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INSTRUCTION MANUAL

FOR

Onan®

ELECTRIC GENERATING PLANTS

DSL

SERIES

DIRECT CURRENT MODELS

ALTERNATING CURRENT MODELS

DUAL PURPOSE MODELS

ONAN 1400 73RD AVENUE N.E. • MINNEAPOLIS, MINNESOTA 55432
A DIVISION OF ONAN CORPORATION

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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, to the original user, that each product of its manufacture is 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 one year 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 above warranty supersedes and is in lieu of all other warranties, expressed or implied, and of all other liabilities or obligations on part of Manufacturer. 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.

DATED August 1, 1963

IMPORTANT

RETURN WARRANTY CARD ATTACHED TO UNIT

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.

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
DAILY AVERAGE	1 Hr.	41 Miles
	4 Hrs.	164 "
	6 "	246 "
	8 "	328 "
WEEKLY AVERAGE	7 "	287 "
	28 "	1,148 "
	42 "	1,722 "
	56 "	2,296 "

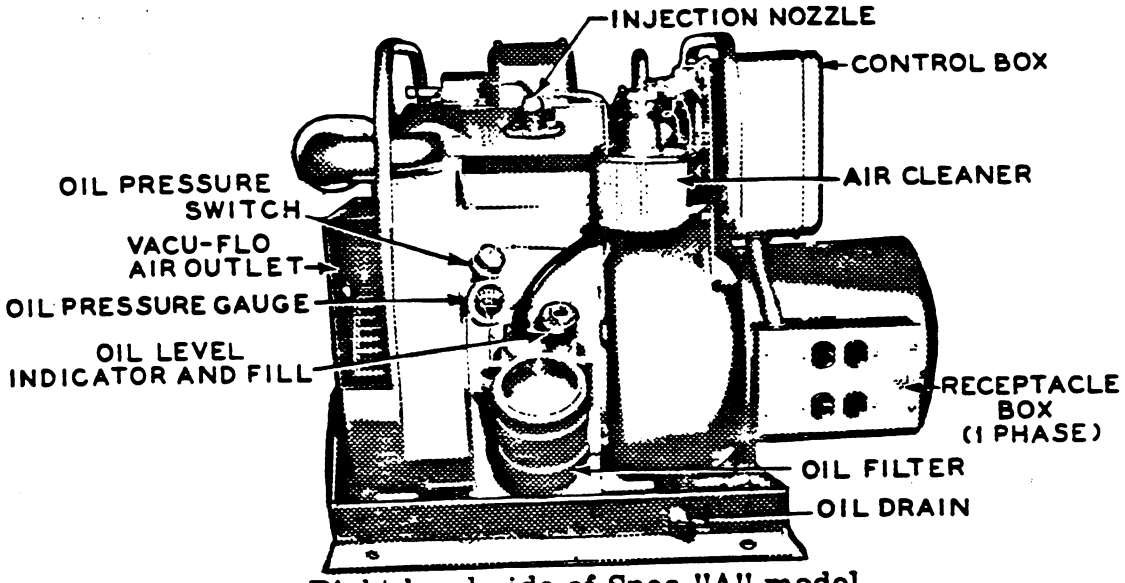
	GENERATING PLANT RUNNING HOURS	AUTOMOBILE RUNNING MILES
MONTHLY AVERAGE	30 Hrs.	1,230 Miles
	120 "	4,920 "
	180 "	7,380 "
	240 "	9,840 "
YEARLY AVERAGE	365 "	14,965 "
	1,460 "	59,860 "
	2,190 "	89,790 "
	2,920 "	119,720 "

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.

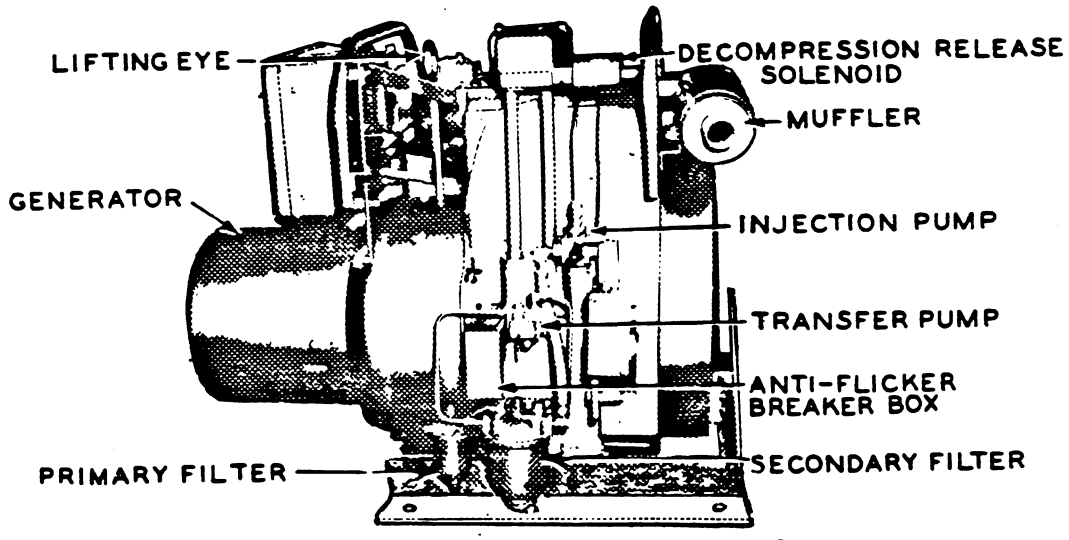
INTRODUCTION

The ONAN DSL Series Diesel powered electric generating plants to which this manual applies are complete electric generating plants. Each plant includes an engine, generator, and necessary accessories. Each plant is thoroughly tested before leaving the factory to assure that all parts are in good condition and that each plant will produce its rated output.

The manual contains instructions on installing, operating, servicing, adjusting, and repairing your plant. Read all instructions carefully. Correct installation, operation, and servicing are important in assuring long life operation. Disregarding these instructions may lead to unnecessary trouble and expense.



- Right hand side of Spec "A" model -



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SINGLE CYLINDER
DIESEL ELECTRIC GENERATING SET
(Views with Rain Hood removed)

DETAILS

The engine is a 4 cycle; vertical single cylinder; 3-1/2 inch bore; 3-1/2 inch stroke; air cooled (Vacu-Flo type); full Diesel engine.

The main and connecting rod bearings are pressure lubricated. The speed is governor controlled. The fuel system has primary and secondary fuel filters. The circulated air is discharged through a single duct. To aid starting, an induction air heater and a glow plug are used.

The generator is of the four pole type, self-excited, saturated field, inherently regulated, revolving armature type, direct connected to the engine. Generator output rating ranges from 2.5 to 3 KW at unity power factor, depending on the voltage and speed characteristics of the model in question. The generator acts as a cranking motor.

The mounted control box contains the necessary operating controls and instruments.

TYPES OF PLANTS

Standard models of the alternating current plants, dual purpose plants, and battery charging plants are covered in this manual. These plants differ mainly in the type of current generated. Where standard model differences in connecting. installing and servicing occur, they will be treated separately.

This instruction manual is supplied with all generating plants of the DSL series. Instructions apply specifically to the standard models. Some special installation or operating conditions may require the operator of this plant to modify these instructions. If the plant has optional equipment, a corresponding specification number appears in its model designation. Some details do not apply to special models. However, by following as closely as possible the recommendations as given in this book, the operator should have no difficulty in making a good installation and in properly operating the generating plant. If the special difference is electrical, refer to the special wiring diagram for that plant rather than the wiring diagrams shown in the rear of this manual.

ALTERNATING CURRENT PLANTS. - Plants of the alternating current type produce their full rated capacity in alternating current (ac) plus 150 watts of direct current (dc) which is used for battery charging purposes. The plant must be operated whenever alternating current is used. A small auxiliary load may be taken from the starting battery for short periods of time while the plant is idle. Always have the battery connected when operating the plant.

The main difference between the 50 cycle plant and the 60 cycle plant 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.

DUAL PURPOSE PLANTS. - Plants of the dual purpose type produce 120 volt alternating current and 32 volt direct current. The total capacity of 3000 watts may be taken from the plant in alternating current or up to 750 watts may be taken in direct current and the balance of 2250 watts in alternating current. Alternating current is supplied directly to the load from the generator and the plant must be operated whenever alternating current is used. Direct current is supplied directly to the load from the battery and direct current 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. The battery specific gravity should be checked at frequent intervals during HIGH charge rate operation. As the battery reaches a fully charged condition the operator must snap the charge rate switch to LOW position. CONTINUOUS OPERATION AT HIGH CHARGE RATE AFTER THE BATTERY IS FULLY CHARGED WILL BURN UP THE BATTERY.

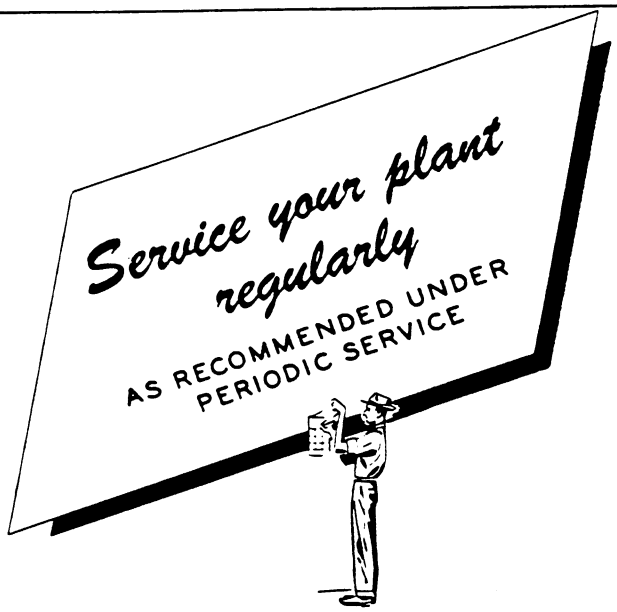
BATTERY CHARGING PLANTS. - Plants of the battery charging type are operated to generate electricity which is supplied directly to the storage battery. Electricity may be used while the plant is running or, as limited by the charge in the battery, while the plant is not running. NEVER OPERATE THIS TYPE OF PLANT WITHOUT HAVING THE BATTERY CONNECTED. AS THE BATTERY BECOMES CHARGED, THE OPERATOR MUST TURN THE RHEOSTAT TO THE LOW CHARGE RATE POSITION. CONTINUOUS OPERATING AT HIGH CHARGE RATE AFTER THE BATTERY IS FULLY CHARGED WILL BURN UP THE BATTERY. Repeated adjustment of the rheostat to gain a tapering off charge rate is desirable.

AVOID BATTERY "BURN UP"!

CONTINUOUS OPERATION AT HIGH CHARGE RATE WHEN THE BATTERY IS FULLY CHARGED, MAY "BURN UP" THE BATTERY !

THE BATTERY INTERNAL RESISTANCE INCREASES AS THE BATTERY REACHES A FULLY CHARGED CONDITION, CAUSING A DESIRABLE TAPERING OFF CHARGE RATE. HOWEVER, THE BATTERY SPECIFIC GRAVITY MUST BE CHECKED FREQUENTLY DURING OPERATION AT HIGH CHARGE RATE.

THE PLANT MAY BE OPERATED AT LOW CHARGE RATE WITHOUT DAMAGING A FULLY CHARGED BATTERY.



GENERAL. - Proper installation of the Diesel powered electric generating plant is essential for satisfactory performance.

The following instructions should be followed as closely as possible. If the instructions cannot be followed as given, use them as a guide and make the best installation that conditions permit.

LOCATION. - The location selected for the plant should be as near to the center of the electrical load as practicable. For example, if several buildings are to be serviced with electricity it is much better and costs less to run lines from a central point to each of the buildings than to run lines from one building to another. Not only will the voltage drop from the plant to load be less but smaller wire can be used to carry the same current without much voltage loss between the plant and the point of service.

The enclosure should be clean, dry, well ventilated, and if necessary. heated in cold weather.

VENTILATION AND COOLING. - There must be a constant supply of fresh air for cooling the plant. Cooling air travels from the rear of the plant, through the generator and over the engine cooling surfaces, and is blown out through a 2-1/2 x 8 inch outlet at the front end of the plant. The outlet usually faces horizontally right, but can be rotated in steps of 45 degrees to right or left limited only by the floor, plant base or hood.

In a large room, or out doors, cooling will be no problem. However, if the plant is installed inside a small room or compartment, provide separate air inlet and outlet openings. Consider the following factors.

To prevent recirculation of heated air, install a duct between the plant air discharge opening and the room or compartment outlet opening. The duct must be equal to or larger than the outlet area at the engine to duct the heated air outside of the compartment. Use a canvas section (flexible material) next to the engine housing to absorb vibrations. Factory test under high temperature conditions indicate satisfactory cooling using 20 square inch area ducting up to 9 feet in length and with no more than 2 radius type 90 degree elbows. Do not use square type elbows. Increase the duct size for longer lengths or if additional turns are necessary, so that back pressure will be minimized. If a louver or screen is required at the duct outlet, increase the size of the duct at the outlet or install the screen diagonally to attain a net open area equal to or greater than the duct area.

Locate the compartment air inlet opening where most convenient. This air inlet opening should be large enough so that air pressure inside the compartment is equal to air pressure outside the compartment. The exact size of the air inlet opening, as necessary for adequate cooling.

is dependent upon several possible variable conditions peculiar to the installation in question. The simplest way to determine whether or not the room inlet is large enough, is to compare the engine circulated air temperature rise with that given in the following table. Hold a thermometer in the air stream near the cylinder head and again at the air outlet scroll. Subtract the air-in temperature from the air-out temperature to determine the temperature rise. If the air temperature rise does not exceed the desired higher temperature given in the table for the respective ambient and load condition, then the supply of cooling air reaching the plant is enough. No damage will result from a lower than expected temperature rise. If operation of the plant in a normally heated room tends to drop the room temperature due to the rapid discharge of air, it may be permissible to install an adjustable register in the outlet duct to permit recirculation of some of the air heated by the engine.

The temperature rise limit given in the table is a goal to strive for and reasonable deviations are permissible. For 50 cycle (1500 rpm) plants the temperature rise will be a nominal 10 per cent lower than given in the table. Lower ambient temperatures also lower the temperature rise. Speeds above 1800 rpm will increase the temperature rise given.

- Table of Desired Nominal Air Temperature Rises at Given Loads -

Continuous Operation At	Rise with 75°F. Air-In	Rise with 110°F. Air-In
Full Rated Load	43 to 50°F.	48 to 55°F.
3/4 Rated Load	37 to 43°F.	41 to 48°F.
1/2 Rated Load	32 to 37°F.	35 to 41°F.
Less Than 1/2 Rated Load.	27 to 32°F.	30 to 35°F.

MOUNTING THE PLANT. - Provide a permanent mounting base of timber, concrete or structural steel. The base

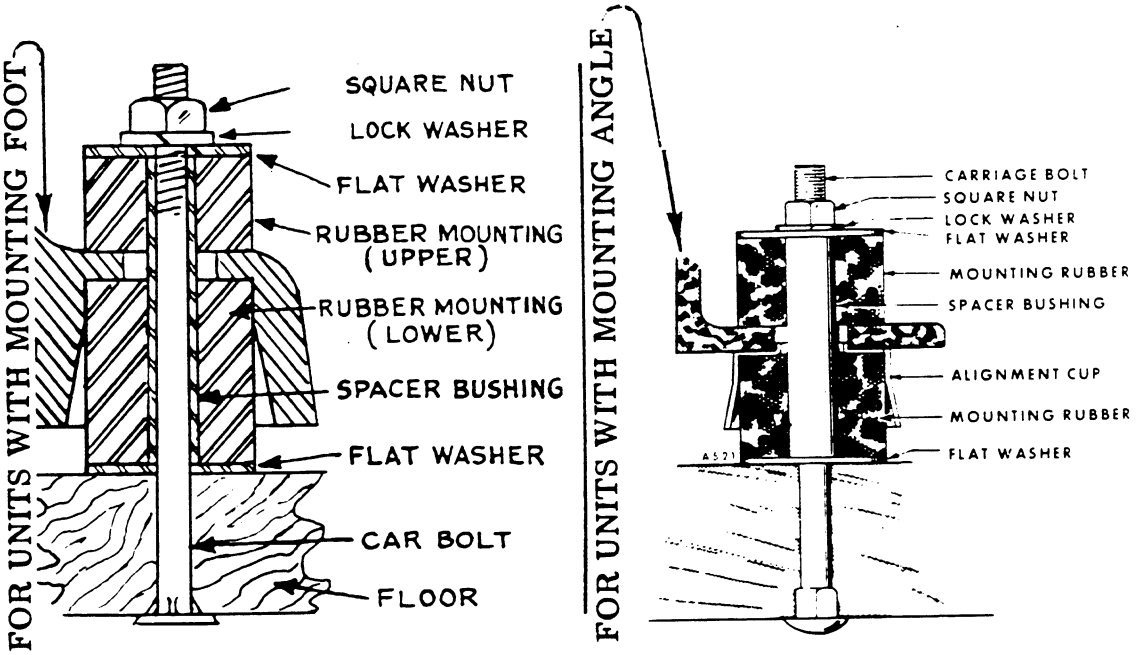


FIG. 1 - MOUNTING CUSHIONS

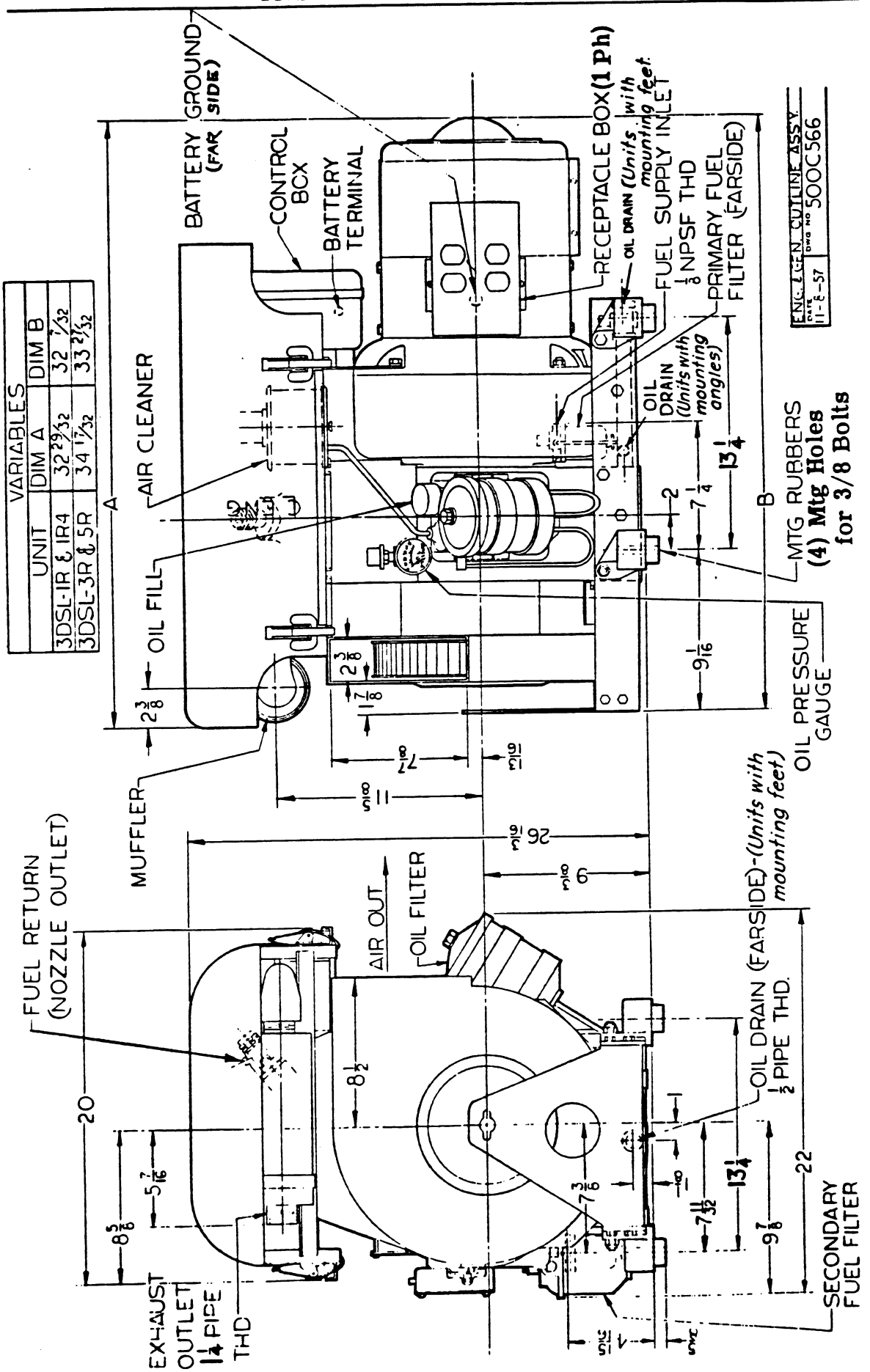


FIG. 2 - DIMENSIONAL OUTLINE

should be a nominal 12 inches or more high and located so that the plant will be accessible for operation and maintenance from all sides.

Use the four rubber mounting cushion assemblies to mount the plant on a permanent base. The rubber cushions help isolate plant vibrations. The metal spacer bushing prevents compressing the cushions when the nut is securely tightened. On units with steel mounting angles, the alignment cup installed between the plant and the lower cushion, centers the mount to prevent metal to metal contact.

Mounting hole centers in the plant base are 13-1/4 by 13-1/4 inches. Use four 3/8" diameter mounting bolts in the floor of the proper length so that(4-1/2" for units with mounting feet)(2-7/8" for units with mounting angles)extend above the floor to pass through the cushions, as illust.

EXHAUST LINE. - Pipe the exhaust gases outside the enclosure, using 1-1/4" pipe or larger. Increase the pipe size, one size for each additional 10 feet used. Support the line to avoid weight being carried by the plant. Use a flexible tubing between engine exhaust outlet and any pipe extension. The exhaust line should be shielded where it passes through a wall or near inflammable material. A thimble 12" larger than the exhaust line must be provided, extending 9" beyond wall or ceiling on each side. If the muffler is to be installed outside the enclosure, provide a suitable rain cap which will not restrict the flow of gases from the plant. If there is danger of personnel contact with the exhaust line, shield or cover with a suitable insulating material. Consult local regulations governing such exhaust lines.

