC VOLTMETER. - The ac voltmeter indicates the voltage of the ac output. On three phase models, the voltage shown will be for the same phase as the amperage shown, according to the position of the selector switch. On a four wire, three phase model, the voltage shown will always be the three phase (higher) nameplate voltage.

METER SELECTOR SWITCH. - The meter selector switch is provided on three phase models. The position of its handle indicates the phase of the generator output that is indicated on the ac ammeter and voltmeter.

RUNNING TIME METER. - The running time meter registers the total number of hours, to 1/10th, that the plant has run. Use it to keep a record of periodic servicing.

CIRCUIT BREAKER. - The circuit breaker is a safety device to protect the generator against damage from an overload. If an overload should occur, the circuit breaker will automatically trip, disconnecting the generator output from the load terminals. After correcting the overload condition, it is necessary to manually reset the breaker to the ON position.

LOW OIL PRESSURE. - In case of engine low oil pressure, the EMERGENCY STOP RELAY acts to stop the plant. After correcting the cause of the low oil pressure, press the PUSH TO RESET button before restarting the plant.

BATTERY, HOT LOCATION. - Batteries will self discharge very quickly when the ambient temperature is consistently above 90^{O}F., such as in a boiler room. To lengthen battery life, dilute the electrolyte from its normal 1.275 specific gravity reading at full charge to a 1.225 reading. The cranking power of the battery will be reduced slightly when the electrolyte is so reduced, but if the temperature is above 90^{O} F. this should not be noticed, and the lengthened battery life will be a distinct advantage.

1. Fully charge the battery.
2. With the battery still on charge, draw off all the electrolyte above the plates in each cell. DO NOT ATTEMPT TO POUR OFF! Use a hydrometer or

filler bulb. Avoid skin or clothing contact with the electrolyte, and dispose of it in a safe manner.

3. Refill each cell with approved water, to the recommended level.
4. Continue charging for 1 hour at a 4 to 6 ampere rate.
5. Test each cell. If the specific gravity is still above 1.225, repeat steps 2, 3, and 4 until the reading is reduced to 1.225. usually, repeating steps 2, 3, and 4 two times is sufficient.

EXCERCISE PERIOD. - If the plant is used infrequently, such as in standby service, start and operate for 15 to 30 minutes at least once a week. This excercise period keeps oil distributed on engine parts, fuel system full, etc., and promotes easier starting.

NO LOAD OPERATION. - Periods of no load operation should be held to a minimum. After about 4 hours of continuous no load operation, the injection nozzles may become fouled enough to require servicing. If it is necessary to keep the engine running for long periods of time when no electrical output is required, best engine performance will be obtained by connecting a "dummy" electrical load. Such a load could consist of heater elements, etc.

GENERAL. - Follow a definite schedule of inspection and servicing, based on operating hours. Keep an accurate record of operating time. Use the running time meter (optional equipment) to keep a record of operation and servicing. Service periods outlined below are for normal service and operating conditions. For continuous duty, extreme temperature, etc., service more frequently. For infrequent use, light duty, etc., service periods can be lengthened accordingly. Refer to the Hercules engine manual for details of engine service operations.

DAILY SERVICE, NORMAL 8 HOURS OF OPERATION.

1. FUEL OIL. - Check, replenish as necessary.
2. CRANKCASE OIL. - Check level, add as necessary.

NOTE

Check the oil level immediately after stopping, before oil in the filter drains back into the crankcase. Drain sediment off.

3. AIR CLEANER. - Check, clean, replenish oil as frequently as necessary.
4. RADIATOR. - Check level, add as necessary.
5. CLEAN AND INSPECT. - Wipe clean of dust, spilled oil, etc. Inspect for loose parts, leaks, etc.

WEEKLY SERVICE, NORMAL 50 HOURS OF OPERATION.