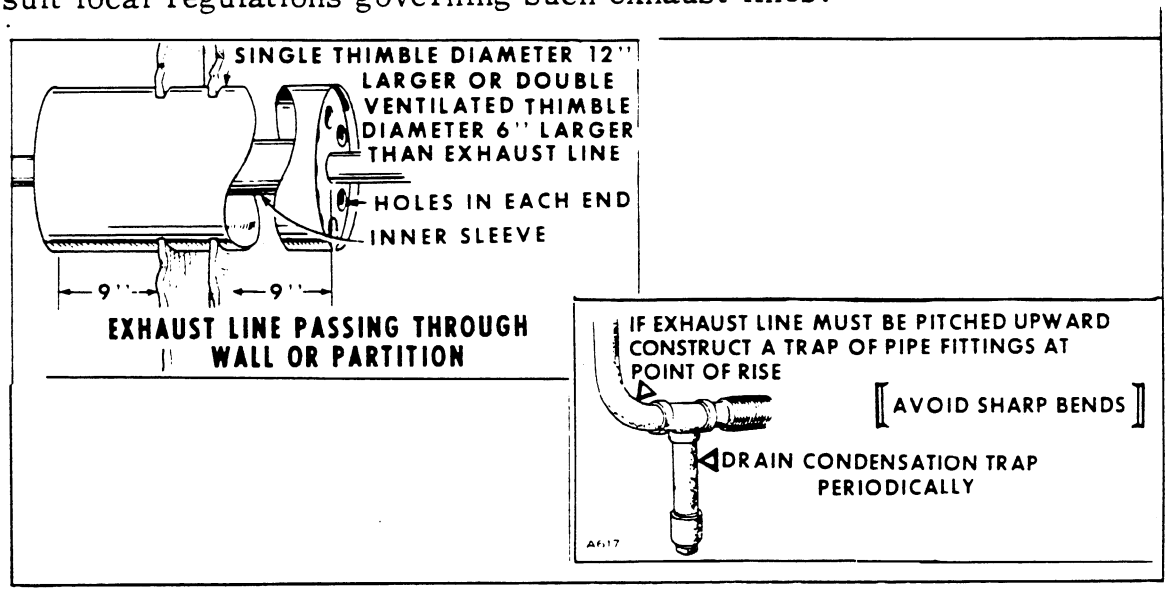


FIG. 3 - EXHAUST INSTALLATION

If the exhaust line must be pitched upward at any point construct a condensation trap of suitable pipe fittings and install it at the point the upward pitch begins.

FUEL TANK. - The fuel tank supplied with the plant should be installed so that the bottom of the tank is not more than 4 feet

below the transfer pump inlet. This distance also applies if a different tank is used. The tank must be within reach of the flexible fuel lines supplied unless additional line is installed.

If a larger fuel tank is to be used, be sure the fuel outlet is near the bottom of the tank and the opening for the return fuel line is in the top of the tank.

FUEL LINES. - Two flexible fuel lines are supplied with each unit, one for the suction line and the other for the return line. Use as few as possible joints, valves, etc. in the suction line to minimize fuel troubles. Valves which do not leak fuel have frequently been found to leak air in the fuel supply line.

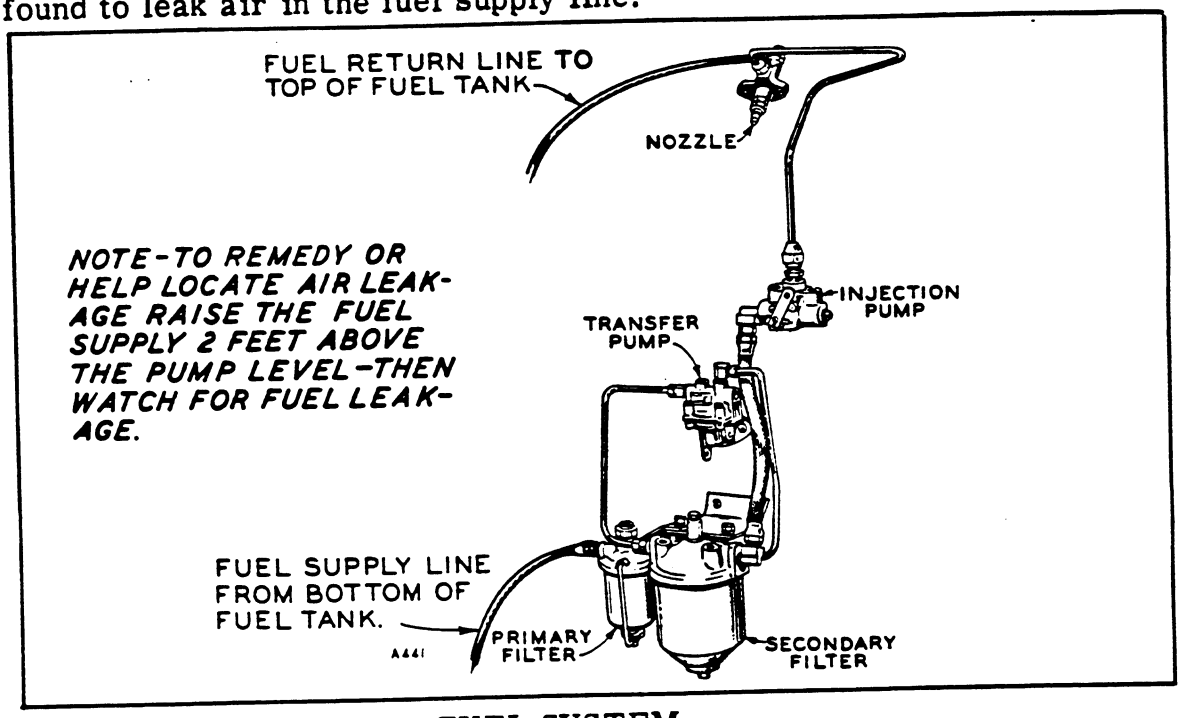


FIG. 4 - FUEL SYSTEM

These fuel lines must be installed between the plant and the fuel tank. However, solid lines may be used from the tank to a point near the plant and the flexible lines connected at this point. The suction line runs from the outlet on the fuel tank to the fitting on the fuel filter. The return fuel line runs from the fitting on the nozzle to the fitting on the top of the fuel tank. Make sure all connections are tight without applying too much pressure on the fitting. On the suction side of the fuel system use pipe thread compound on all connections having a pipe thread. Do not use compound on connectors or flared fittings. An air leak at any point in the suction side of the fuel system will cause hard starting and inefficient operation.

WIRING. - Use sufficiently large insulated wire to connect the load wires to the generator leads at the plant. The wire 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 a fused main switch in the load circuit near the plant. Refer to the wiring diagram for electrical connections.

CONNECTING THE LOAD (AC PLANTS). - Where connections are made by joining two wires always be sure to tape, or otherwise insulate, each connection thoroughly.

A. 1 PHASE, 2 WIRE OR 3 WIRE PLANTS. - Single phase plants are equipped with output receptacles. No preliminary connections are necessary. Connection is completed by a grounding type three prong load wire plug. The grounding prong serves to ground the load equipment to reduce shock hazard. The operator is prevented from plugging into the wrong voltage because the 120-volt output receptacle receives only a plug with parallel blades while the 240-volt output receptacle receives only a plug with blades in line.

B. 3 PHASE, 3 WIRE PLANTS. - Three output leads from the generator enter a junction box and are marked "M1", "M2" and "M3". Single phase, 240-volt current and three phase 240-volt current are obtainable. None of the leads are grounded.

It is advisable to install terminals on the leads from the load circuit breaker (or fused switch) so that a good solid connection can be made by bolting the leads together. Another method is to use solderless connectors. Properly insulate each wire-to-wire connection.

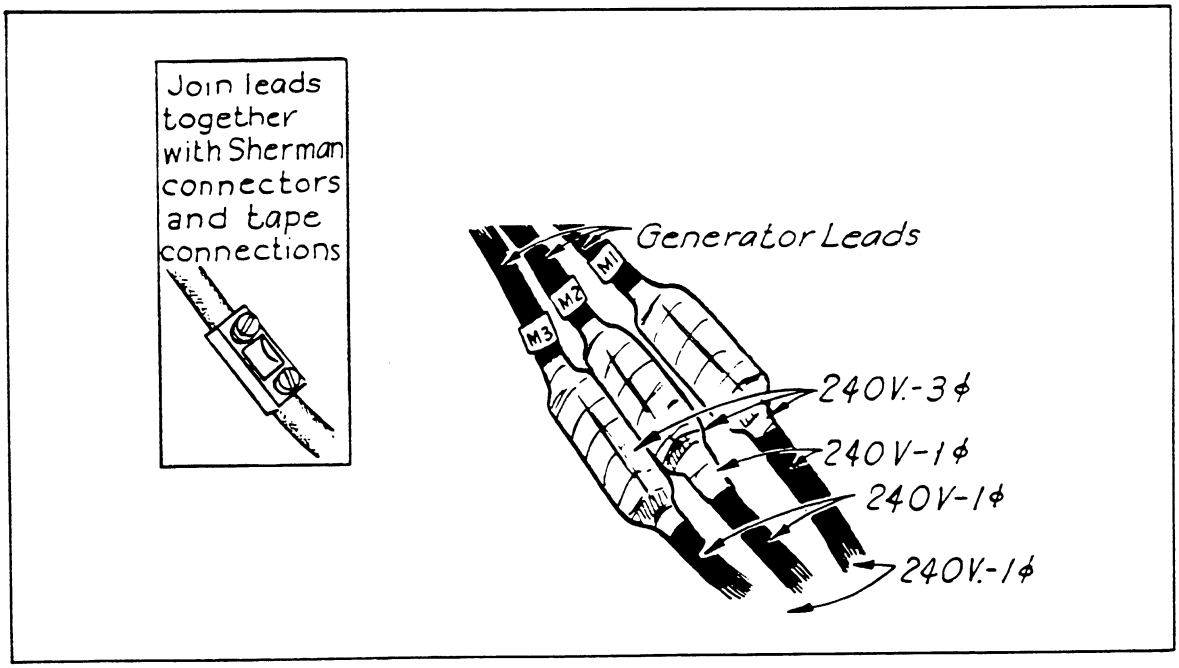


FIG. 5 - 3 PHASE - 3 WIRE LOAD CONNECTIONS

For a 3 phase, 3 wire circuit, connect one main line wire to each of the three output terminals of the fused switch or circuit breaker. If the direction of rotation of the connected load is not correct after the plant is started, reversing the connections between any two terminals will correct the directions of rotation. To assure in phase connections, use a phase sequence indicator.

Three, 240 volt, single phase circuits may be obtained by connecting the two load wires of each circuit to any two terminals as illustrated. 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 of the three circuits 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.

CONNECTING THE LOAD (Dual Purpose Plant, 120V. AC-32V.DC).- For connecting the 120 volts ac load, refer to the instructions as given for the single phase, two wire plant.

For connecting the 32 volt dc load, refer to the instructions as given for the 32 volt Battery Charging Plants.

CAUTION: Remember that a total of up to 750 watts of direct current and 2250 watts of alternating current may be used at the same time or divided in any proportion within the rated output limits of the generator. Maximum dc output should not exceed 750 watts. Total current available is 3000 watts. If only alternating current is used, 3,000 watts is available. When direct current is used, subtract the amount of direct current used from the total generator capacity to find the amount of alternating current available. For example: If 500 watts of dc is used, only 2,500 watts of ac is available.

CONNECTING THE LOAD (Battery Charging Plants). - The main line load circuit should be connected to the batteries through a 100 ampere fused switch or circuit breaker. The lead wires from the battery fuse block to the main line fuse block should be of sufficient size to carry the full rated capacity of the generator plus the full rated capacity of the battery. Branch circuits from the main circuit should be properly fused. Smaller wire may be used for these branch circuits but the wire should be large enough to carry the amperage of the load on each circuit.

Make connections from the main line switch to the fused battery switch. Connect leads to the terminals on the battery side of both switches. Observe the same polarity used in connecting the battery. Refer to the Battery Connections illustration.

CONNECTING THE BATTERY(24 or 32 Volt Battery Charging Plants). - The 24 volt and 32 volt plants have an UNGROUNDED system. In this system, all electrical components of the plant (except the heater circuit which is used only during starting) are electrically insulated from the engine and control box. For marine installations with this system it is not essential whether or not the generating plant polarity agrees with the polarity of other electrical equipment aboard.

NOTE: The ungrounded system may be converted to a grounded system by connecting a ground to the panel terminal (or load) to which generator lead A2 is connected. (Connecting to the opposite side will blow the fuse). Then the battery polarity may be reversed (battery positive connected to plant negative terminal and battery negative connected to plant positive terminal) provided the next start is made by the start switch (rather than by manual cranking) to correct the generator polarity. Battery polarity of a grounded plant must agree with polarity of other electrical equipment aboard (on marine installations only) to avoid severe electrolysis (chemical) action causing damage to propellors, sea cocks, etc., which contact salt water, while the plant is running.

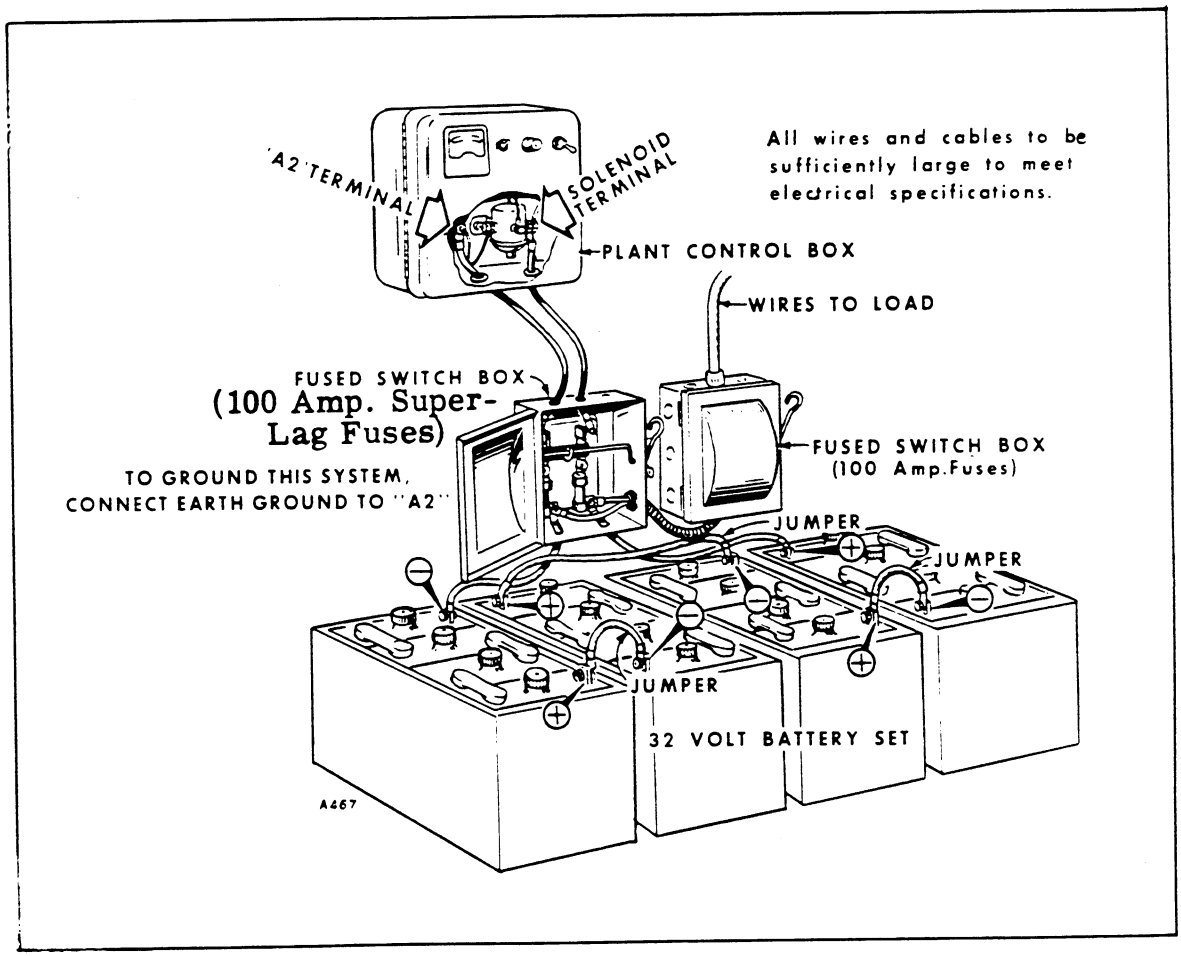


FIG. 6 - BATTERY AND LOAD CONNECTIONS - 32-VOLT BATTERY CHARGING PLANTS

Ammeter readings on these units will be correct only when the battery positive is connected to the start solenoid. With the polarity reversed (battery negative cable connected to the solenoid) the ammeter will read "discharge" instead of "charge". The reading can be corrected by reversing the wires connected to the ammeter terminals.

Battery cables and batteries are not supplied with battery charging units. Procure those accessories from the equipment dealer.

Prepare the batteries for operation and install them according to the battery manufacturer's instructions.

A fused switch should be installed between the plant and the batteries as illustrated. Run cable from the battery to the switch and then from the switch to the plant control box, so that the battery positive (+) connects to the start solenoid in the control box and the battery negative (—) connects to the (B—) terminal in the control box (terminal to which generator lead A2 is connected).

It is advisable to connect the ground last when connecting a battery and to disconnect the ground first when disconnecting a battery.

CONNECTING THE BATTERY (Dual Purpose Plants). - A grounded system is used. These plants are designed to operate with either a negative or a positive grounding of the battery without regard to polarity. However, unless the generator is properly grounded with respect to other electrical equipment aboard, severe electrolysis (chemical) action will be set up when the unit is running. This will cause damage to propellors, sea cocks and other fittings which contact salt water.

Ammeter readings on these units will be correct only with a negative ground. With a positive ground the ammeter readings will be reversed. To correct the reading reverse the wires connected to the ammeter.

Battery connections incorporating a fused switch box should be as described and illustrated for the 32 volt battery charging plants, except use the generator frame GROUND instead of the control A2 terminal. Refer to those instructions.

CONNECTING THE BATTERY (AC Plants). - A grounded system is used. These plants are designed to operate with either a negative or a positive grounding of the battery without regard to polarity. However, unless the generator is properly grounded with respect to other electrical equipment aboard, severe electrolysis (chemical) action will be set up when the unit is running. This will cause damage to propellors, sea cocks and other fittings which contact salt water, and applies only to a marine installation.

Ammeter readings on these units will be correct only with a negative ground. With a positive ground the ammeter readings will be reversed. This can be remedied by reversing the wires connected to the ammeter terminals.

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

Batteries should always be installed on a wooden or metal rack to afford a free circulation of air around the battery.

Cables for making connections between the plant and the battery are supplied with all remote start plants even though the starting batteries are not. The short jumper cable connects the two 6-volt batteries in series to produce 12-volts. The two longer cables connect the battery to the plant. These two long cables are the same size and length.

Spread open the battery cable terminal enough so that driving it onto the battery post is avoided. Have both surfaces clean and apply a film of petroleum jelly to them to prevent corrosion. Install the cable to make full contact with the battery post to minimize current loss here.

Make battery connections as follows:

If a single 12 volt battery is used for the plant, connect one of the long battery cables from the positive (+) post on the battery to the POSITIVE terminal on the plant control box. Connect the other long cable from the negative (—) post on the battery to the NEGATIVE terminal on the generating plant. The short jumper cable is not used with a single 12 volt battery. Be sure connections are tight at all points.

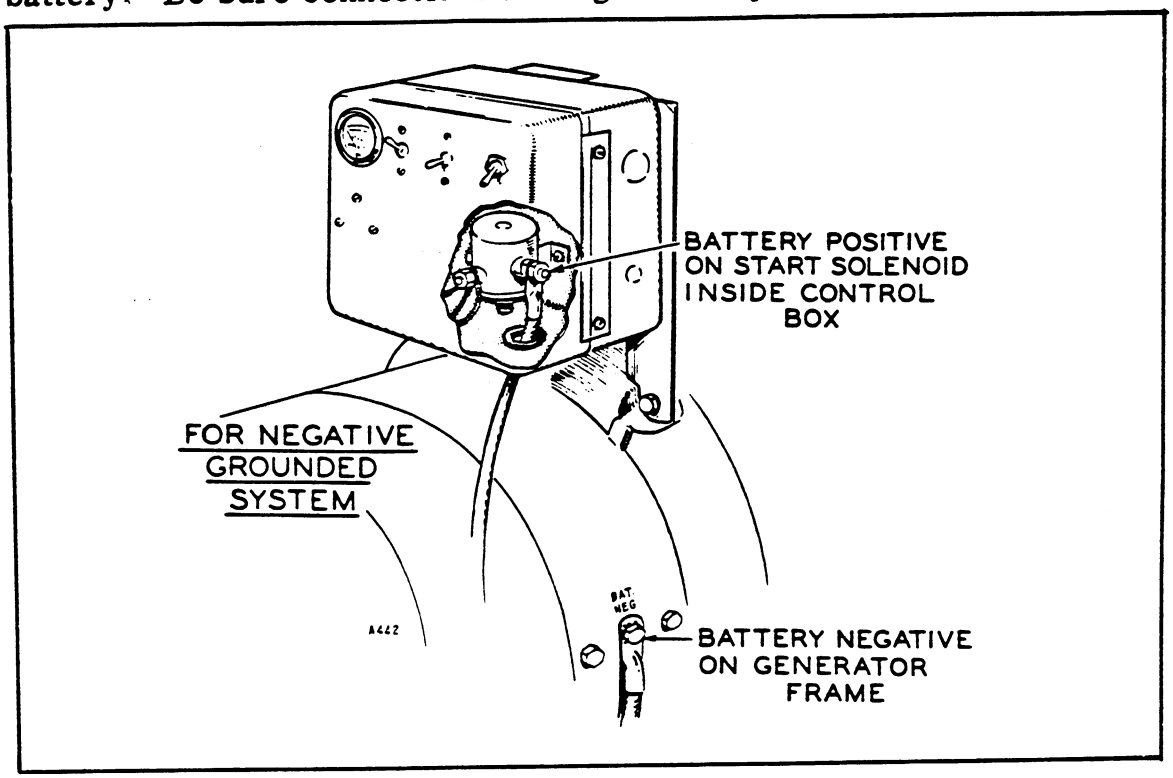


FIG. 7 - BATTERY CONNECTIONS - AC MODELS ONLY

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 make the longer cable connections as described in the above paragraph.

CONNECTING REMOTE START-STOP STATIONS (Remote Starting Plants Only). - One or more remote control start-stop stations may be installed at various points. The wire length from the plant to the switch determines the wire size necessary. Comply with this chart:

WIRE SIZE NECESSARY (Minimum)	MAXIMUM PERMISSIBLE WIRE LENGTH (In Feet)			
	3DSL-1R, 2R, 3R, 5R 205DSL-51R, 52R, 53R, 55R	3DSL-1R4	3DSL-232R	205DSL-224R
#18	85	140	200	130
#16	135	240	335	220
#14	215	360	500	350
#12	350	575	800	550

A terminal block located in the control box has terminals marked 1, 2, and 3. Terminal number 1 is used as a common ground, terminal number 2 connects to the stopping circuit of the plant and terminal number 3 connects to the starting circuit of the plant. The terminal marked B+ (where used), is to be used only with an automatic control installation.

Connect each switch "OFF" terminal to the number "2" terminal on the plant terminal block. Connect each switch "ON" terminal to the number "3" terminal on the plant terminal block. Connect the switch common (not marked) terminal to the number "1" terminal on the plant terminal block.

Connect the switch common (center) terminal to the No1 terminal of the plant. Connect another terminal of the switch to the terminal block number 2 position. Connect the remaining switch terminal to the terminal block number 3 position. Number 2 is the stopping circuit, number 3 is the starting circuit, and number 1 is grounded. If additional remote switches are installed, they must be connected in a parallel circuit.

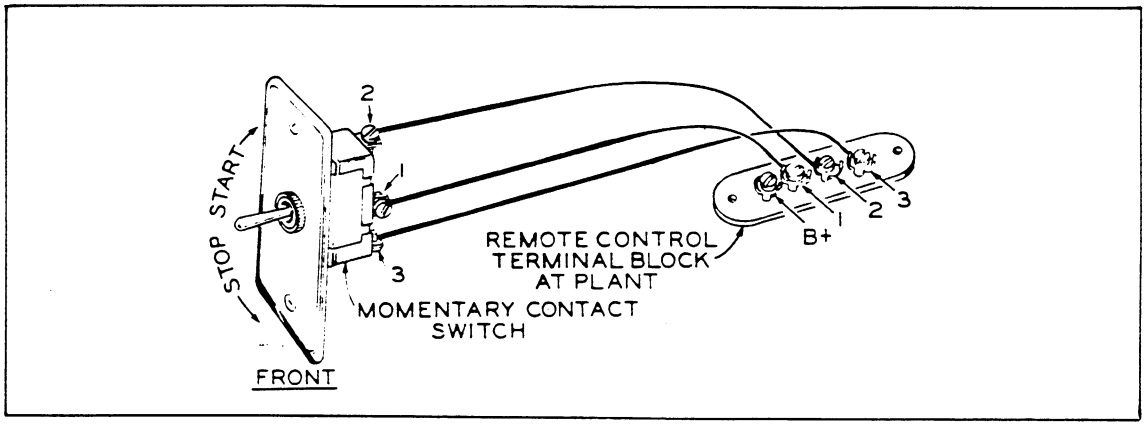


FIG. 8 - REMOTE START STOP STATIONS

AUXILIARY LIGHTING CIRCUIT (Alternating Current Plants). - An auxiliary lighting circuit may be connected to the starting battery if so desired. This auxiliary circuit will provide for a night light, trouble or service light. The maximum load on this circuit should not exceed 150 watts at any time. Lights, fixtures, connectors, and wire should conform to those needed for a 12-volt dc circuit. Make connections directly at the battery. This load will prevent "burning up" of a fully charged battery during continuous operation at low charge rate.

GROUNDING, ALL PLANTS. - If grounding is called for in local electrical codes, or if radio interference necessitates it, provide a separate ground. Also the operator will desire to protect himself from possible dangerous electrical shocks by grounding the generator plant and branch circuits. Radio interference may result if the plant is grounded to a water pipe or to a ground used by a radio. Drive a 1/2" diameter rod or pipe into the ground as near to the plant as possible. Make certain that the ground rod will always penetrate moist earth. Fasten an approved ground clamp to the rod. Run a wire (number 8 or larger) (never smaller than 2 sizes smaller than the largest wire used in the system) from the clamp to the plant ground terminal.

The installation must be mechanically secure, and must have low resistance electrically. Comply with national and local electrical codes.

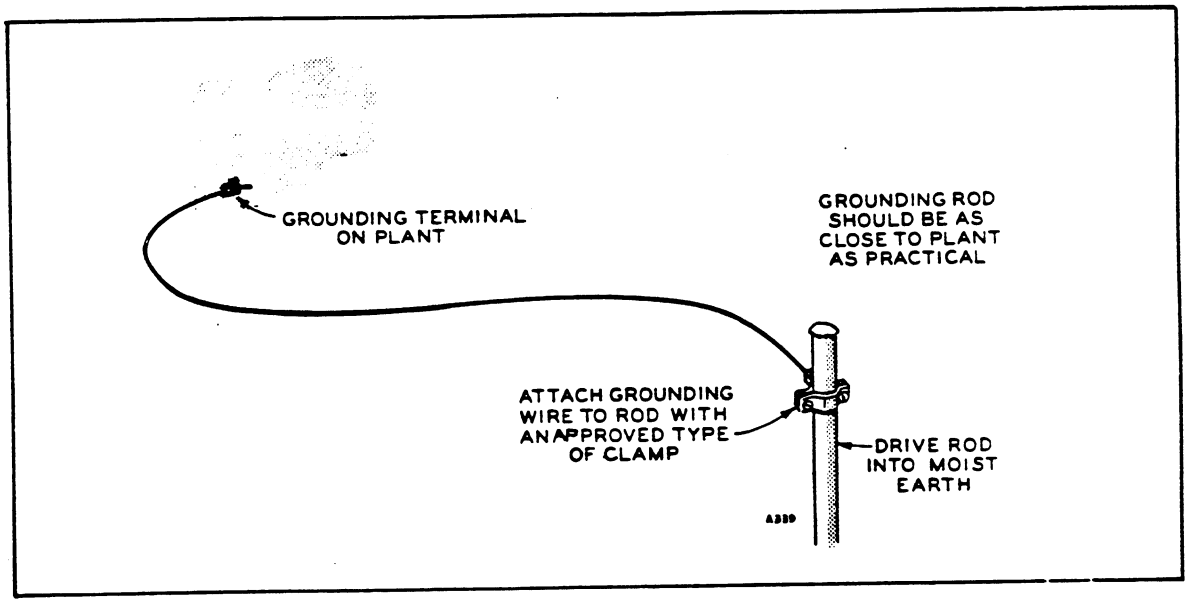


FIG. 9 - PLANT GROUNDING

CHECKING NEUTRAL BRUSH RIG POSITION. - Witness marks show the neutral brush rig position as adjusted at the factory. Details are given in the Maintenance and Repair Section of the manual. Check the brush rig position and see that all generator brushes are in place in their guides.

RECHECK. - Carefully recheck all instructions to see that nothing has been left undone. Then supply the engine with proper oil and fuel as described under Preparation, Operation, and Periodic Service in the manual.

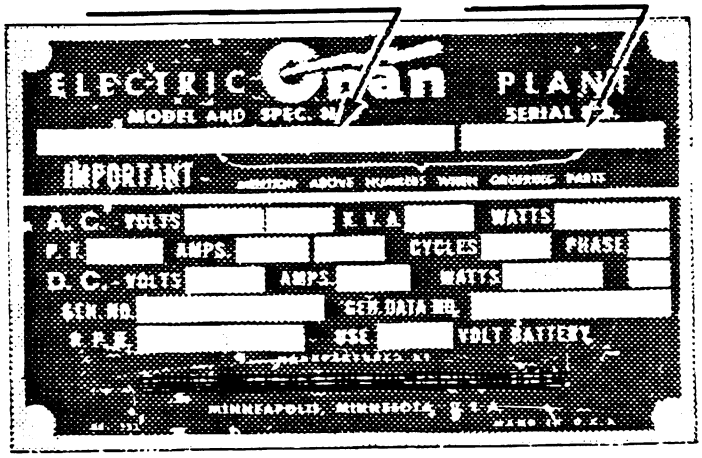
Bleed the air from the fuel system as instructed under Preparation in the manual.

Important !

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

WRITE IN NUMBERS SHOWN ON PLANT NAMEPLATE

MODEL & SPEC. NO. SERIAL NO.



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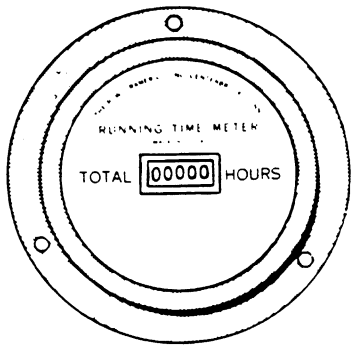
RUNNING TIME METER

To facilitate changing oil and servicing at proper intervals install a running time meter. Specify plant model with inquiry!



RECOMMENDED FUEL. - No. 2 Furnace Oil. Premium Diesel fuels not required.

Alternates ..... No. 1 Furnace Oil (distillate and range oil) and kerosene may be used but one quart (U. S. Measure) of SAE No. 30 lubricating oil should be added to each 25 gallons of such fuel to provide lubrication for fuel injection equipment.

SPECIFICATIONS. - (Specifications may be changed without notice).

GRAVITY (Minimum) A.P.I.	30
VISCOSITY (Saybolt Universal at 100°F.)	30.5 to 45 Seconds
CETANE NUMBER	43 Minimum
SULPHUR (by weight)	1% Maximum
CONRADSON CARBON (10% Bottoms)	0.15% Maximum
FLASH POINT	130°F. Minimum or legal Minimum
WATER AND SEDIMENT (by volume)	None
POUR POINT	Must be 10° lower than minimum temperature at which fuel oil is to be used.

Use fuel with low sulphur content to minimize ring sticking and bearing corrosion. Keep fuel supplies in clean containers and adequately protected from rain, snow and dirt. KEEP THE FUEL SYSTEM CLEAN. If removal of any part becomes necessary, wrap it in clean paper, never in cloth or waste. Use clean diesel fuel for cleaning parts.

RECOMMENDED OIL. - Use detergent lubricating oils classified by the American Petroleum Institute as Service "DG", or, as marketed by most manufacturers, "MS/DG". If sulphur content of fuel is higher than recommended maximum, use Service "DS" lubricating oil (or series III, having more detergent and other additives).

Use SAE No. 30 grade (viscosity) oil in the crankcase of the engine as instructed under PERIODIC SERVICE. Multiviscosity oils, as 5W-20 or 10W-30, are not recommended, especially at higher temperatures, as the oil consumption increases greatly. At low temperature where cold starting may be difficult and high oil consumption is not a factor, the use of multiviscosity oil may be justified.

OIL CAPACITIES. - Crankcase - 4 quarts excluding filter (U. S. Measure).

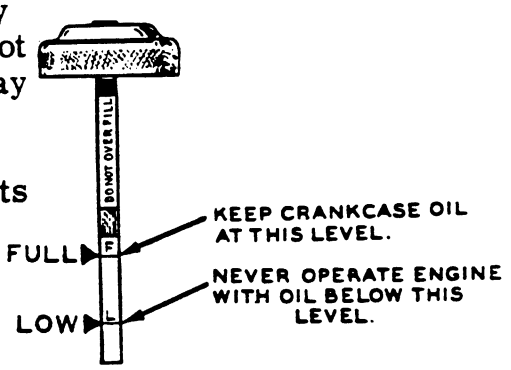


FIG. 10 - OIL LEVEL INDICATOR

PREPARATION FOR STARTING. - Fill the fuel tank with clean fuel.

Fill the crankcase with 4 Quarts (U.S. Measure) of the recommended viscosity and service grade of lubricating oil. This excludes oil for the filter. If the preparation is for cold temperature operation, do not put the oil into the crankcase until just before starting.

NOTE: SAE No. 10W oil may be used at temperatures below 40°F. See Cold Temperatures under the heading ABNORMAL OPERATING CONDITIONS.

CAUTION: BE SURE TO REPLACE OIL FILL CAP SECURELY OR AIR LEAKAGE AT THIS POINT MAY REDUCE CRANKCASE VACUUM, RESULTING IN OIL LEAKAGE AT THE OIL SEALS.

Open the room air inlet ventilator, except as necessary to control the air flow for cold temperature operation.

See that the main line switch or circuit breaker is in the OFF position.

Lubricate the governor linkage ball joint with powdered graphite. Place a drop of SAE No. 30 oil on the other governor linkage joints.

Open the fuel shutoff valve at the fuel tank.

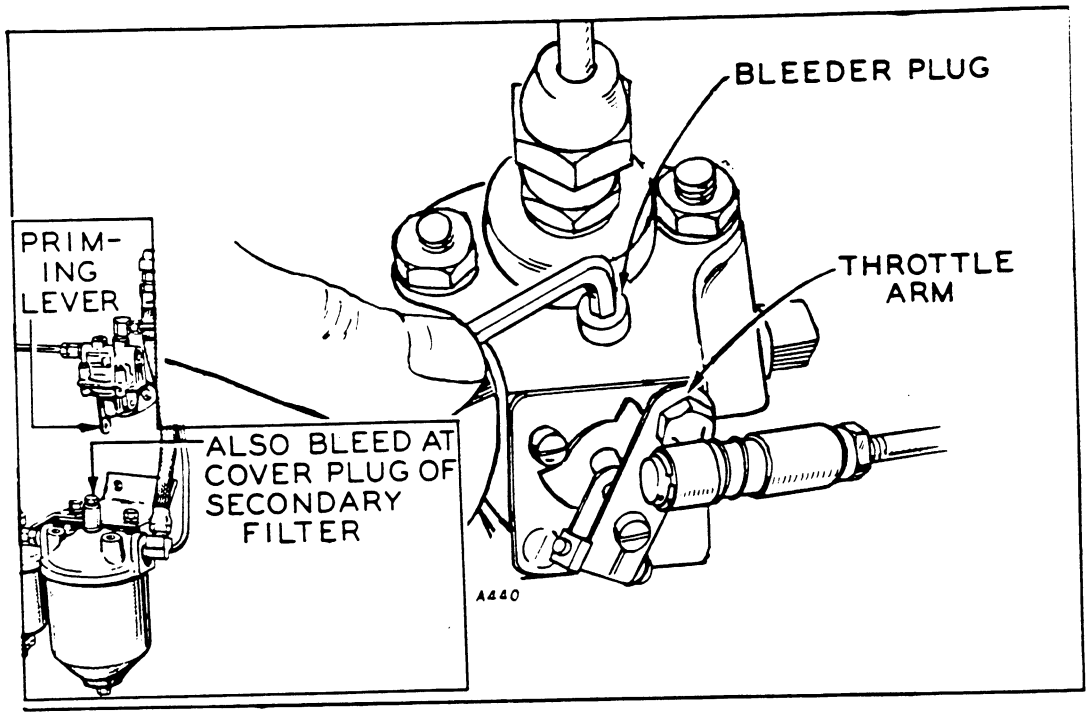


FIG. 11 - BLEEDING THE FUEL SYSTEM

Loosen the injection pump bleeder plug located just above the throttle arm. Then work the primer lever on the fuel pump until fuel flows freely at the plug opening and there are no air or foreign gas bubbles in evidence. Either tighten the plug now, or leave it "cracked" during the first minutes of operation to allow the escape of a trickle of fuel as well as additional air and gases. Another bleed plug is located at the top of the secondard fuel filter. Bleeding by this plug extracts any air-trapped in the secondary filter cover and should be done in conjunction with the regular method at the injection pump. Tighten this plug before completing the bleeding at the injection pump. Refer also to the illustration, Fuel System And Filter Service, which appears in the PERIODOC SERVICE section herein.

CAUTION: If the cam is on the high side the pump will not operate. Turn the crankshaft over one complete revolution to correct. Leave the primer lever at the "in" position when through priming the fuel system to allow normal operation of the pump.

The air bleeding procedure should be followed when starting a new engine, an engine that has been idle for a long period of time, or an engine that has run out of fuel.

STARTING THE PLANT

Select the starting instructions which apply, Remote or Electric Start. For starting in cold weather or high humidity conditions, pre-heat for one minute just before cranking by operating the heater switch located on the control panel. Also when starting a plant at temperatures below 50°F., refer to the suggested aids contained in the section. ABNORMAL OPERATING CONDITIONS.

Check the entire installation to see that all connections and preparations have been made. If the preparation has been made for cold temperature operation, be sure the crankcase is filled with proper oil.

The engine will have a sharp knock as it fires until it has warmed up. This is a normal condition.

STARTING ELECTRICALLY (Remote-Starting Plants). - (a) Decompression release mechanism operates electrically. However, if its plunger was manually locked IN, disengage its pin from the locking notch. (b) Depress the START switch to crank electrically. The manifold heater and glow plug heat automatically during cranking electrically. (c) When the engine is turning over fast enough to build up lubricating oil pressure. then the decompression release will operate. (d) Continue to press the start switch until the engine comes up to speed. (NOTE: If false starts indicate more time is required to gain sufficient cranking speed before compression takes place. temporarily disconnect or ground-out the wire to the solenoid and operate the plunger manually for an emergency start.)

STARTING ELECTRICALLY (Electric-Starting Plants). - Compression release lever should be in "START-STOP" position. (b) Depress both START switch and HEATER switch. (c) When engine is turning over rapidly, throw compression release lever to RUN position. (d) Continue to depress both start switch and heater switch until engine comes up to speed.

STARTING MANUALLY (Remote-Starting Plants). - Manual cranking is strictly for emergency in the event of a discharged battery. The principle is to spin the flywheel fast enough so that its momentum will carry past the compression stroke after the compression release mechanism is disengaged. Someone to assist the operator will be of help.

The hand cranking starter is geared to double the hand cranking speed. Its driving shaft engages the crank dog by pressing the engaging button and is disengaged by a spring when tension is not held on the hand crank. Before attempting to hand crank, work the engaging button to assure that the spring is functioning properly and internal lubrication is adequate.

If desired, the hand crank may be used with care at the same time as cranking is attempted electrically. In this case the controls, on remote start plants only, will operate electrically.

(a) Compression release mechanism should be engaged to prevent compression. (b) Work the priming lever on the transfer pump a few times to assure adequate fuel. CAUTION: Leave this lever inward so that the normal pump action is not restricted. (C) Depress the heater switch and hold it for one minute before cranking and continue to hold it during and after cranking until the engine comes up to speed. (d) Engage the hand crank and crank the engine. (e) When at top cranking speed, disengage the compression release mechanism to allow compression and running. (f) Check the lubricating oil pressure immediately. (g) Do not operate the plant unless the battery is connected.

GENERAL FALSE START. - Should the engine fail to fire within about 30 seconds, release the switch and check the fuel system before attempting to start the engine again.

If the engine fires but fails to continue running, chances are that the fuel system has an air leak or air pocket in the fuel suction line at some point. Bleed the fuel system of air as given under PREPARATION and check fuel connections for leaks. Then repeat the starting procedure.

Complete failure of oil pressure will leave the oil pressure switch open and the solenoid will not be energized to permit compression and running.

DECOMPRESSION RELEASE SOLENOID (Remote Starting Plants Only). - The decompression solenoid must operate to allow compression. If the solenoid fails to work automatically, its plunger may be operated by hand. To operate by hand, push the plunger on the solenoid IN when engine compression is desired and turn the knurled knob on the plunger until the pin is locked in place. To stop the engine, turn the knob until free and pull out as far as it will go. This allows the spring loaded shaft to engage with the exhaust valve rocker arm when the exhaust valve opens, to prevent engine compression and affect stopping.

Failure of the solenoid to operate may be caused by the plunger becoming gummed up or by electrical failure. To remove the plunger knob for disassembly, remove the locking pin

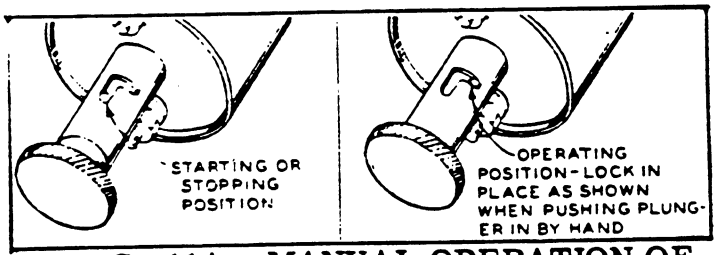


FIG. 11A - MANUAL OPERATION OF DECOMPRESSION RELEASE SOLENOID

POINTS TO CHECK AFTER STARTING THE PLANT

OIL PRESSURE. - The pressure reading on the gauge should be between 20 and 30 pounds at normal operating temperature. The reading will be higher until the engine warms up. Should the oil pressure drop to 10 pounds, shut the plant off at once and determine the cause. Correct the trouble before starting the plant again.

OIL LEAKAGE. - If oil leakage occurs at the oil seals or the anti-flicker breaker plunger (ac plants), check the breather tube check valve and oil fill cap. The check valve disc must work freely. The oil fill cap must be air tight.

FUEL LEAKAGE. - Fuel leakage may occur at the nozzle base when a new engine is being started the first few times after the initial start has been made. To correct, tighten the nozzle mounting screws. Should trouble occur with the nozzle or injection pump, install a new part.

BATTERY CHARGING RATE (AC Plants) . - A two way switch permits the selection of two charging rates, a high rate of 6 to 9 amperes and a low rate of 2 to 4 amperes. Use the high rate if the battery is down or the plant is to be run for only a short period of time. Use the low rate if the battery is up or the plant is to be run for a long period of time.

Keep the battery in a well charged condition at all times. Keep the level of the electrolyte above the separators at all times. Unless the battery manufacturer specifies a different level, fill each cell with clean distilled water to a point 3/8 of an inch above the separators.

BATTERY CHARGING RATE (Dual Purpose Plant). - The charging rate of the battery is controlled by a HIGH-LOW charge switch located on the plant control box. When this switch is at the HIGH position, the charging rate is a maximum of 30A. When the switch is at the LOW position the charging rate is about 3 amperes.

CAUTION: The total ac load on the Dual Purpose plants should not exceed 2250 watts when the charge switch is at the HIGH position. When the charge switch is at the LOW position, the full ac capacity of 3000 watts may be used.

If the battery is in a discharged condition, throw the charge switch to the HIGH position and leave it there until the battery nears a fully charged condition. Then return it to the LOW position. Keep a close check on the battery with a hydrometer. Add distilled water as necessary to keep the level of the electrolyte above the separators according to the battery manufacturer's recommendations.