1. CRANKCASE OIL. - Drain and refill unless experience indicates otherwise. Refer to LUBRICATION in the Hercules manual.
2. OIL FILTER. - Replace the element at time of oil change. Use a Purolator #P-70FF replacement element.

SEMI-MONTHLY SERVICE, NORMAL 100 HOURS OF OPERATION.

1. CRANKCASE BREATHER. - Clean and inspect.
2. FAN BELT. - Inspect and adjust - 1/2 inch play. Use ONLY Onan replacement belt #511P60 (Gates Rubber Co. #8256), except spec A models use 511K63 belt and pulley replacement kit.
3. FUEL FILTER. - Drain sediment. Reprime.
4. COOLING SYSTEM. - Check for rust or scale formation.

MONTHLY SERVICE, NORMAL 200-250 HOURS OF OPERATION.

1. CHARGE GENERATOR. - Oil bearings sparingly, check brushes.
2. STARTER. - Oil front bearing sparingly, check brushes.
3. INJECTION NOZZLE. - Check for proper spray pattern, etc. Refer to the Hercules manual.
4. AC GENERATOR. - Check brushes, replace if worn to 1/2 inch or if damaged. DO NOT LUBRICATE.

GENERATOR

GENERAL. - The generator normally requires little maintenance other than the regular PERIODIC SERVICE operations, which should never be neglected. Some generator tests are simple to perform, do not require major disassembly, and require only a continuity type test lamp set. Other tests require special equipment and extensive disassembly of the generator. Partial disassembly, and removal of the generator is necessary in order to make certain engine repairs.

GENERATOR REMOVAL. - To disassemble the generator for removal, first remove the brush springs and brushes. Disconnect field coil and other lead wires which connect to the brush rig, to permit removal of the end bell and brush rig as an assembly. Be sure to tag each wire and its connection point as it is disconnected, to assure correct reconnection.

After removing the end bell mounting screws, carefully tap the end bell straight backward to free it from the armature bearing. Provide blocking under the main frame. Remove the screws that attach the generator frame to the engine rear, and carefully pull the frame assembly straight back over the armature. Use care not to allow the frame to drag or catch on the armature laminations.

To remove the armature, carefully block up the armature and remove the screws mounting its drive disc to the engine flywheel. Slide the armature away from the engine.

COMMUTATOR AND COLLECTOR RINGS. - The mica insulation between the commutator bars, or segments, was originally undercut to a depth of 1/32 inch below the commutator surface. After a long period of service, the surface of the commutator may become worn down level with the mica. This condition would cause noisy brushes, sparking of the brushes, and pitting of the commutator. The mica should again be undercut to 1/32 inch depth. Remove the brush springs and pull all the brushes out of the guides. After tagging any leads disconnected (to assure correct reconnection) remove the end bell. With a mica undercutting tool, or an improvised tool fashioned from a hack saw blade (Fig. 6), carefully cut the mica between all of the commutator bars down to the 1/32 inch depth. Use care to avoid scratching the surface. Remove any burrs which may be formed along the edges of the bars, and clean all spaces between bars completely free of any metallic particles, Fig. 7 .

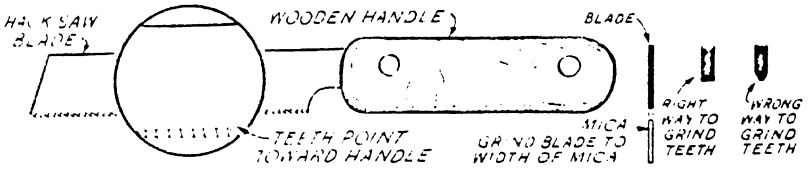

FIG. 7 - MICA UNDERCUTTING TOOL

If some unusual operating condition should cause the surface of the commutator or collector rings to become grooved, out of round, pitted, or rough, it will be necessary to remove the armature and turn the damaged commutator or collector rings in a lathe, to "true" the surface. Before centering the armature in the lathe, remove the ball bearing to prevent getting any dirt into it. After turning smooth, be sure to undercut the commutator mica as previously described. When the armature is reinstalled, reduce the run-out at the bearing end as much as possible before installing the end bell.