Cycling the battery between a charged and discharged condition at regular intervals is recommended.

These plants produce alternating current as well as direct current and must operate at about 1800 rpm for the 60 cycle plants to produce the right frequency of current. NEVER INCREASE ENGINE SPEED TO INCREASE THE CHARGING RATE. Engine speed should be adjusted only to correct the rpm of the plant to obtain the right frequency.

BATTERY CHARGING RATE (Battery Charging Plants). - The battery charging plants have a rheostat in series with the shunt field circuit of the generator. The charging rate to the battery is controlled by turning the rheostat knob as required to raise or lower the charging rate.

Set the charge rate at the point where the ammeter shows the rate of charge recommended by the battery manufacturer. Allow the plant to run for a period of about one hour. Then reset the charge rate to the point where the ammeter again shows the recommended charging rate. The charge rate at any given setting will gradually get lower as the battery nears a fully-charged condition and its internal resistance increases. This gives a "tapering off" effect to the charge which is desirable. Check the ammeter once in a while during the end of the charge period. If necessary, reset the charge rate to keep the needle of the ammeter on the charge side. See "When To Operate the Plant."

ADJUSTING ENGINE SPEED - ALL PLANTS. - Engine speed should be maintained as given for governor adjustment under ADJUSTMENTS section. Adjustments are made by increasing or decreasing governor spring tension. Turn the speed adjusting nut in to increase spring tension (also engine speed and generator voltage) or out to decrease it. Be sure to lock the adjustment with the two hex nuts. It is not advisable to attempt a governor adjustment unless an instrument for checking speed or voltage is available.

WHEN TO OPERATE THE PLANT (AC Plants) . - Plants of the alternating current type must be operated whenever electricity is required. When the battery is fully charged snap the charge rate switch to LOW position.

WHEN TO OPERATE THE PLANT (Dual Purpose Plants). - Plants of the dual purpose type must be operated whenever ac electricity is required, or whenever the 32 volt battery requires recharging. When the battery is fully charged snap the charge rate switch to LOW position.

WHEN TO OPERATE THE PLANT (Battery Charging Plants). - Plants of the battery charging type are operated to generate electricity which may be

supplied directly to the storage battery or divided in any proportion within the output limits of the generator between the battery and the connected load, the battery receiving that portion of the current not required by the connected load. Should the connected load require more current than the generator produces, the additional current needed to operate the connected load is furnished by the battery but only for the period of time that the battery retains a high enough charge to furnish this additional current. The total electrical load may be double the plant capacity, or even more, for the period of time that the battery remains in a well charged condition. However, the connected load should not be greater than the actual plant capacity if the battery is in a discharged condition. DO NOT OPERATE THIS TYPE OF PLANT UNLESS THE BATTERY IS CONNECTED. WHEN THE BATTERY IS FULLY CHARGED, TURN THE RHEOSTAT KNOB TO LOW RATE POSITION. The plant must be operated to recharge the battery whenever it becomes discharged.

ENGINE RACES. - Shut off the engine at once. Check for the cause. The governor linkage must be properly connected. If oil is being drawn into the intake air stream, check for a faulty crankcase breather valve and for a loose fit of the oil fill cap or a similar reason for the crankcase partial vacuum not being maintained.

LIGHTS FLICKER (AC Plants). - Service the anti-flicker breaker points as instructed under PERIODIC SERVICE section.

VALVE CLEARANCE. - Check the valve clearance at the end of the first 50 hours of running time. Check only as required thereafter.

BLACK SMOKE FROM EXHAUST. - Black smoke coming from the exhaust outlet is an indication of trouble. Should the condition exist, shut the plant off immediately and determine the cause.

Main causes of black smoke are overloading the generator, poor grade or dirty fuel, improper operation of the injection pump or nozzle, or improper fuel injector timing.

Black smoky exhaust is a normal condition with an overloaded generator. This condition can easily be remedied by simply reducing the load.

Black smoky exhaust at less than rated generator capacity indicates faulty combustion. Continued operation of the plant in this condition may result in stuck rings, blow-by at the rings or premature blackening of the crankcase oil from carbon. Faulty combustion is a direct result of loss of compression or faulty injection.

Many of the main causes of faulty combustion are listed in the "Troubles and Remedies" section. Refer to this section for possible causes should trouble of this nature occur.

STOPPING THE PLANT

Disconnect the main load from the plant and let the plant run for a few minutes at no load to allow the engine time to cool gradually before stopping the engine.

To stop the remote-starting plant, hold the stop switch at STOP position until the plant has completely stopped running. Use either the switch at the plant or a remote station.

To stop the electric-starting plant move the compression release lever to the START-STOP position.

If due to some electrical fault the remote-starting plant will not stop by the stop switch, manually pull the decompression release plunger outward until the plant stops. The plunger may have been locked at the IN position.

If for any reason the electric-starting plant will not stop when the compression release lever is thrown to the STOP position, hold the injection pump throttle arm at the closed position until the engine stops running.

If for any reason the remote-starting plant will not stop when the decompression release plunger is pulled OUT to the STOP position, hold the injection pump throttle arm at the closed position until the engine stops running.

If the plant is consistently operated at very light load, it is advisable to operate the plant at full load for about 5 minutes just before stopping to help dispose of carbon deposits.

FUEL KNOCK

A sharp knock that occurs when the engine is first started will usually diminish gradually as the engine warms up under load. If the fuel knock continues, correct one or more possible causes. Bleed the fuel system to remove any air, and to check for adequate fuel transfer pump capacity. Repair any leaks in the fuel line where air is sucked in. Provide adequate fresh air for engine combustion. Adjust the nozzle if necessary to agree with fuel used as instructed under ADJUSTMENT section.

Close ventilator openings as necessary during cold weather operation to allow the engine to warm up to normal operating temperature. Care should be taken not to close these ventilators too much. Even though the unit is installed in a room without heat it will generate a large amount of heat itself and may eventually overheat unless sufficient ventilation is provided. Readjust ventilator openings from time to time until the unit operates best without overheating. Best operating conditions are with room temperatures of 50^{o}F. to 70^{o}F. for cold weather operation.

INJECTION PUMPS

- Injection pumps are highly precision built -- Close fits must hold high pressure.
- Fuel supplied to the injection pump must be clean!
- Avoid tampering with injection pump unnecessarily!
- Before disassembling, clean your hands, then dip hands in clean diesel fuel to avoid corrosion of lapped fit parts!
- Consult your dealer for latest exchange service or repair information!

COLD TEMPERATURE SUGGESTIONS

Full Diesel engines fire on compression alone and starting problems may occur at temperatures of 50°F. and below. Read the following paragraphs carefully. They contain many helpful hints on cold weather starting.

If the engine temperature is expected to drop low enough to require a lighter oil for starting, drain the crankcase oil while warm from running. Be sure to add oil before the next start.

To aid starting under cold conditions, use a viscosity oil in the crankcase just light enough to permit cranking and adequate lubrication. If necessary to use very light oil (as "Service DG", SAE No. 5W), and if heavy duty or continuous operation is expected, change the oil to SAE No. 30 as soon as the engine reaches operating temperature.

Be sure the fuel used has a low pour point (at least 10 degrees lower than the prevailing temperature) and will flow freely and not congeal in the lines. Fuel tends to congeal in the filters and fuel lines at low temperatures. If trouble of this nature occurs, warm the fuel or change to a No. 1 Diesel fuel (or alternate) having a lower pour point.

The lowest temperature at which the fuel will flow through a pipe is known as the pour point or congealing point.

The fuel in the combustion chamber is ignited by the rise in temperature of the air in the chamber due to compression. The glow plug helps ignite the fuel during the starting period. Under cold conditions, preheat for about 1 minute just before starting, by holding the heater switch at ON position.

Any means of increasing the temperature of the air being drawn into the combustion chamber will aid starting.

Fuel does not flow freely in cold weather and air locks may occur often. When bleeding the fuel system be sure to clear all air pockets.

Crank the engine a few revolutions by hand to free it up before attempting to start it.

The battery capacity decreases with lowering temperatures. Because of this it is necessary to keep the battery fully charged at all times in order to crank a cold engine fast enough to start it. A temporary addition of a 12 volt battery, connected in parallel, during the starting period will

improve cranking speed. Install this booster battery permanently if conditions require it. (Applies only to 12 volt system.)

Check the charged condition of the battery often with a hydrometer. Batteries will freeze between temperatures of 20°F. above zero and 50°F. below zero, depending on the state of charge.

Drain, clean and replace element in the fuel filter only as necessary to keep the fuel clean. Remember that any foreign particles that enter beyond the filter during cleaning will be forced into the injection pump and will probably cause trouble.

Keep all fuel tank screens clean.

Keep supplies of fuel free of water. If fuel containing water is used, it may freeze and close off the fuel supply.

Let the engine warm up slowly before applying the load. Watch the oil pressure carefully. Do not apply any load until the oil circulates freely.

HOT TEMPERATURE SUGGESTIONS

Keep the level of the oil in the engine crankcase at or near the full mark at all times.

Be sure there is ample ventilation so that radiated heat from the engine is not recirculated. Provide more or larger air inlets if necessary.

Keep all cooling surfaces clean and free of dust, dirt and grease or oil.

DUST AND DIRT

Check plant operation more often and service as needed.

Service the air cleaner as often as necessary to assure a free passage of air. Sufficient fresh air is necessary for full power output.

Check the commutator and brushes of the generator often and see that the brushes ride freely in their holders and make good contact. See GENERATOR under Maintenance and Repair for service instructions.

Keep supplies of fuel and oil in airtight containers.

Keep the plant as clean as practicable.

ONAN DIESEL ENGINE SERVICE CHART

The following recommended Engine Service Chart may be used as a guide for servicing ONAN Diesel Engines.

The chart is based on favorable operating conditions. The actual service period may be somewhat longer or shorter than shown - depending on operating conditions.

SERVICE REQUIRED	HOURS OF OPERATION										
	100	200	300	400	500	600	700	800	900	1000	2000
Change oil (check level daily)	x	x	x	x	x	x	x	x	x	x	
†*Service air cleaner (Do not wash)	x	x	x	x	x	x	x	x	x	x	
Clean crankcase breather	x	x	x	x	x	x	x	x	x	x	
Replace oil filter cartridge	x	x	x	x	x	x	x	x	x	x	
Check anti-flicker points (AC only)					x					x	
Inspect generator brushes, commutator, slip rings		x		x		x		x		x	
†Clean primary fuel filter										x	x
Drain sludge secondary fuel filter										x	x
Check valve tappets	x									x	x
Grease generator bearing (if not seal bearing)										x	x
Clean engine and oil base											x
Clean injector nozzles	As Required										
†Replace secondary fuel filter	As Required										
Grind valves and remove deposits	As Required										
Replave valve, piston rings, etc.	As Required										
Replace water pump rotor (marine units only)	As Required										

* Check air cleaner often. Remove air filter cartridge and shake out accumulated dirt every 50 hours. Install new cartridge each 500 hours.

† For information on servicing these parts for "Contractors" model 3DSL-1E2236, refer to Contractors Model Section.

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

Periodic Inspection: For Loose or Poor Connections, Fittings, etc.

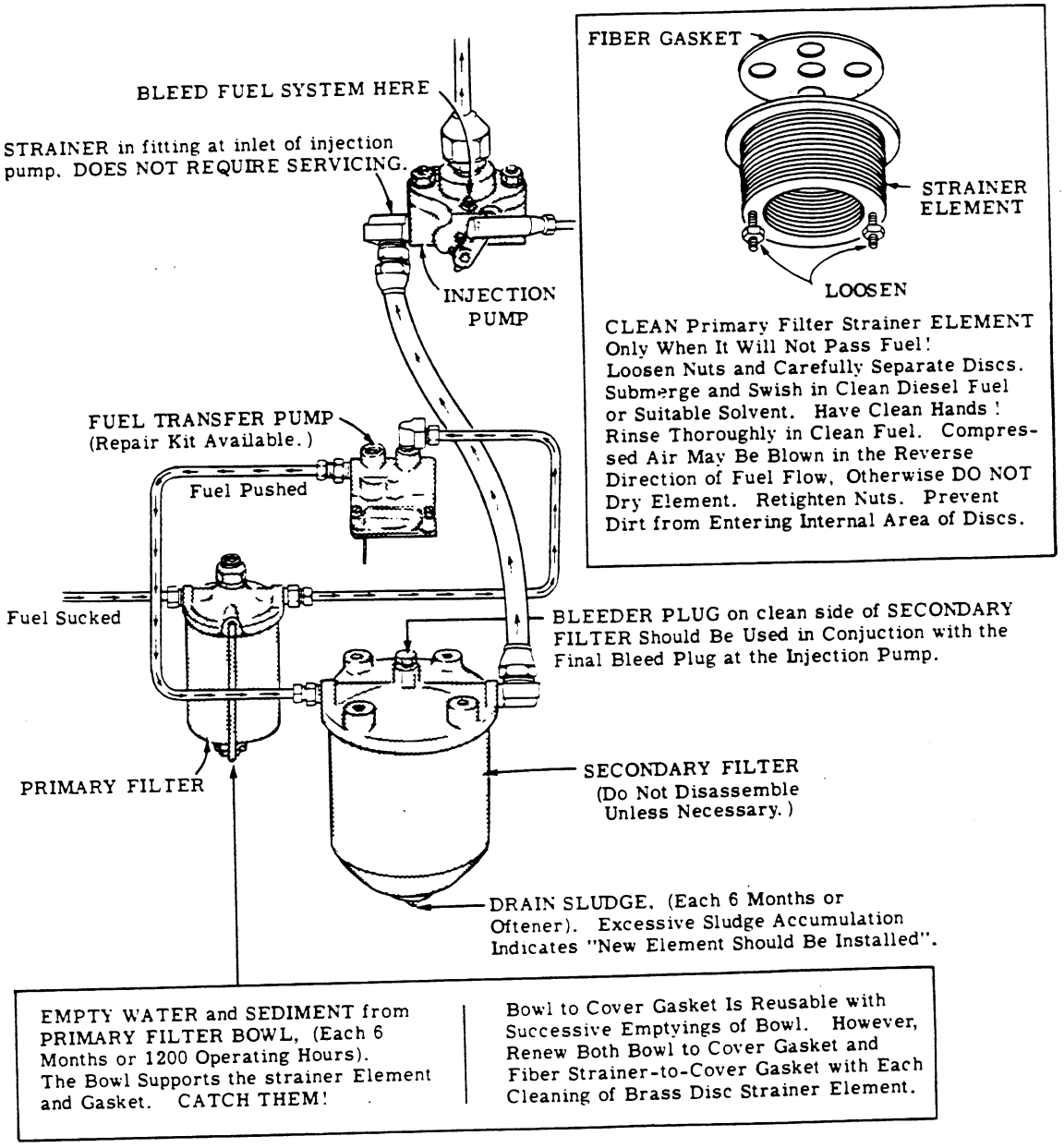
Recommended Oil: Heavy Duty Detergent or Oil designated for Service DG, DS or MS/DG. Use the proper SAE number oil for the lowest temperature at the engine as expected at the time of starting. Above 40°F. (4°C) use SAE 30, Below 40°F. (4°C.) use SAE 10.

Recommended Fuel: No. 2 furnace oil. Premium Diesel fuels are not required.

Alternate Fuel: No. 1 furnace oil (distillate and range oil) and kerosine may be used but one quart (U.S. Measure) of SAE No. 30 lubricating oil should be added to each 25 gallons of such fuel to provide lubrication for fuel injection equipment.

THE BEST PROTECTION AGAINST FILTER TROUBLE IS THE USE OF CLEAN FUEL

NOTE: Filters Should Be Cleaned Only When Necessary. The Primary Filter May Have To Be Cleaned **Several** Times Before It Becomes Necessary To Clean The Secondary Filter.



WHEN CLEANING FUEL SYSTEM INTERNAL PARTS, "SWISH" THEM THOROUGHLY IN CLEAN DIESEL FUEL. DO NOT ATTEMPT TO WIPE DRY. HAVE HANDS CLEAN. BE THOROUGH!

BEFORE TOUCHING POLISHED PARTS, DIP HANDS IN DIESEL FUEL.

FIG. 12 - FUEL SYSTEM AND FILTER SERVICE

GENERAL. - Certain services must be performed periodically if the plant is to continue operating efficiently and economically. Service periods are based on hours of running time under normal operating conditions. For extreme conditions of load, temperature, dust, dirt, etc., service more often. The operator should enter dates serviced on a service chart.

DAILY SERVICE

Perform the following services daily or at the end of each 8 hours of running time, whichever occurs first.

FUEL. - Check the fuel supply often enough to avoid running out of fuel. Use only clean containers and clean fuel as recommended under PREPARATION or ABNORMAL OPERATING CONDITIONS.

CRANKCASE OIL. - Check the oil level in the crankcase. Fill to the full mark with SAE No. 30 oil (A.P.I. Service "DG") or as otherwise recommended for low temperature starting. Replace the fill cap securely.

CLEANING. - Keep the plant clean.

WEEKLY SERVICE

Perform the following services weekly or at the end of each 50 hours of running time, whichever occurs first.

CRANKCASE OIL. - Change the crankcase lubricating oil every 100 hours of running time unless sludge formation or condensation forms during cold weather operation. Then, change oil more often. Change the oil filter cartridge each time the crankcase oil is changed. Remove the old oil from the filter before replacing the cartridge.

GOVERNOR LINKAGE. - If available, use only powdered graphite on the governor linkage ball joint, otherwise, use a light non-gummy oil. On other joints of the governor to throttle linkage, place a drop of SAE No. 30 oil.

BATTERY. - Check the level of the fluid in the starting batteries. Add distilled water, if necessary, to bring the fluid to 3/8" above the separators, or as otherwise recommended by the battery manufacturer.

AIR CLEANER (Dry, Cartridge Type). - Every 50 hours remove element (air filter cartridge) and shake out accumulated dirt. Install new element every 500 hours or more often under extreme dust conditions. DO NOT WASH.

INSPECTION. - Tighten all loose nuts, bolts, connections, etc.

VALVE CLEARANCE. - Check the valve clearance at the end of the first 50 hours of running time. Reset the valve clearance if necessary.

MONTHLY SERVICE

Perform the following services monthly or at the end of each 200 hours of running time, whichever occurs first.

ANTI-FLICKER. - Check the anti-flicker breaker points and condenser of the alternating current plants. Clean the points with a fine stone and reset the point gap to .025" if necessary. If the points are badly pitted or burnt, replace them. Burnt points are usually an indication of a faulty condenser. Replace the condenser if it tests faulty. If the lights still flicker, adjust the clip on the resistor to correct.

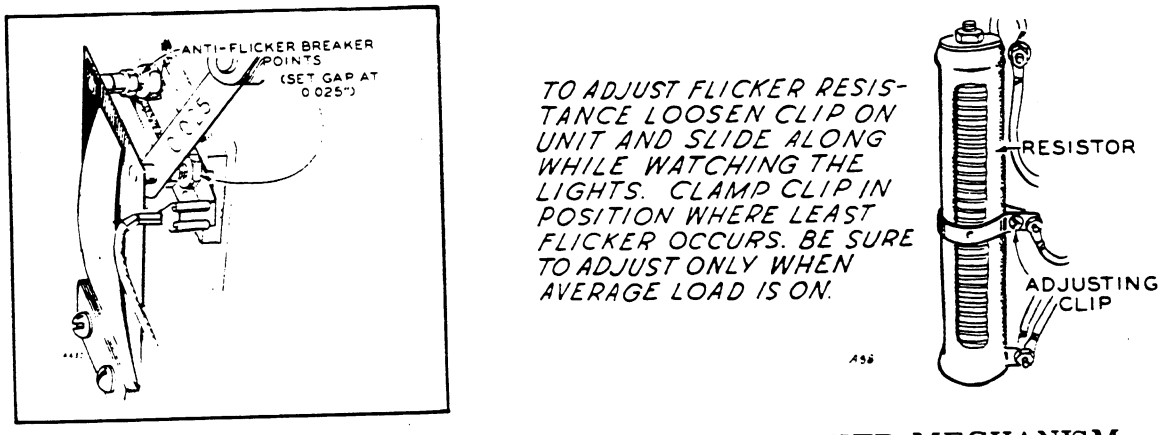


FIG. 13 - SERVICING THE ANTI-FLICKER BREAKER MECHANISM - AC MODELS

GENERATOR. - Check the generator brushes. Brushes worn to 5/8 inch in length should be replaced.

Check the commutator and collector rings (ac plants only). Brush surfaces must be smooth and cylindrical to assure good brush contact. See

GENERATOR under the heading Maintenance and Repair for repair instructions.

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

VALVES. - Valve grinding is a service that must be performed periodically if the engine is to continue operating efficiently. Hard starting, low power or excessive fuel or oil consumption, indicate a low compression condition. An engine in good running condition should have a compression reading of at least 370 pounds per square inch at 70°F. Because only specialized Diesel repair shops are likely to be equipped to measure compression, symptoms of low compression can usually be the guide for determining repair intervals.

Loss of compression may be due to a poor valve condition, worn or sticking piston rings, worn piston ring grooves, or to worn cylinder walls. If the exhaust valve is leaking, it can be heard at the exhaust outlet on the plant. If the intake valve is leaking, a hissing noise will be heard at the air cleaner opening. A compression leak past the piston rings can be heard at the oil fill opening.

FUEL SYSTEM. - Necessary fuel filter service is dependent upon the cleanliness of the fuel used. Engine operation is the best indication of necessary filter service. Refer to the page herein on SERVICING THE FUEL FILTER. The primary filter may have to be serviced several times before it is necessary to service the secondary filter. The factory recommends having a spare secondary fuel filter element on hand for use if trouble occurs. More damage may result in dirt getting into the fuel system during periodic servicing of the filters than might be gained by a periodic service aimed at preventing trouble.

Fuel filters must be assembled air tight. Bleed the fuel line in accordance with instructions under PREPARATION, after the fuel filter is serviced.

Remember any dirt allowed to pass the fuel filter might clog the fuel injection pump or nozzle. Water and sediment will settle to the bottom of the fuel filter bowl when the plant is stopped. To determine if plant failure is due to air leakage at the filter, raise the fuel supply above the level of the fuel filter.

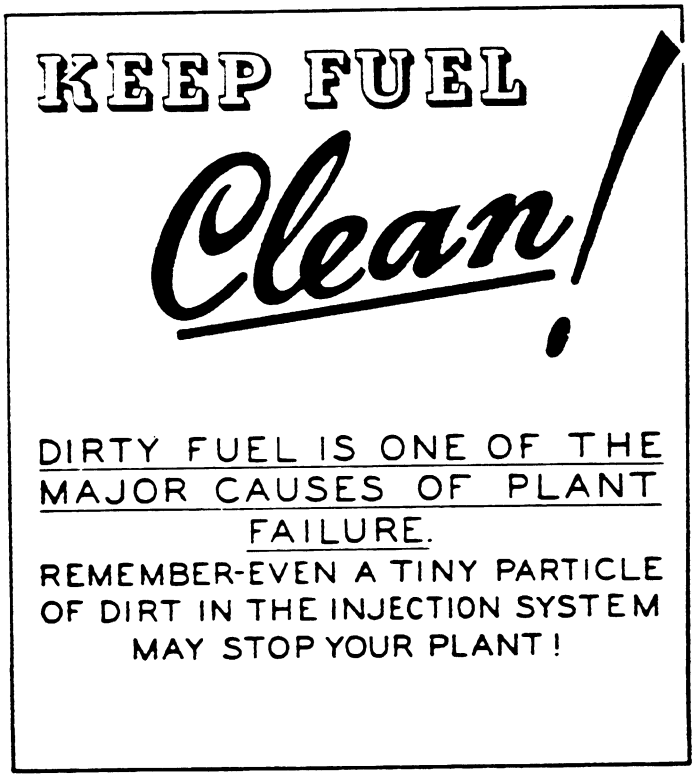
SEMI-YEARLY SERVICE

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

GENERATOR. - Check the generator brush rig to see that it has not shifted from its original position. Operation of the generator with the brushes out of "neutral" position causes rapid brush wear and excessive arcing of the brushes. A chisel mark on the brush rig ring against the support in the end bell was made at the factory to indicate the "neutral brush position".

The generator has a double-sealed pre-lubricated bearing which does NOT require future greasing.

EXHAUST. - Inspect the exhaust system for carbon deposits. Carbon removal is necessary especially if the plant is consistently operated at very light load. Operating at full load for about 5 minutes just prior to stopping the plant will help eliminate carbon accumulation.



GOVERNOR. - The governor is set at the factory to maintain close regulation of engine speed and generator voltage, within the limits given herein, and according to the plant nameplate rating. The governor seldom requires additional adjustment. If necessary, it should be adjusted by someone properly equipped and experienced with generating plants. Study carefully the following paragraphs and check each point in the order given.

A. GOVERNOR ADJUSTMENT PROCEDURE. - Check the position of the governor arm, the throttle lever, and the governor linkage. Make adjustments as instructed under GOVERNOR ARM AND LINKAGE and THROTTLE LEVER AND THROTTLE LEVER STOP, if necessary.

After the governor arm, throttle lever and linkage have been carefully adjusted as instructed, start the plant and check the no load rpm. Correct as instructed under SPEED ADJUSTMENT, if necessary.

When all other adjustments have been completed, check the rpm between no load and full load. Make adjustments as instructed under SENSITIVITY ADJUSTMENT, if necessary.

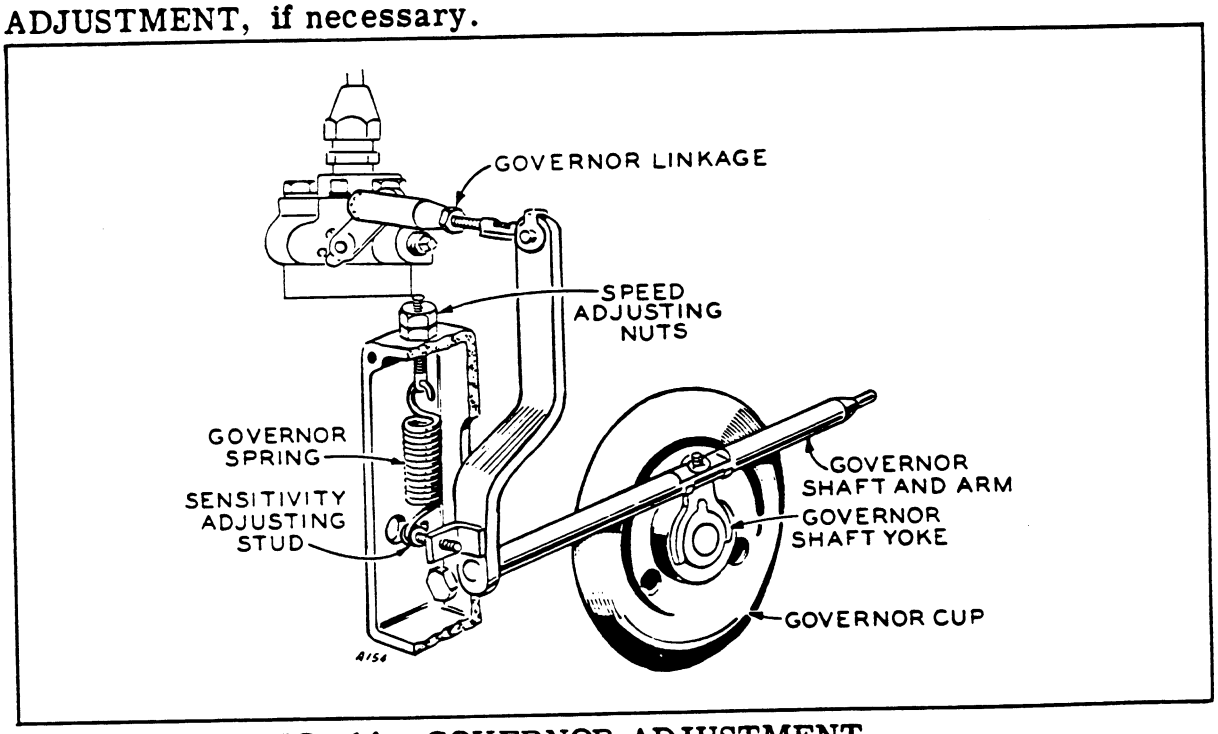


FIG. 14 - GOVERNOR ADJUSTMENT

B. GOVERNOR ARM AND LINKAGE. - Check the governor arm and linkage and the throttle lever for a binding condition and for excessive slack or wear at connecting points. A binding condition at any point will cause the governor to act slowly and regulation will be poor. Excessive looseness will cause a hunting condition and regulation will be erratic. Work the arm back and forth several times by hand while the plant is stopped. If either of these conditions exist, find out at which point the trouble lies and adjust or replace the part as required.

The linkage and the position of the governor arm must synchronize the travel of the governor and the throttle lever so that the governor is at the wide open position when the throttle is at the wide open position and the governor is at its closed position when the throttle is at its closed position. The position of the governor arm on its shaft is fixed and the adjustment is made through the connecting linkage. Turn the governor arm away from the injection pump as far as it will go to place the governor shaft yoke against the governor cup. Then with the tension of the governor spring holding the arm at the wide open position, adjust the linkage by turning the ball joint farther on or off the link to hold the throttle lever so that the arm of the stop is about 1/32" from the stop screw (wide open position of the throttle shaft) when the engine is stopped. The engine starts at wide open throttle. Be sure there is no looseness or binding at any point. See the illustration, Adjusting the Throttle Lever.

C. THROTTLE LEVER AND THROTTLE LEVER STOP. - The throttle lever should never require readjustment unless it has become loosened or has been removed as during parts replacement procedures. On most engines the throttle lever position is exactly parallel to the injection fuel line (to nozzle) when the shaft is held so that the nameplate stop screw is exactly midway between the arms of the throttle stop. The adjustment is the same whether the lever and stop are brass or steel material. If lever adjustment is necessary, loosen the lever screw, attain the correct lever position, retighten the screw, then if necessary, adjust the governor linkage length.

The throttle lever stop is also adjustable but the position of this stop should never be changed or altered in any manner as it fixes the position of the shaft which in turn determines the flow of fuel to the injection pump.

Should the throttle lever stop ever work loose or be loosened accidentally, adjust it as follows:

Crank the engine by hand until the TC mark on the flywheel and the mark on the flywheel housing are in line on the compression stroke, then back up about 1/6 of a turn (60°) against rotation.

Disconnect the fuel line from the injection pump outlet.

Remove the valve from the injection pump outlet.

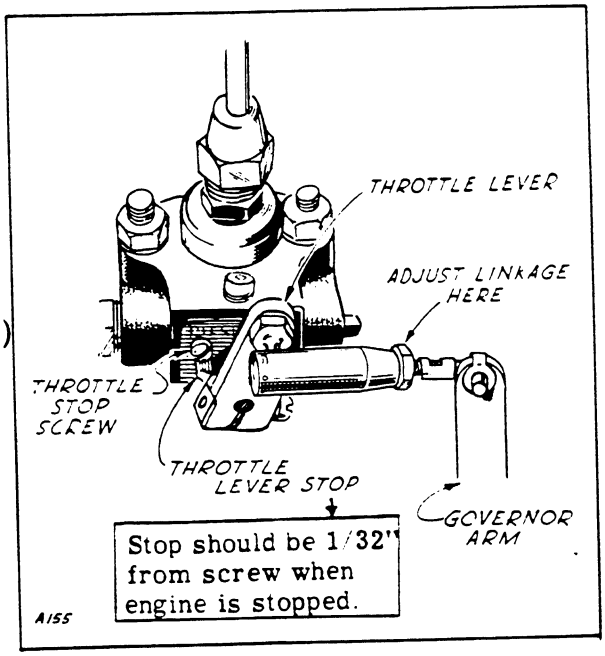


FIG. 15 - ADJUSTING THE THROTTLE LEVER

Remove the throttle lever and loosen the throttle stop socket screw so that the shaft will be free to turn.

Place a .030" feeler gauge over the throttle stop pin or screw and turn the throttle stop to the left until it rests against the gauge.

Have someone work the manual primer on the fuel transfer pump. Use a steady motion so that the flow of fuel will be fairly steady.

Slowly turn the shaft to the right until fuel flows freely from the injection pump outlet.

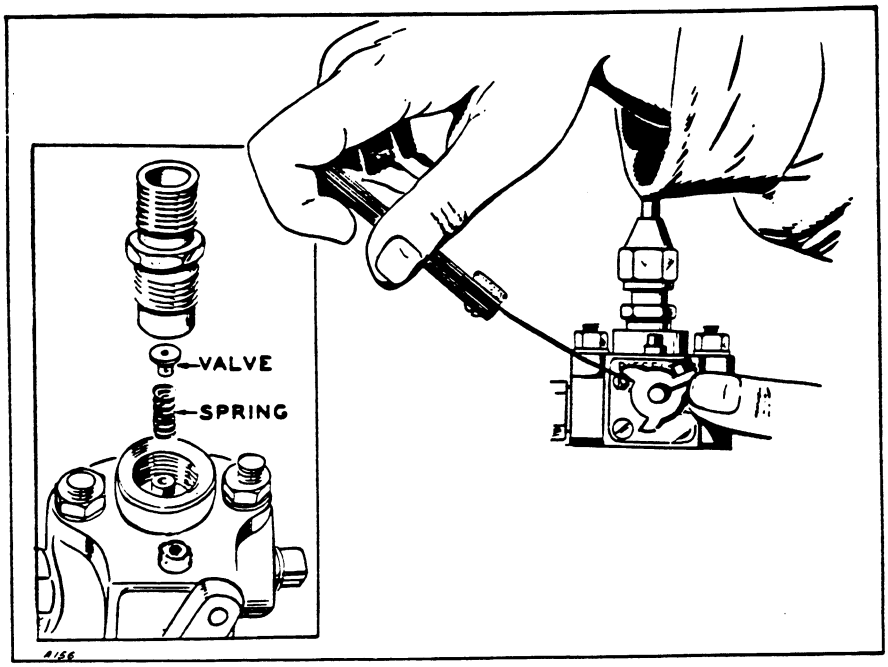


FIG. 16 - ADJUSTING THE THROTTLE LEVER STOP

Slowly turn the shaft to the left until fuel just stops flowing. NOTE: If the flywheel has been turned too far or not far enough before TC mark the fuel may not stop flowing at any point. If this happens turn the flywheel a few degrees one way or the other to correct the condition.

Without disturbing the position of the shaft, tighten the throttle stop socket screw securely to lock the shaft in place.

Replace the throttle lever and reset the position as described in a previous paragraph. Adjust the connecting linkage if necessary.

Replace the valve in the injection pump outlet and connect the fuel line to complete the job.

D. GOVERNOR SPRING. - Due to the fact that springs become fatigued and lose their original tension from long usage it sometimes becomes necessary to replace the governor spring to get proper regulation.

It is difficult to determine whether or not a spring is fatigued. Usually if all other adjustments have been properly made and regulation is still erratic, the trouble can be corrected by replacing the governor spring and resetting the sensitivity and speed adjusting screw.

E. GOVERNOR SPEED ADJUSTMENT. - The speed at which the engine operates is determined by the tension applied to the governor spring. Engine speed also determines the output voltage of the generator. Increasing spring tension increases engine speed and generator voltage.

Decreasing spring tension decreases engine speed and generator voltage. No load engine speed should be maintained as given below. Check engine speed with a tachometer.

Speed tests and voltage tests should be made when the plant is warm, running for at least one hour before the final test is made.

Nominal engine speed and generator voltage should be as follows:

AC PLANTS: Maximum no load engine speed should not be more than 1920 rpm for 60 cycle plants, nor more than 1710 rpm for 50 cycle plants.

Maximum no load voltage should not be more than 126 volts for 115 volt circuits, nor more than 252 volts for 230 volt circuits. Voltage limits for circuits of other voltages will be multiples of these shown.

Minimum engine speed at full rated generator capacity should not be less than 1710 rpm for 60 cycle plants, nor less than 1500 rpm for 50 cycle plants.

Minimum voltage at full rated generator capacity should not be less than 110 volts for 115 volt circuits nor less than 220 volts for 230 volt circuits.

Maximum speed drop from no load to full load should not be more than 60 rpm.

BATTERY CHARGING PLANTS: Engine speed of the battery charging plants should be not greater than 1950 rpm at no load and not less than 1750 rpm at full load. If a speed adjustment is needed, turn the speed adjusting nut in to increase engine speed and generator voltage or out to decrease engine speed and generator voltage. Be sure to lock the adjustment with the two hex nuts.

DUAL PURPOSE PLANTS: Refer to AC PLANTS.

F. GOVERNOR SENSITIVITY ADJUSTMENT. - The position of the sensitivity adjusting screw controls the travel and leverage of the governor spring and determines the rpm spread between no load and full load. This rpm difference should not be more than 60 rpm (for ac current). Check with a tachometer.

For more speed drop from no load to full load, turn the sensitivity screw out. For less speed drop from no load to full load, turn the sensitivity screw in. Always recheck engine speed after making a sensitivity adjustment.

A hunting condition (engine alternately increasing and decreasing speed) may result from the rpm between no load and full load being too low. Should this condition exist, turn the sensitivity screw out until the condition is corrected. Regulation is better with the end of the spring held closer to the governor shaft but the tendency to hunt is increased. Make the adjustment that gives the best regulation with no hunting. A more likely cause of the engine hunting is lack of fuel due to improper adjustment or blockage of the fuel system.

VALVE TAPPET AND COMPRESSION RELEASE CLEARANCE. - Remove the top plate from the rocker box.

Turn the crankshaft in a clockwise direction until the "TC" mark on the flywheel and the mark on the edge of the flywheel housing timing hole are in alignment on the compression stroke.

The valve nearest the compression release is the exhaust valve. There are two adjustments to be made when correcting the clearance of this valve. Note that the exhaust rocker arm has a compression release adjusting screw and a larger screw for adjusting the valve clearance.

The screw for the compression release must be adjusted first and while the adjusting screw for the exhaust push rod is backed off. A clearance too great, when adjusting this smaller screw, will prevent proper stopping of the engine. A clearance too small will allow the rocker arm to rap against and possibly damage the solenoid plunger used on the remote starting type of plant. Proceed as follows:

Place the compression release mechanism at disengaged (RUN) position.

Back away (turn in) the exhaust valve tappet clearance adjusting screw.

Clearance for the release mechanism is 0.027". Place a 0.027" feeler gauge between the exhaust valve stem and the rocker arm and turn the smaller screw inward until it touches the low section of the compression release shaft or plunger, and causes a slight drag on the feeler gauge. Tighten the lock nut and recheck the clearance.

Valve tappet clearance is for cold setting. The push rods are the steel type and valve tappet clearance is 0.015". After completing the compression release adjustment, place a 0.015" feeler gauge between the exhaust valve stem and the rocker arm and turn the self-locking screw in or out with a wrench as required to correct the clearance. The feeler gauge should have just a slight drag on it when moved back and forth if the clearance is correct.

Repeat the foregoing paragraph for the intake valve. Reinstall all parts removed. Return the release assembly to engaged (START) position.

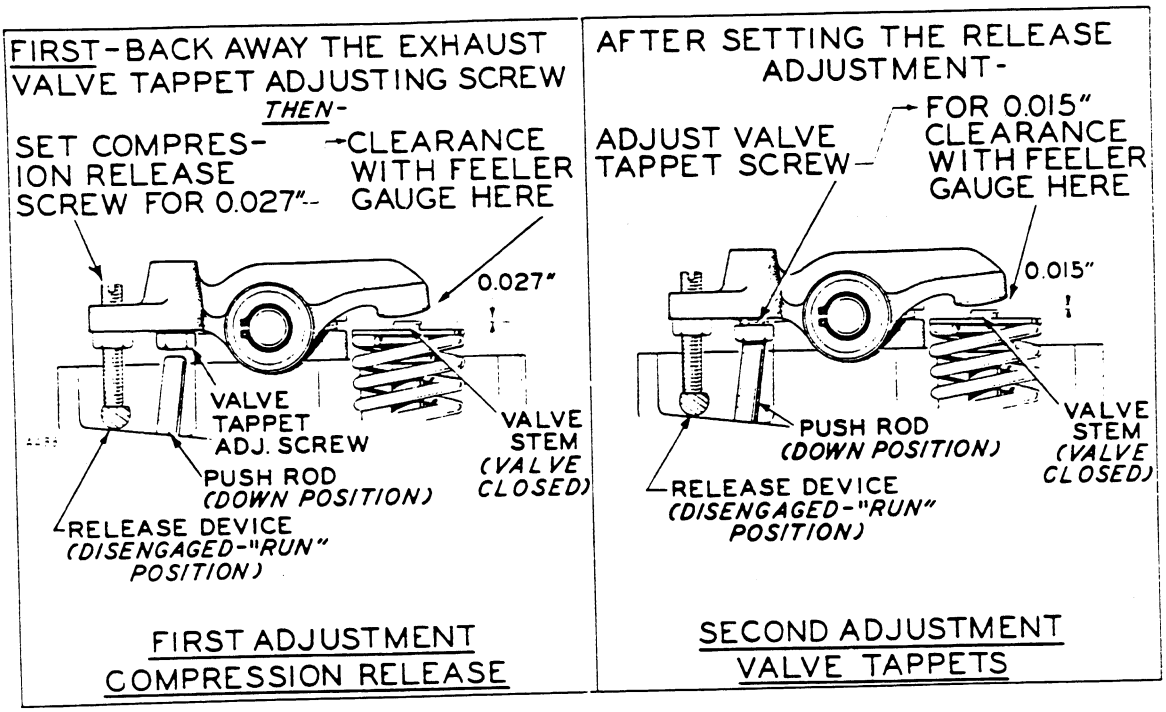


FIG. 17 - ADJUSTING VALVE TAPPET CLEARANCE

TIMING THE INJECTION PUMP TO THE ENGINE. - The fuel injection pump is timed to the engine at the factory and should not require retiming at any time. However, should it become necessary, adjustment can be made by means of an adjustable tappet which operates the injection pump.

Timing is 4^{o} BTC (Before Top Center) - PO (Port Opening).

Port Opening is the stage in the operating stroke of the injection pump when the fuel spillback passages align to end the injection.

Crank the engine over slowly by hand until the "PO" mark on the flywheel aligns with the indicating pin or mark on the flywheel housing timing hole on the compression stroke. The compression release lever should be in the "RUN" position so that the exhaust valve is free to operate. Cranking will then become more difficult as the piston comes up on the compression stroke.

Remove the fuel injection pump.

The timing gauge is wider at one end than the other. Insert the wider end into the opening for the injection pump. The bottom end should just make contact with the top of the tappet screw with both side arms of the gauge resting on the face of the crankcase. As measured by a depth micrometer, the setting should be 1.552" plus or minus 0.002". Remove the tappet to adjust it. Measure and repeat procedure until adjustment is correct.

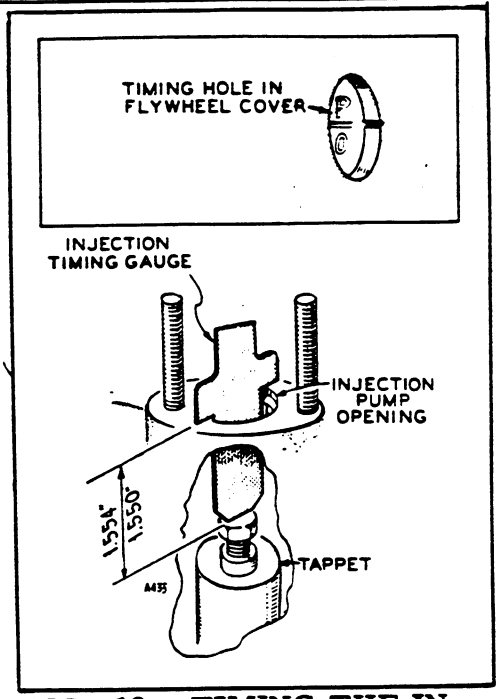


FIG. 18 - TIMING THE INJECTION PUMP TO THE ENGINE

Install the injection pump. Be sure the neoprene seal is in place between the injection pump and the crankcase. Connect the fuel lines. Tighten the fuel line nuts only enough to prevent leakage.

Bleed the fuel system as instructed in PREPARATION section of this book.

NOZZLE ADJUSTMENT. - A nozzle adjustment is recommended only as a means of correcting a fuel knock resulting from a change in the type of fuel used. Otherwise the original setting of the adjusting screw should not be disturbed. The adjustment is made as follows:

Start the engine and allow it to run until it is thoroughly warmed up.

Remove the top cover (A) from the nozzle holder, as illustrated.