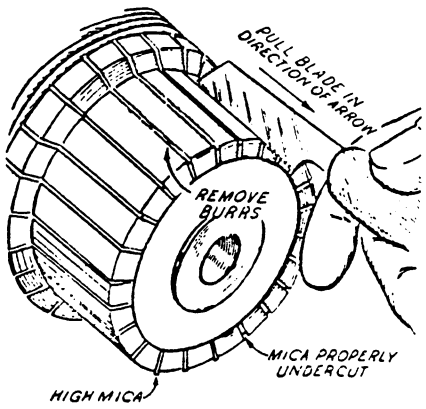

FIG. 8 UNDERCUTTING MICA

BRUSH RIG. - It is unnecessary to loosen or remove the brush rig from the end bell for average generator servicing. However, if the brush rig has been loosened or removed for any reason, the brush rig must be returned to its exact original position. This original position was marked at the factory in the test run and must be maintained as long as the original brush rig and armature are continued in service. The position can be identified by a mark across the outer edge of the brush rig supporting ring, which mark must align with the marked support in the end bell. Improper positioning of the brush rig will cause excessive arcing of the brushes, burning of the commutator, low generator output, and possible serious damage to the generator windings from over-heating.

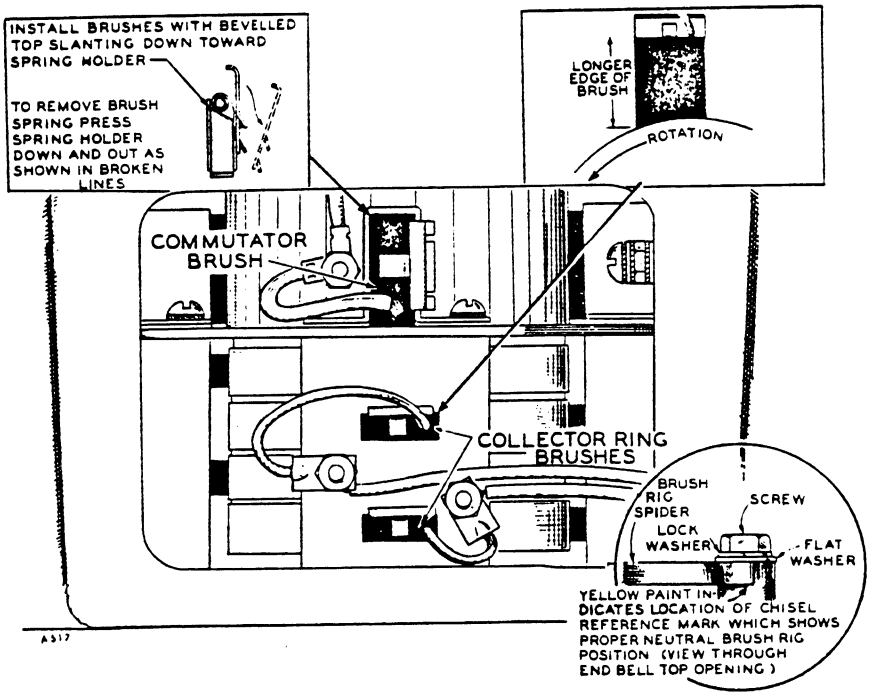

FIG. 9 - BRUSH RIG

GENERATOR WINDINGS TEST PROCEDURE

Some generator tests do not require complete disassembly of the generator, and can be performed with the use of a continuity type test lamp set. Other tests require extensive generator disassembly and the use of an armature growler or other equipment usually found only in an electrical repair shop.

NOTE:

> Individual coils of the field coil set can be installed. Proper installation of individual coils can best be done by a qualified service shop.

It is seldom practicable to make internal repairs of generator windings. However, an external lead wire can be repaired as necessary.