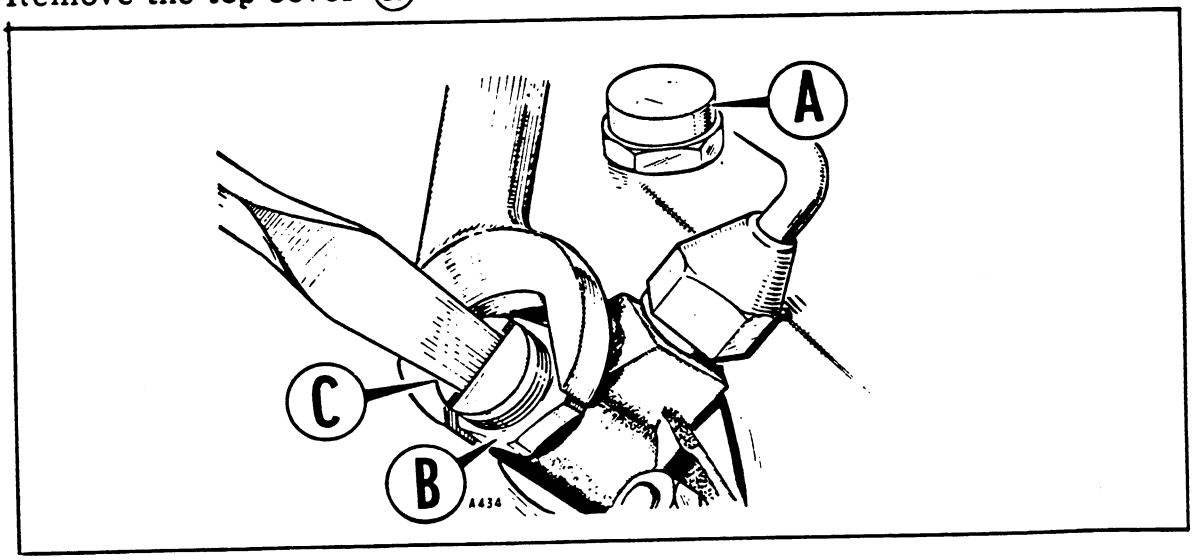


FIG. 19 - NOZZLE ADJUSTMENT

Loosen the lock nut (B) just enough to allow the adjusting screw (C) to turn.

Insert a screwdriver into the screwdriver slot of the adjusting screw (C), hold a wrench on the lock nut (B) and turn the adjusting screw in first one direction and then the other until the knock is least noticeable. CAUTION: Do not turn the adjusting screw more than one turn in either direction from its original position. If nozzle adjusting screw is turned out too far, the burning gases from the combustion chamber may be forced back into the nozzle, causing it to foul and the pintle to stick. If this happens, the nozzle will need to be cleaned or replaced.

Lock the adjusting screw nut (B) securely after making an adjustment. Then replace the cover (A) securely on the nozzle holder being sure the copper washer is in place under the cover.

Nozzle failure may be due to foreign material causing the pintle to become jammed. Check all other possible causes first. With hands cleaned and dipped in clean diesel fuel, remove nozzle nut from combustion chamber end of nozzle holder. Inspect nozzle pintle. If jammed or scored, install a new nozzle. If fouled with carbon, clean and continue in service, using cleaning tool set available through the dealer.

GENERAL. - Repairs should be made by a competent mechanic familiar with diesel engines and electric generator plants. Refer to the Troubles and Remedies section for service diagnosis. Before refinishing to use an oversize or undersize part be sure the size desired is available. Maintain fits and clearances as given in the Table of Clearances.

TABLE OF CLEARANCES

	MINIMUM		MAXIMUM
Valve Rocker Arm Clearance - Cold		.015"	
Valve Face Angle		44°	
Valve Seat Angle		45°	
Valve Stem Clearance in Guide - Exhaust	.003"		.0045"
Valve Stem Clearance in Guide - Intake	.0015"		.003"
Valve Guide Extends Above Cyl. Head		13/16"	
Valve Seat Width	3/64"		1/16"
Crankshaft Main Bearing Clearance	.0025"		.004"
Crankshaft Rod Journal - Standard Size	2.3745"		2.3750"
Crankshaft Endplay	.010"		.015"
Camshaft Bearing Clearance	.001"		.003"
Camshaft Endplay	.003"		
Connecting Rod Bearing Clearance - Forged Steel Rod with Precision Type Bearings (Measured parallel with length of rod)	.001"		.003"
Connecting Rod Endplay	.002"		.011"
Timing Gear Backlash	.001"		.006"
Oil Pump Gear Backlash	.003"		.005"
Piston Clearance in Cylinder (at bottom of skirt)	.0035"		.0055"
Piston Pin Clearance in Piston - tap fit	.0000"		.0003"
Piston Pin Clearance in Rod Bushings	.0002"		.0007"
Top Compression Ring Gap in Cylinder	.010"		.020"
Other Compression Rings and Oil Ring Gap in Cylinder	.010"		.015"
Injection Pump Timing - 4° BTC - P.O.	1.552"	±	.002"
Anti-Flicker Breaker Point Gap (AC Units only)		.025"	
Compression Release Adjusting Screw - With Release at Running Position		.027"	
Exhaust Valve Head to Face of Cylinder Head (Maintain by grinding new seat)	.030"		
Cylinder Bore - Standard Size	3.5015"		3.5025"
Crankshaft Main Bearing Journal-Std. Size.	2.7495"		2.7500"
Injection Nozzle Opening Pressure	1750 lbs.	minus 0,	plus 50.

ASSEMBLY TORQUES

Assembly torques as given here require the use of a torque indicating wrench. These assembly torques will assure proper tightness without danger of stripping the threads. If a torque wrench is not available, you will have to estimate the degree of tightness necessary for the stud, nut or screw being installed and tighten accordingly. Be careful not to strip the threads. Check all studs, nuts, and screws often. Tighten as needed to prevent them from working loose. Specially designed "Place Bolts" do not require a lock washer nor a gasket under their heads.

CYLINDER HEAD STUDS AND NUTS. - 70 pounds feet torque.
CONNECTING ROD BOLTS(with locks). - 27 to 30 pounds feet torque.
CONNECTING ROD PLACE BOLTS(no locks). - 40 to 45 lbs. feet torque.
ARMATURE THRU STUD AND NUT. 40 to 45 pounds feet torque.
NOZZLE HOLDER. - 15 to 20 pounds feet torque.
BEARING PLATE PLACE BOLTS. - 45 to 50 pounds feet torque.
INJECTION PUMP. - 20 to 25 pounds feet torque.

ENGINE

CYLINDER. - The cylinder bore of a new engine is 3.5015 to 3.5025". If the new engine was bored to oversize originally the bore will be .005" oversize. If the cylinder bore measures more than .005" out of true, the cylinder should be refinished to use the next available oversize piston. Pistons and piston rings are available in .010", .020", and .030" oversize. Use standard rings with .005" oversize.

If the cylinder does not need refinishing, it is advisable to remove the ridge from the top of the cylinder wall before replacing the piston and rings. Also read the following paragraph on PISTON AND PISTON RING SERVICE.

PISTON AND PISTON RING SERVICE. - The piston has three compression rings and one oil control ring. Inspect each ring carefully for fit in piston grooves, for tension, and for seating on the cylinder walls. If there is any doubt as to the condition of the old piston rings, install new rings. New rings will seat much faster and better if the cylinder walls are roughened with a wire brush or an abrasive such as emery cloth. Be very careful to remove all abrasive from the engine.

Clean all carbon from the piston, rings, cylinder, cylinder head, valves, gasket surfaces, etc. before installing any parts.

Carefully inspect the piston. If the piston is badly scored or burned, very loose in the cylinder, has badly worn ring grooves or otherwise is not in good condition, install a new piston. A new piston should also

be installed if the old one is loose on the piston pin and a .002" oversize pin will not correct the fit. Handle the piston carefully to avoid nicking the walls. Any raised surface of this type must be dressed down carefully with a fine stone.

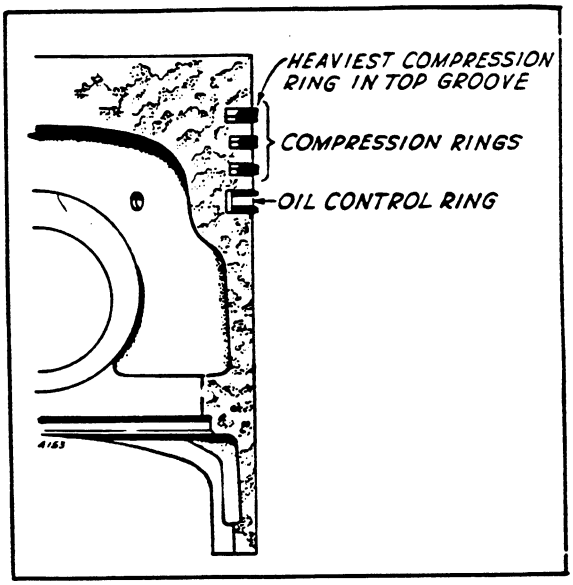


FIG. 20 - LOCATING PISTON RINGS

When installing piston rings fit each ring singly to the cylinder at the bottom of its travel. The correct ring gap while in the cylinder is between .010" and .015" for all rings except the top compression ring. The gap for this ring is from .010" to .020". Rings usually need some filing at the ends to obtain the right gap. Do not use rings that need a lot of filing at the ends to obtain the right gap as they will not seat properly on the cylinder walls. Install all rings on the piston before installing the piston in the cylinder and coat the cylinder walls with a thin coat of lubricating oil. Rings of the tapered type will be marked "TOP" or identified in some other manner, and this identifying mark must be placed nearer the closed end of the piston.

Space the ring gaps 1/4 of the way around the piston from each other, being sure no ring gap is directly in line with the piston pin. Coat the crankshaft bearing journal with oil before securing the rod. Apply light oil liberally to the cylinder walls and rings.

CONNECTING RODS. - The connecting rod should be serviced at the same time as the piston or piston rings are serviced as the rod must be removed with the piston. The rods are forged steel with replaceable bushings and bearings.

For fits refer to the TABLE OF CLEARANCES. Bearings and rods are available in undersize and piston pins are available in oversize. See the parts list.

When replacing the connecting rod pin bushing, install a bushing from each side, flush with the rod, to allow a 1/16" groove for oil passage. The rod bearings are precision size and require no reaming.

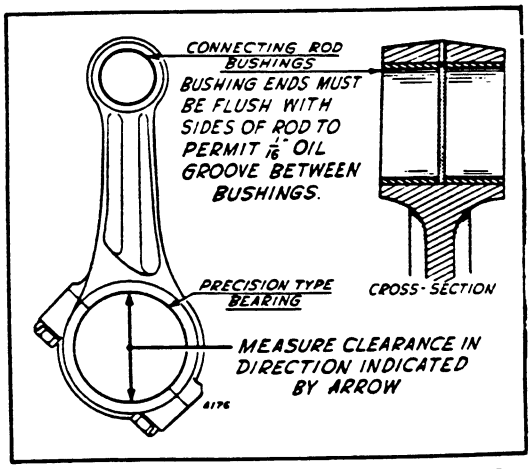


FIG. 21 - CONNECTING ROD SERVICE

Oil the crankshaft journal. Install the rod with the cap toward the inspection hole, and the marks on the rod and cap aligned. Crank the engine by hand to see that the rod is free. If necessary, rap the rod cap sharply with a heavy soft hammer to set the rod square on the journal.

VALVE SERVICE. - The valves are of the overhead type and are located in the head. If the cylinder head sticks, rap it sharply with a heavy soft hammer to loosen. Do not use a pry.

Clean all carbon from the cylinder, cylinder head, valves, valve seats, valve stems and valve guides. Thoroughly clean the gasket surface of the cylinder head and block. Carefully check all valves. Replace any valves that are badly burned or pitted, have badly worn or warped stems, or that will have a thin edge when refaced. Inspect the valve guides for wear. Replace guides that are badly worn. To install new guides, press them in, using a tool which is recessed to avoid pressure near the stem hole, then ream from end nearer valve seat, see Table of Clearances herein.

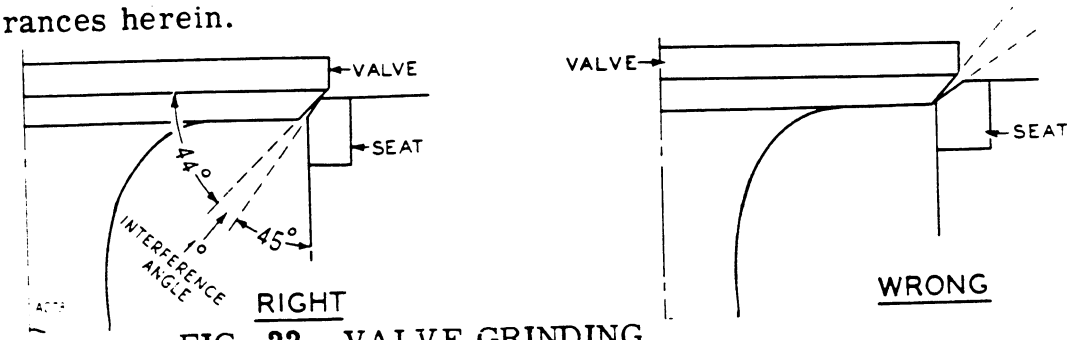


FIG. 22 - VALVE GRINDING

The valve FACE angle is 44°. The valve SEAT angle is 45°. This 1° interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life.

The valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where stellite faced valves and seats are used. Valve faces should be finished in a machine to 44°. Valve seats should be ground with a 45° stone, and the width of the seat band should be 3/64 to 1/16 of an inch wide.

When installing a NEW exhaust valve insert seat, maintain a minimum clearance of 0.030" from the exhaust valve head to the face of cylinder head by grinding the seat.

Remove all grinding dust from engine parts and place each valve in the cylinder head. Check each valve for a tight seat, using an air pressure type testing tool. If such a tool is not available, make pencil marks at intervals acorss the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

Reassemble all parts removed and adjust the valve clearance.

VALVE ADJUSTMENT. - See Adjusting the Valves under ADJUSTMENTS.

FLYWHEEL. - The generator frame assembly, the armature and the generator adapter must be removed to expose the flywheel. To remove the flywheel, turn until the keyway is downward, place a heavy punch against the crankshaft just above the keyway and hit the punch a hard blow with a heavy hammer. Repeat if necessary.

Should the installation of a new flywheel become necessary, the "TC" (top center) and "PO" (port opening) locations should be determined and marked on the flywheel. A dial gauge should be used as illustrated. Proceed as follows:

Install the flywheel on the crankshaft and turn the flywheel with rotation until both valves open and close and continue about 1/2 turn until the piston is at the top of the cylinder.

Remove the cylinder head, secure the cylinder block to the crankcase and place a dial gauge, having 1/1000 of an inch readings, so that the gauge contacts the center of the piston or directly over the piston pin.

Turn the flywheel slightly until the dial gauge needle indicates the piston is exactly on top center. Use a straight edge and a scratch awl and make a mark across the flywheel directly in line with the mark on the edge of the timing inspection hole in the flywheel housing. This will be the "TC" mark.

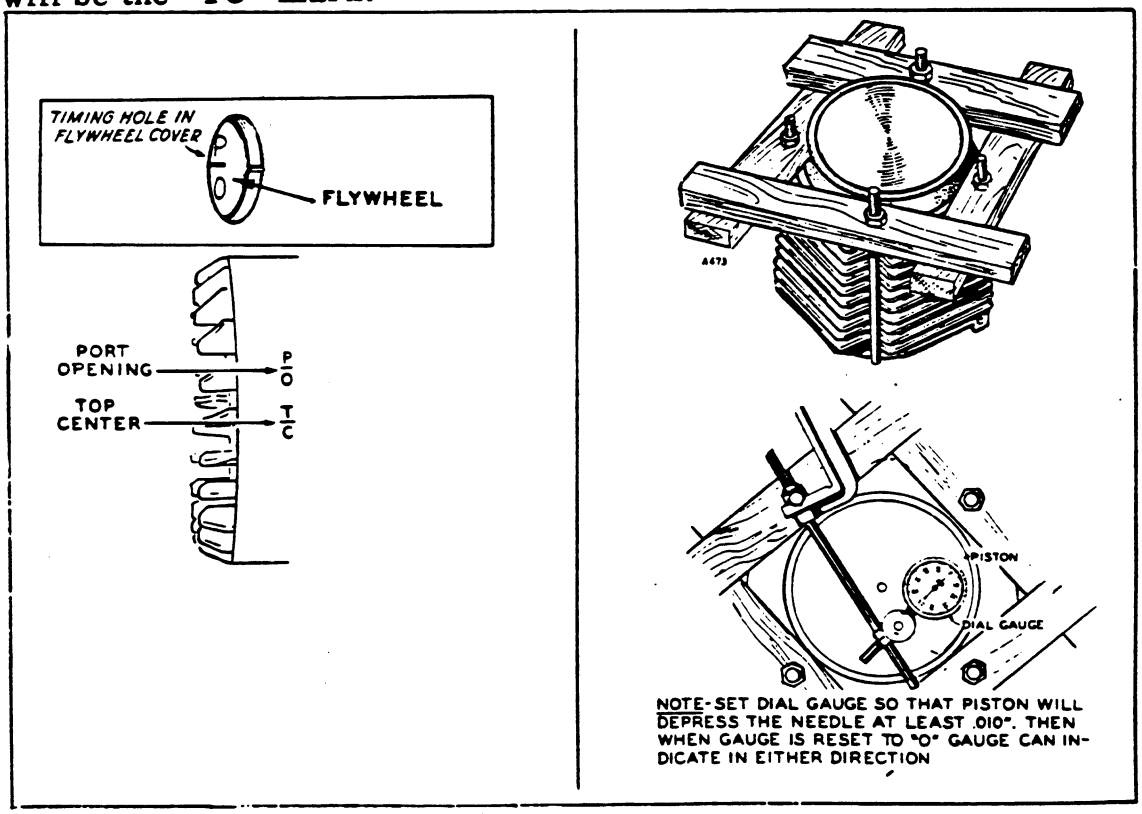


FIG. 23 - INSTALLING A NEW FLYWHEEL

Turn the dial gauge until the "O" mark and the needle on the gauge are directly in line.

Turn the flywheel against rotation until the dial gauge reads 5-1/2 (.0055") on the dial for 4° P.O. Mark the flywheel at the indicator with a straight edge and scratch awl.

Remove the flywheel and deepen the marks with a chisel. An identifying mark should be made near each mark. The first mark (cranking rotation) will be "PO", the other mark is the "TC" mark.

Install the flywheel (be sure the key is in place) remove the dial gauge, and replace other parts removed.

GEAR COVER. - Tap the gear cover gently with a soft hammer to loosen it. Do not pry.

When installing the gear cover, do not lose the governor-shaft-end-thrust ball. Position the governor cup so that the chamfered (smoothest) hole will admit the stop pin located on the gear cover.

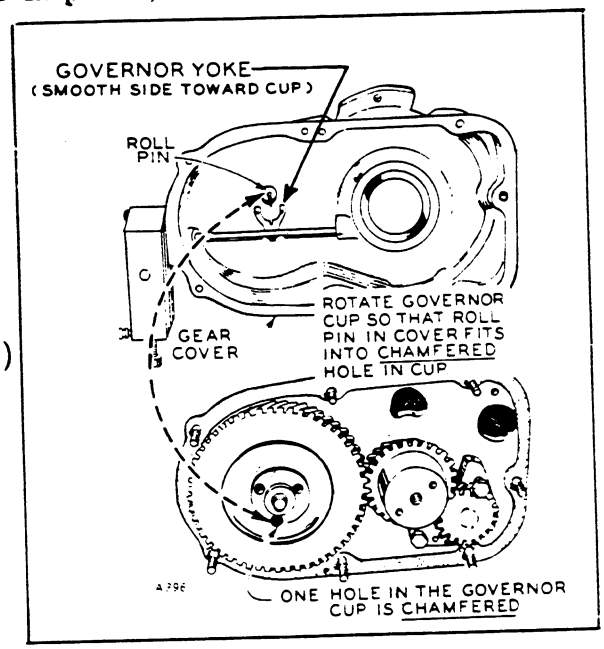


FIG. 24 - REPLACING THE GEAR COVER

Turn the governor arm and shaft until the yoke is flush against the gear cover and hold it in this position while installing the gear cover. Be careful not to damage the gear cover oil seal. Use a piece of shim stock to cover the keyway on the crankshaft. Install a new gear cover oil seal if necessary. Oil seal expander and driving tools are available.

GOVERNOR CUP. - With the gear cover removed the governor cup can be taken off by removing the snap ring from the camshaft center pin and sliding the cup off. Be sure to catch the ten 9/16" flyballs as they will fall out when the cup is removed.

When installing a new governor cup, tip the plant upward from the blower end, place the flyballs in their places and install the governor cup and the snap ring on the

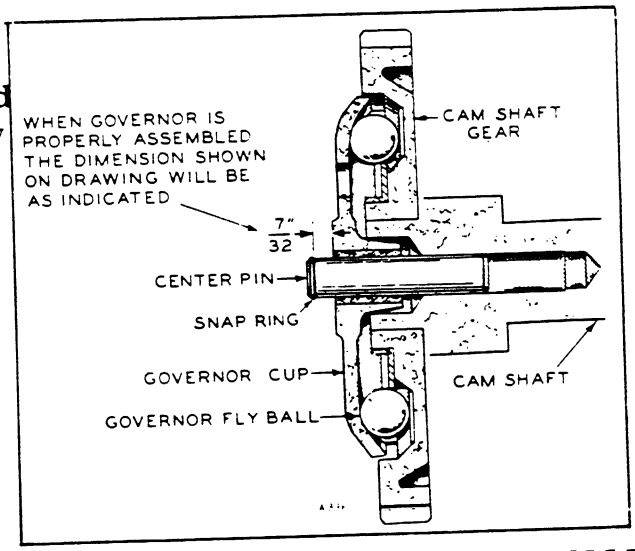


FIG. 25 - GOVERNOR CUP ASSEMBLY

center pin. The distance from the snap ring to the governor cup sleeve, when the cup is flush against the flyballs, must be exactly 7/32 of an inch for the governor to operate properly. If it is less than 7/32 of an inch, remove the cup and carefully dress down the face of the cup until this clearance is obtained. If more than 7/32 of an inch, the camshaft must be removed and the center pin carefully pressed in by means of an arbor press to allow 7/32 of an inch travel. Leave the cup and snap ring on the pin to measure by. Be very careful not to damage the center pin.

CRANKSHAFT GEAR. - The crankshaft gear is keyed and a drive fit to the crankshaft and is fastened with a lock ring. To remove the gear, attach a gear puller to the gear's three #10-32 tapped holes on a 2-1/2" diameter. When installing a crankshaft gear, have the key in place, face the "0" timing mark outward, and drive the gear on up to the crankshaft shoulder. Be sure the marked tooth ("0" timing mark) meshes with the marked camshaft gear tooth.

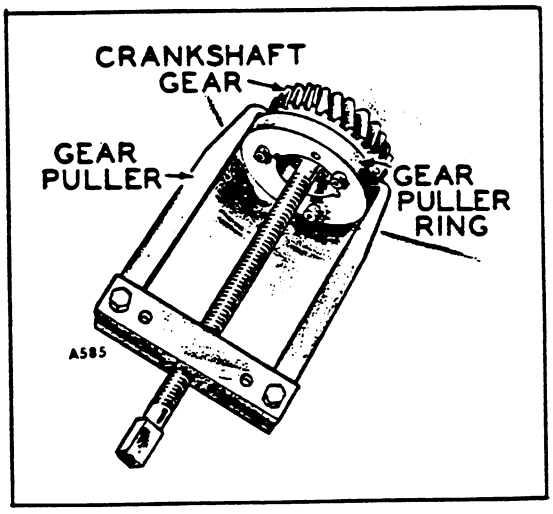


FIG. 26 - REMOVING THE CRANKSHAFT GEAR

Should it become necessary to replace the crankshaft gear, the camshaft gear must also be replaced as these gears are sold only as a matched set.

CAMSHAFT GEAR. - The camshaft and gear should be removed from the engine as an assembly. Before this can be done all parts necessary to expose the gears must be removed from the front of the engine. In addition to the transfer pump, the valve tappets, the anti-flicker plunger (AC Plants) and the injection pump and tappet must be removed from the engine. If necessary, insert a screwdriver between the block and the gear and apply a little pressure to loosen the camshaft.

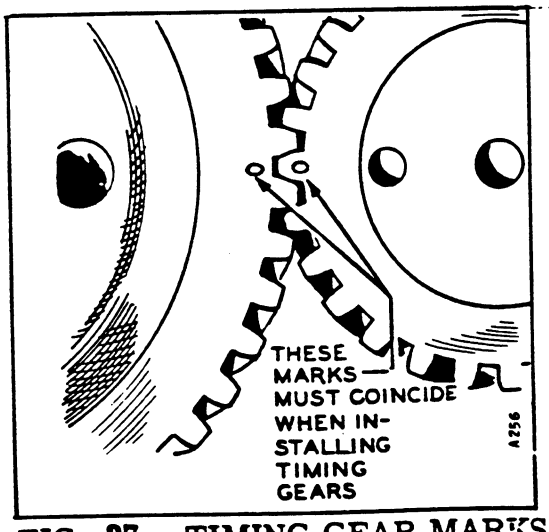


FIG. 27 - TIMING GEAR MARKS

If the gear is to be removed from the shaft, remove the snap ring from

the center pin and then the governor cup and flyballs. Then place the camshaft and gear in an arbor press and remove the gear. Be very careful not to damage the center pin.

If the camshaft gear must be replaced, the crankshaft gear must also be replaced as they are sold only as a matched set. When pressing the camshaft gear into place on the shaft, be sure the key is in place and that the gear is straight on the shaft.

When installing the camshaft and gear, be sure the thrust washer is in place behind the camshaft gear. The thrust washer provides for proper camshaft endplay.

Minimum endplay can easily be determined by pushing in on the camshaft gear and crankshaft gear and inserting a .003" feeler gauge between the camshaft gear and the crankshaft gear washer to check the gap. A gap of less than .003" indicates excessive crankshaft endplay.

Always be sure that the timing marks on the gears are aligned as illustrated whenever gear position has been disturbed.

CRANKSHAFT. - The engine must be completely disassembled to remove the crankshaft. Whenever making major repairs on the engine always inspect the drilled passages of the crankshaft and if necessary, clean them to assure proper lubrication of the connecting rods. The bearing journals should also be inspected. If they appear scored and cannot be smoothed out by dressing down, a new crankshaft should be installed or the crankshaft re-machined to take available undersize main and connecting rod bearings. See the parts list.

Crankshaft endplay should be between .010" and .015". This clearance can be checked by inserting proper size feeler gauges between the main bearing flange and the crankshaft thrust surface. Clearance can be adjusted by using gaskets as needed behind the bearing plate.

BEARINGS. - The crankshaft main bearings are of the sleeve type. The "bronze" faced main bearing and separate thrust washer is original equipment beginning Serial 647119. When used to replace the flanged aluminim bearing as used on earlier models, you must drill one additional hole and install a second lock pin to prevent each thrust washer from riding on the crankshaft.

Main bearings are available in standard or .002", .010", .020" or .030" undersize, and do not require finishing to size after installation. When driving or pressing the bearing in, align the oil passages in the bearing and bore. Oil the bearings. When installing the crankshaft, install a thrust washer at each end with grooved side against crankshaft and engaged with lock pins (coat with oil to hold while assembling). Measure the crankshaft end play, see table of clearances.

The oil groove of the front camshaft bearing must be centered at the top. The slot in the rear camshaft bearing must be nearer the inside of the crankcase and must align with the plunger hole (ac units). Press or drive the front bearing in flush with the bearing boss and the rear bearing in flush with the expansion plug groove. Replace the expansion plug of the rear camshaft bearing. Coat the bearing journals with light oil before installing the camshaft.

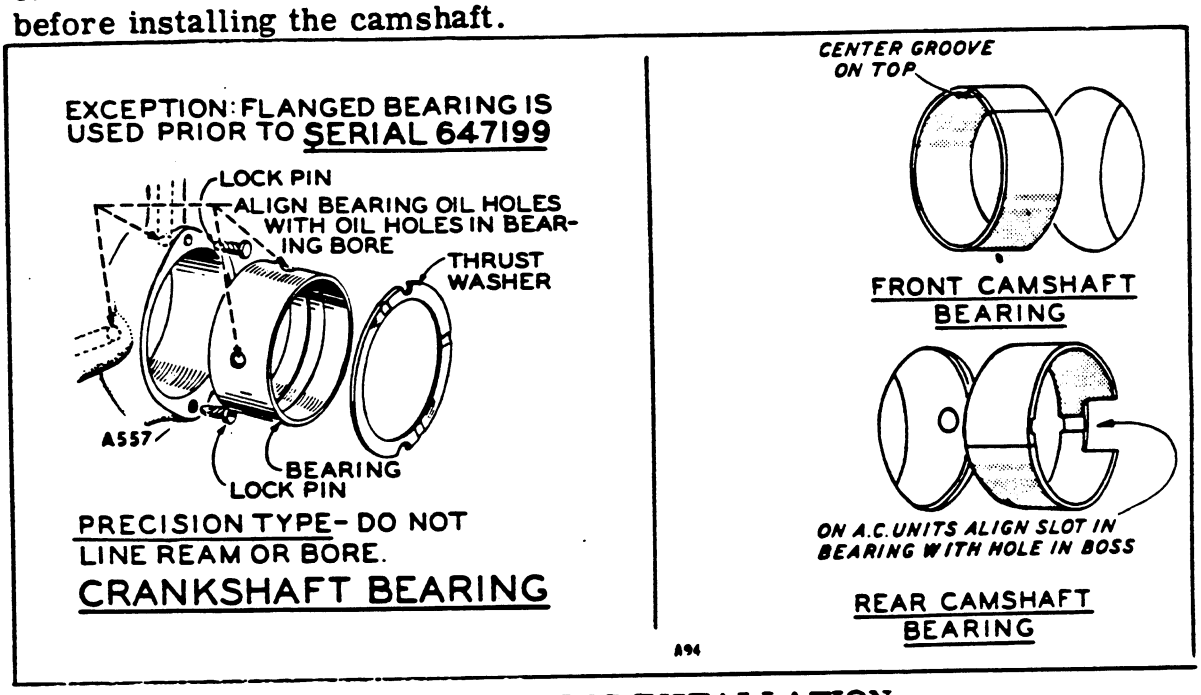


FIG. 28 - BEARING INSTALLATION

The camshaft bearings must be line bored or line reamed after being installed in the crankcase. Any reliable machine shop should be able to perform this service. If equipment for line boring or reaming is not available locally, see the dealer from whom you purchased the unit or return it to the factory for repairs. Refer to the Table of Clearances.

OIL SEALS. - The gear cover must be removed to replace its oil seal. Drive the old seal out from the inside toward the outside of the gear cover.

The bearing plate must be removed before the rear oil seal can be removed. Drive the old seal out from the inside toward the outside of the bearing plate.

When installing the gear cover oil seal, lay the gear cover on a board so that the bearing boss is supported; otherwise the gear cover may be distorted when installing the oil seal. Tap the oil seal into place until it is flush with the boss. Cover the keyway with shim stock when installing the gear cover. Remove the shim stock as soon as the oil seal

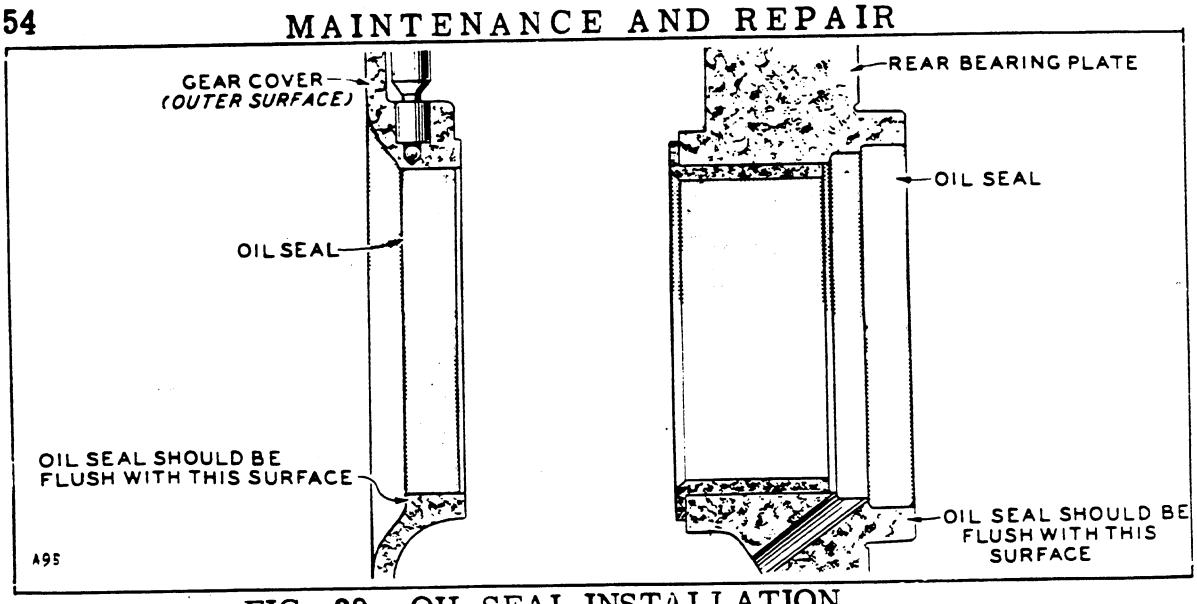


FIG. 29 - OIL SEAL INSTALLATION

is safely over the keyway. Seal installing tools are available.

When installing the bearing plate oil seal, drive the seal into the bearing plate until it is flush with the outer end of the boss. Use a piece of hollow pipe that will fit over the crankshaft and contact the oil seal near the outer edge. Drive the seal in evenly all the way around. Use a piece of shim stock over the keyway to avoid damaging the seal.

OIL PUMP. - To remove the pump from the crankcase, unscrew the oil pump assembly from the intake cup as illustrated.

Check the oil pump thoroughly for worn parts. Except for gaskets, component parts of the oil pump are not individually available. A faulty oil pump should be replaced with a complete new pump.

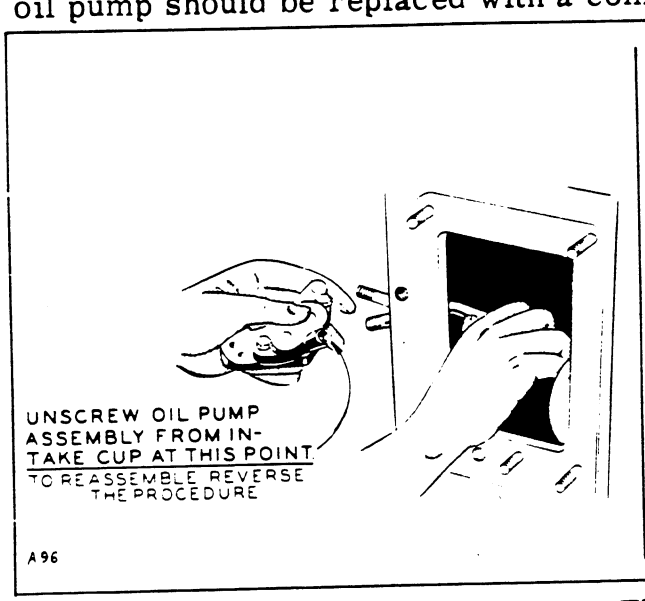


FIG. 30 - OIL PUMP REMOVAL

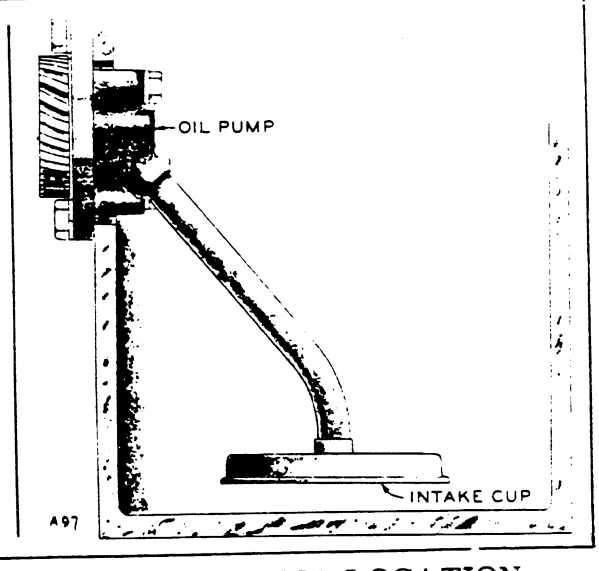


FIG. 31 - OIL PUMP LOCATION

Reverse the order of removal when installing the oil pump. Several adjustments may have to be made before the suction cup is positioned parallel with bottom of the crankcase.

OIL PUMP BY-PASS. - The By-Pass is not adjustable and normally requires no service. To determine if high oil pressure is caused by the plunger stuck closed or if low pressure is caused by the plunger stuck open, clean the By-Pass.

Drain the crankcase oil and remove the filter and breather mounting plate to make the By-Pass accessible.

Disassemble as illustrated and clean with diesel fuel or kerosene.

Install By-Pass with cap toward oil reservoir.

Install parts removed and refill crankcase.

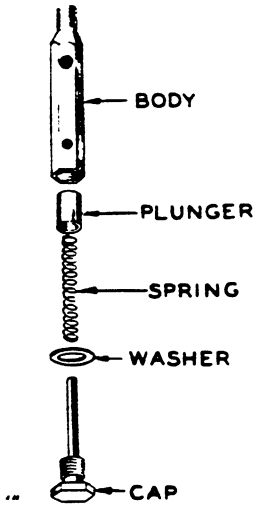


FIG. 32 - OIL PUMP BY-PASS

CRANKCASE BREATHER VALVE. - A partial vacuum is created in the engine whenever the engine is running. The work of the crankcase breather valve is to help maintain this partial vacuum and prevent oil leakage. If the engine begins to leak oil, the check valve in the breather cap may be sticking.

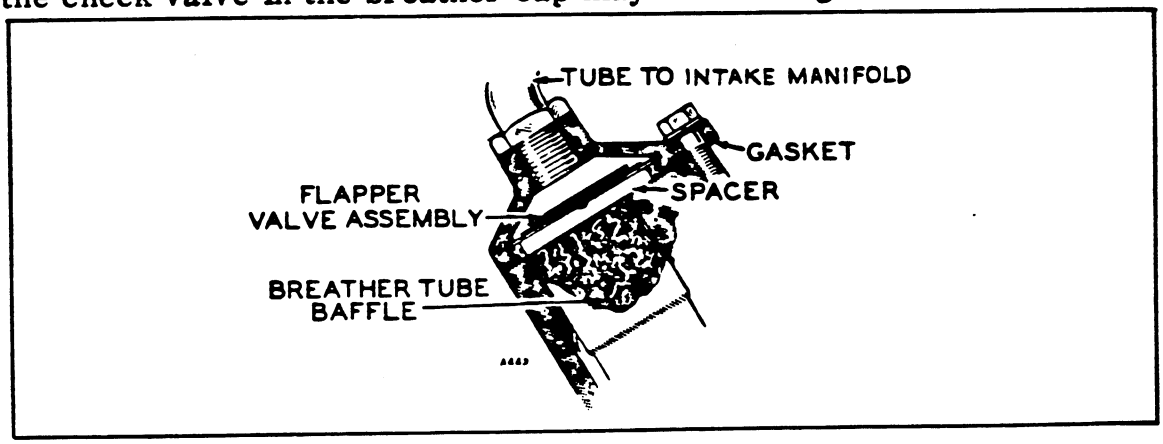


FIG. 33 - SERVICING CRANKCASE BREATHER VALVE

Remove the breather cap. Then remove the breather valve from the breather cap and inspect it carefully. If the flexible disc is stuck or does not work freely, soak it in diesel fuel or kerosene for a few minutes. Flex it to permit all the sludge to dissolve. To determine if valve is functioning properly, hold it in place while operating the engine. If not, install a new breather valve. Inspect the metal wool in the breather tube. If necessary, clean by slushing the assembly in kerosene or diesel fuel. Install all parts removed making sure the large flat portion of the breather valve is placed downward.

OIL PRESSURE SWITCH (Remote-Starting Plants). - The oil pressure switch makes contact at approximately 5 pounds oil pressure. It serves primarily as an operating switch to close the decompression-release circuit. It is not intended to give adequate plant protection in case of a gradually diminishing oil pressure or too low oil level. Complete failure of oil pressure will open the switch to stop the plant (except if solenoid plunger has been manually locked IN).

For ungrounded systems, since the switch used is not internally grounded, the second terminal is for completing the circuit. Make connections electrically secure. A switch failed closed will prevent normal cranking. A switch failed open will prevent compression.

DECOMPRESSION RELEASE SOLENOID (Remote-Starting Plants). - On the knurled knob of the solenoid plunger is stamped the voltage (12V or 32V) of the solenoid and whether it is to be used with a grounded (G) or ungrounded (NG) system.

ROCKER ARM PUSH RODS AND PUSH ROD SHIELDS. - The push rod shields are a drive fit into the collars at the crankcase and a loose fit into the rocker box. "O" rings must be installed on the shields after the rocker box is in place. Turn the crankshaft until the rocker arm lifts and press the "O" rings into place with a blunt tool.

To lift out the push rod tappets from the crankcase, insert a bent wire into the drilled hole in the tappet.

FUEL SYSTEM. - Instructions for servicing various parts of the fuel system are given under PERIODIC SERVICE. The fuel system must be leak proof or air leaks may occur and cause trouble. If Permatex or an equivalent thread sealing compound is used on fuel line fittings USE EXTREME CARE THAT NONE ENTERS THE SYSTEM.

FUEL TRANSFER PUMP. - A transfer pump of the diaphragm type is used to transfer fuel from the fuel tank through the filter to the injection pump. If fuel does not reach the filter, make the following checks before removing the fuel pump. Check the fuel tank to see that there is enough fuel in it and the shut-off valve is open. Disconnect the fuel line at the transfer pump outlet and work the priming lever on the pump. Fuel should spurt out of the line at the pump. If priming lever does not operate, crank engine one revolution. If there is enough fuel in the tank, the shut-off valve open, and the line between the tank and pump is clear but fuel does not spurt out of the transfer pump outlet, repair or replace the pump. Transfer pump failure is usually due to a leaking diaphragm, a valve or valve gasket; a weak or broken spring; or wear in the driving linkage. A pump repair internal parts kit is available. Check for diluted lubricating oil. Rotating the diaphragm

1/4 turn will release it from the driving link. Lubricate the linkage before installing the pump.

GASKET. - Always use new gaskets when replacing any part that requires a gasket. Thoroughly clean the surface that the gasket contacts before installing the gasket. Gaskets are listed singly in the parts list, also in kit form under SERVICE KITS.

GENERATOR

The generator normally needs little care other than a periodic check of the brushes, commutator and collector rings. If a major repair job on the generator should become necessary, have the equipment checked by a competent electrician who is thoroughly familiar with the operation of electric generating equipment. Continuity tests may be performed without disassembly of the generator.

GENERATOR DISASSEMBLY. - The procedure is mostly self-evident. Remove the band and endcover. Remove constant-pressure-type springs and lift all brushes. To lift brushes using conventional type springs, allow the spring to press against the side of the brush.

Remove generator through stud nuts. Hold both the end bell with its brush rig and the frame assembly, since they are separate parts, and remove them as one assembly from the adapter. Screw driver slots in the adapter provide for prying the frame loose. Be careful not to let the frame assembly rest or drag on the armature.

Remove the armature and hub as an assembly. The hub is a keyed and pressed fit on the armature shaft, and engages with pins and a mating surface on the engine flywheel. Because the stud holds both the armature and the flywheel, attempt to remove only the armature and allow the flywheel to remain on the crankshaft. Turn the nut to the end of the armature through stud. While pulling outward with one hand under the armature, strike a sharp endwise blow on the nut to loosen the armature.

If the armature does not come loose, place a heavy brass rod on the armature shaft near the ball bearing and strike a sharp downward blow on the rod with a hammer. Rotate the armature 1/2 turn before repeating. Do not strike the commutator, collector rings, or bearing.