FIELD COIL TESTS

To test the field coils for an open circuit or a grounded circuit, use a test lamp set. As each lead wire is disconnected, tag it and its connection point, to assure correct reconnection.

OPEN CIRCUIT TEST. - To test for an open circuit, connect one test lamp lead to the F+ coil terminal, and the other test lamp lead to the F - coil lead. If the test lamp fails to light, an open circuit in the shunt winding is indicated.

If an indicated open circuit can not be isolated in an external lead, or in a loose terminal, a more thorough test of individual coils will be necessary. Consult a qualified service shop.

GROUNDED CIRCUIT TEST. - To test the field windings for a grounded circuit, connect one test lamp lead to a bare metal part of the generator frame. Connect the other test lead to the coil terminal F+. If the test lamp lights, a grounded circuit is indicated. If inspection locates the ground in an external lead, repair as necessary. To locate a grounded coil, remove the screws mounting one of the pole shoes to the generator frame. Push the pole shoe and coil away from contact with the frame. If the ground is thus eliminated (test light goes out), the ground has been isolated at the loosened coil. Repeat as necessary until the grounded coil is located. Usually, the grounded point of the coil can be easily identified and the insulation repaired at the point of damage.

SHORT CIRCUIT TEST. - A short circuit test requires the use of special equipment and testing of individual coils. A sensitive ohmmeter can be used to test the resistance of each coil winding. If one coil winding shows an ohmmeter reading of more than 10% LESS than average reading of the other three coils, that coil is short circuited.

ARMATURE TESTS

The armature is wound with two separate windings, dc and ac. The dc winding produces direct current for exciting the field. The ac winding produces the alternating current output of the generator. Replace a defective armature with a new one.

GROUNDED CIRCUIT TEST. - Use a test lamp set to test both armature windings for a grounded circuit. Connect one test lamp lead to a bare metal point on the armature shaft. Contact the other test lead to the commutator surface. If the test lamp glows, the dc portion of the armature is grounded. Repeat the test, contacting the collector rings. If the test lamp glows, the ac portion of the armature is grounded. Replace a grounded armature with a new one.

AC WINDING, OPEN CIRCUIT TEST. - Use a test lamp set to test the ac winding for an open circuit. If the generator is the 115/230 volt, single phase model there are TWO ac windings. Contact the test lamp leads to the two collector rings nearest the ball bearing. If the test lamp fails to light, an open circuit in that winding is indicated. Repeat the test in the same manner, contacting the two collector rings nearest the commutator. If the test is made between the two middle collector rings, the test lamp should not glow - if it does, a short circuit between the two windings is indicated.

If the generator is a 3 phase, 3 wire model, contact one test lead to the collector ring nearest the commutator (no winding is connected to the ring next to the bearing). Contact the other test lead to the next two collector rings, in turn. If the test lamp fails to light on either test, an open circuit is indicated.

If the generator is a 3 phase, 4 wire model, contact one test lead to the collector ring nearest the bearing. Contact the second test lead to each of the next 3 collector rings, in turn. If the test lamp fails to light on any of the 3 tests, an open circuit is indicated.

AC WINDING, SHORT CIRCUIT TEST. - An armature growler is required for making an ac winding short circuit test. Follow the test procedure recommended by the growler manufacturer.

DC WINDING, OPEN OR SHORT CIRCUIT TEST. - An armature growler is required to make a satisfactory test. Follow the test procedure recommended by the growler manufacturer.

CONTROL BOX EQUIPMENT

The control box equipment requires no maintenance other than keeping it dry, free of dust, and all connections electrically tight. If any of the control box equipment fails to function properly, replace the defective part with a corresponding new part. Repairs or adjustments on such parts are seldom practicable.

Always disconnect the starting battery before working on any control box equipment. Tag or otherwise mark each lead and its connection point before disconnecting it, to assure correct reconnection. Check carefully for loose or broken connections, or for damaged insulation.