BRUSHES AND SPRINGS. - Inspect brushes periodically. Brushes worn to 5/8 inch should be replaced. Replace springs if damaged or if proper tension is questionable. Rapid brush wear may be caused from high mica between commutator bars, rough commutator or collector rings, or from a deviation from "neutral" position in the adjustment of the brush rig. NEVER bend the constant-pres-

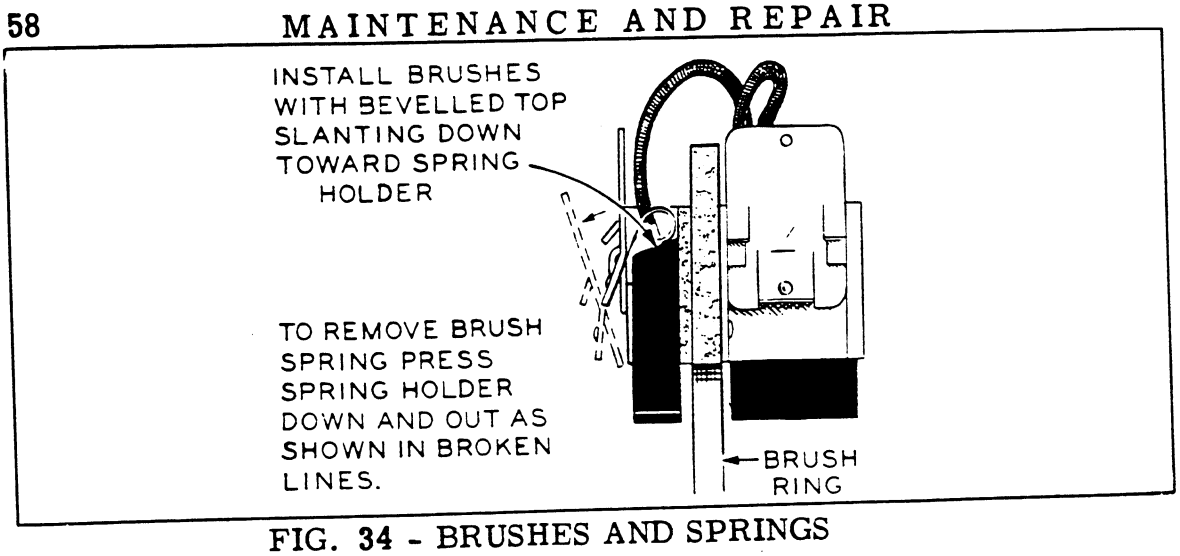


FIG. 34 - BRUSHES AND SPRINGS

sure-type spring over the edge of its support.

BRUSH RIG POSITION. - Check the witness mark on the brush rig and if necessary align it with the boss in the end bell. If the brush rig is adjusted so that there is arcing of the brushes, brush wear will be rapid, voltage and current will not hold steady, and the generator may overheat.

Whenever a new brush rig or armature is installed, the brush rig must be adjusted to the point where the brushes do not arc regardless of where the witness mark falls. This is commonly known as the "neutral" brush position.

COLLECTOR RINGS (AC Units) . - If the collector rings become grooved or out of round, or the brush surface becomes pitted or rough so that good brush seating cannot be maintained, remove the armature and refinish the collector rings in a lathe.

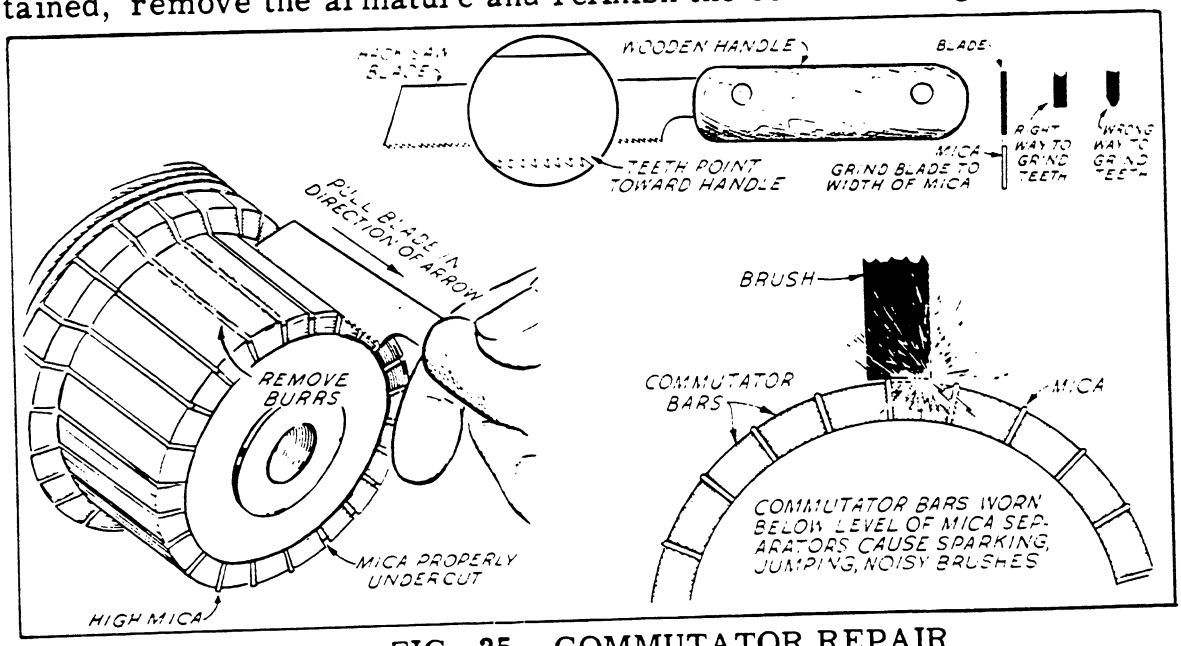


FIG. 35 - COMMUTATOR REPAIR

If the commutator appears to be rough or scored refinish it at the same time. Remove or adequately shield the ball bearing during refinishing.

COMMUTATOR. - The commutator bars wear down with usage so that the mica between them must be undercut. This should be done as soon as the mica on any part of the commutator touches the brushes. A suitable undercutting tool can be made from a hack saw blade. Avoid injury to the surfaces of the copper bars. Leave no burrs along the edges of the bars. The mica must also be undercut whenever the commutator is refinished.

TESTING WINDINGS. - A test lamp set and an armature growler are required for the various tests. Before making any tests, lift all brushes into their holders and disconnect the load circuit wires from the plant. If the armature tests defective, the practical repair is to replace it. If a field coil tests defective, replace the entire coil assembly unless the trouble is in one of the external leads. Then it can be repaired as the nature of the trouble requires.

ARMATURE GROUND TEST. - To test the armature for a grounded condition, lift or remove the brushes so that none contact the commutator or collector rings. Use a continuity type test lamp set. Place one test prod on the commutator, and

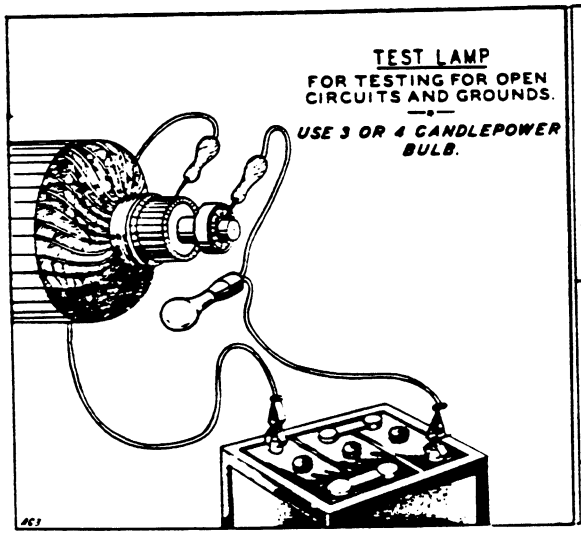


FIG. 36 - CONTINUITY TEST LAMP

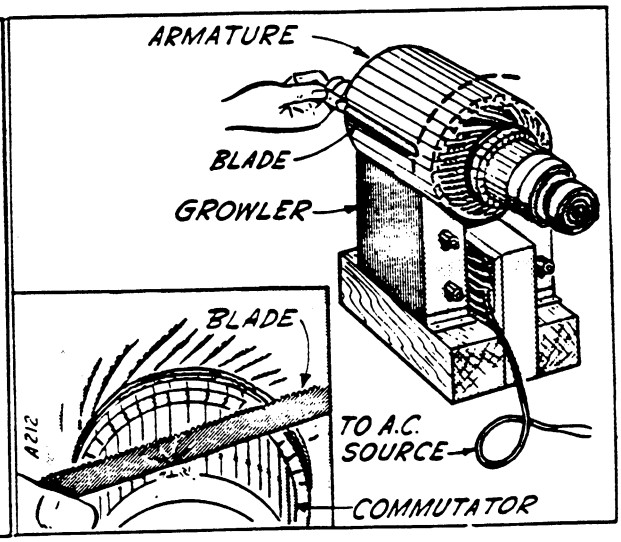


FIG. 37 - ARMATURE GROWLER

the other test prod on a bare, clean part of the armature shaft. The test prods must make good electrical contact. The test lamp should not glow. If the test lamp does glow, the dc winding or the commutator is grounded. To test the ac winding, place one test prod on one of the collector rings and the other test prod on the armature shaft. If the test lamp glows, the ac winding or a collector ring is grounded. Replace a grounded armature with a new one.

ARMATURE OPEN CIRCUIT TEST. - The armature ac winding may be tested for an open circuit without removal of the armature. Testing the dc winding requires removal and the use of an armature growler.

To test the ac winding, be sure all brushes are lifted or removed. Use a test lamp set. Place one test prod on each of the collector rings. If the test lamp does not glow, the ac winding is open circuited.

To test the dc winding, place the armature in a growler. With the growler current on, pass a smooth steel strip across the commutator segments. Repeat all around the commutator. At some point around the commutator, a spark should occur as the strip contacts two adjacent segments. Rotate the armature slightly and repeat the test. Continue until a spark is obtained between all adjacent segments. If no spark is obtained at some point, an open circuit is indicated. (NOTE: A short circuit in the winding might prevent sparking. This condition may be indicated by the short circuit test described in the next paragraph.) Replace an open circuited armature with a new one.

ARMATURE SHORT CIRCUIT TEST. - To test for a short circuit, place the armature in a growler. With the growler current on, hold a steel strip about 1/2 inch above the armature laminations. Pass the strip back and forth over the laminations. Cover as much of the lamination area as possible. If the strip is magnetically attracted to the armature at any point, a short circuit is indicated. After testing in one position, rotate the armature slightly in the growler and repeat the test. Continue until a complete revolution of the armature in the growler has been made. Replace a short circuited armature with a new one.

TESTING FIELD WINDINGS. - Use a test lamp set for all tests except a short circuit. The field coils of all ac plants are saturated shunt wound, the Remote Start plants having a series field winding in addition for cranking and battery charging purposes. When testing a field coil assembly, disconnect all of its external leads from their terminals. Tag and mark each lead to assure proper connections when reassembling.

TESTING FIELD WINDINGS FOR GROUNDS. - To test a coil assembly for a ground, disconnect its external leads and touch one test prod to the terminal of one of its leads and the other test prod to the generator frame. If the lamp lights, the coil assembly being tested is grounded. The ground may be in a coil, coil connection, or coil lead. Repair or replace as needed.

TESTING FIELD WINDINGS FOR OPEN CIRCUIT. - To test a coil assembly for an open circuit, disconnect its external leads and touch one test prod to the ter-

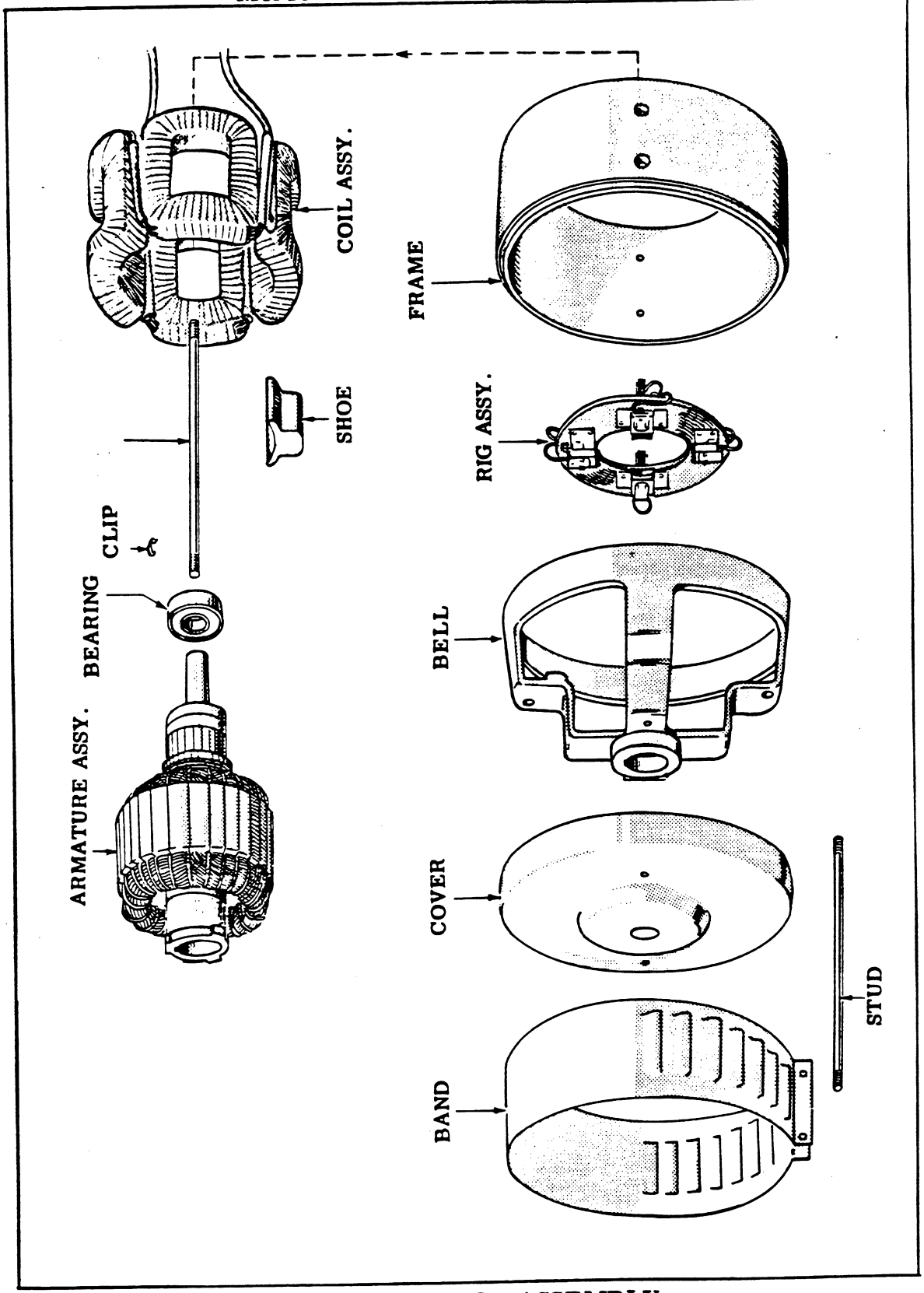


FIG. 38 - GENERATOR ASSEMBLY

minal of one coil winding lead and the other test prod to each of the other leads of that coil winding in turn. If the lamp does not light, the circuit being tested is open. If the fault lies in connection between coils or in a coil lead, the trouble can be repaired. If it is inside the coil proper, replace the entire coil assembly.

BALL BEARING. - If replacement of the armature ball bearing becomes necessary, pull the bearing from the shaft with a suitable bearing puller. Be careful not to damage the armature shaft because it must remain true to serve as a turning center when refinishing the commutator or collector rings. Drive the bearing on to the shoulder on the shaft. Use a double-sealed pre-lubricated ball bearing.

GENERATOR ASSEMBLY. - When reassembling the generator, see that there are no nicks or dirt on the armature blower tapered surface. These conditions may cause an excessive run-out (wobble) at the bearing end. Run-out should be within 0.002". Tighten the armature through stud nut securely.

CONTROLS

If any of the control equipment fails to function properly, replace the defective part with a new part of the same kind rather than try to repair the old part. No attempt should be made to repair such parts as meters, fuses, switches, relays, or receptacles. Check all electrical connections and contacts whenever servicing control equipment.

Always disconnect the battery whenever servicing controls to avoid accidentally starting the plant. When disassembling controls, tag each lead that has to be removed and mark the connection point of the lead on the tag to assure correct connections when reassembling.

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PROTECT

YOUR INVESTMENT!

PREPARE IDLE PLANTS FOR STORAGE. SEE "PREPARING UNITS FOR STORAGE".

FREQUENT INTERVALS OF OPERATION UNDER FULL LOAD IS RECOMMENDED FOR BETTER OPERATION OF THE PLANT NORMALLY BEING RUN UNDER ONLY LIGHT LOAD. REFER TO "STOPPING THE PLANT".

This section is specifically for "Contractor's" models 3DSL-1E2236 and 2E2236. These models are designed for exciter cranking through a toggle switch on the plant; there are no relays in the control. Superior fuel and air filtration systems permit operation under extremely dusty, dirty conditions.

These supplementary instructions are to be used, where they apply, instead of the instructions for the standard generating plants. For instructions not covered in this section, refer to the appropriate section for the standard plants.

FUEL FILTERS. - The interval at which periodic service is performed depends, to a great extent, on operating conditions. A clean fuel system is imperative. Each filter has a drain valve in bottom of filter. Sediment should be drained by opening the drain valve at least after each 50 hours of operation, unless experience and operating conditions indicate otherwise.

The element in the primary filter should be replaced after each 300 hours of operation. This too, may have to be altered according to conditions.

The secondary filter normally requires less attention than the primary filter, which eliminates most of the foreign matter from the system. Fuel starvation indicates that the secondary filter element should be replaced.

Fuel filters must be assembled air tight. A Bleed plug is located on top of each filter to bleed air and gases from the system. Refer to preparation section.

AIR CLEANER. - Servicing the air cleaner depends on operating conditions. An integrated pre-cleaner, represented by the glass jar, traps most of the larger dust particles, and the foam element stops the very minute particles.

Periodic service includes cleaning the glass jar before it becomes completely filled with dust and washing the foam element with a detergent and water solution as often as necessary, possibly every day. After it has been washed and dried, a light coat of 10W-30 motor oil should be wiped onto the outside of the element.

CONTROLS. - The start switch energizes the series winding in the generator for electrical starting. The oil pressure switch causes the decompression solenoid to close after the engine has reached sufficient speed to create about 5 pounds oil pressure. The battery is charged at a rate of about 2 amperes. A rectifier in the charging circuit restricts the flow of current to the battery. The charge condition

of the battery can be determined with a hydrometer. The engine is stopped by actuating the stop switch to de-energize the decompression solenoid. The stop switch must be closed before the engine can be re-started

The glow plug and manifold heater are controlled by a switch on the control panel. These two components should be energized until the engine comes up to full speed.

POSSIBLE CAUSE	REMEDY
ENGINE CRANKS TOO STIFFLY	
Load not disconnected from unit.	Disconnect load from unit when starting.
Too heavy oil in crankcase.	Use only recommended grades.
Engine stuck.	Disassemble and repair.
Compression release in running position. NOTE: Engine may not even turn over.	Compression release must be at start position when starting the engine.
ENGINE WILL NOT START WHEN CRANKED	
Air in fuel system.	Bleed the fuel system.
Lack of fuel or faulty injection caused by dirty fuel.	Keep fuel tank filled. Keep fuel clean. Use only recommended fuels.
Clogged fuel filter.	Keep supplies of fuel clean. Replace fuel filter element.
Poor fuel.	Use only recommended grades.
Poor compression due to leaky gasket, loose head, worn valves or piston rings.	Tighten cylinder head. Replace cylinder head gasket if necessary. Grind valves, replace if necessary.
Wrong injection pump timing.	Check the injection pump timing.
ENGINE CRANKS SLOWLY OR WILL NOT CRANK	
Defective or discharge battery.	Replace or recharge battery.
Loose connections or broken wire in generator circuit.	Tighten loose connections. Replace terminals or wire where necessary.
Corroded battery terminals.	Clean corroded terminals. Replace cable if necessary.
Generator brushes worn excessively or making poor contact.	Replace brushes. See that brushes make good contact.
Short circuit in generator or load circuit.	Repair as needed.

POSSIBLE CAUSE	REMEDY
ENGINE CRANKS SLOWLY OR WILL NOT CRANK (Cont.)	
Dirty or corroded points in start solenoid switch (Remote-starting Plants only).	Replace switch.
Decompression-release-solenoid faulty, (Remote-Starting Plants only).	Replace solenoid if cleaning does not correct. Extract plunger-locking pin to disassemble for cleaning. Note that 32V solenoids stamped "NG" are the not-grounded-to-engine type.
ENGINE RUNS BUT VOLTAGE DOES NOT BUILD UP	
Poor brush contact.	See that brushes seat well on commutator and collector rings (where used), are free in holders, are not worn shorter than 5/8 inch and have good spring tension.
Open circuit, short circuit or ground in generator.	Check and repair or replace as described under GENERATOR in the Maintenance and Repair Section.
VOLTAGE UNSTEADY BUT ENGINE NOT MISFIRING	
Speed too low.	Adjust governor to correct speed.
Injection pump fuel metering shaft not properly adjusted.	Adjust as instructed under SPECIAL ADJUSTMENTS.
Poor commutation or brush contact.	Refinish commutator or undercut mica if necessary. See that brushes seat well on commutator and collector rings (where used), are free in holders, are not worn shorter than 5/8" and have good spring tension.
Loose connections.	Tighten connections.
GENERATOR OVERHEATING	
Short in load circuit.	Correct short circuit.
Generator overloaded.	Reduce load.

POSSIBLE CAUSE	REMEDY
GENERATOR OVERHEATING (Cont.)	
Improper brush rig position.	Adjust to "neutral" position.
ENGINE OVERHEATING	
Improper lubrication.	See Low Oil Pressure.
Poor Ventilation.	Provide ample ventilation at all times.
Dirty or oil cooling surfaces.	Keep the engine clean.
Retarded injection timing.	Retime.
Generator overloaded.	Reduce load.
VOLTAGE DROPS UNDER HEAVY LOAD	
Engine lacks power.	See Engine Misfires at Heavy Loads.
Poor compression.	Tighten cylinder head, grind or replace valves, replace piston rings - as needed.
Faulty injection.	Check fuel system. Dirty fuel is main cause. Use only recommended fuels.
Dirty air cleaner.	Service the air cleaner.
Dirty fuel filter.	Keep fuel clean. Service filter per Periodic Service.
Restricted exhaust line.	Clean or increase the size.
ENGINE MISFIRES AT LIGHT LOAD	
Faulty injection.	Dirty fuel is main cause. Use only recommended fuels.
Poor compression.	Tighten cylinder head, grind or replace valves, replace piston rings - as needed.
Poor grade of fuel.	Use only recommended fuels.

POSSIBLE CAUSE	REMEDY
ENGINE MISFIRES AT HEAVY LOADS	
Faulty ignition.	Dirty fuel is main cause. Use only recommended fuels.
Dirty air cleaner.	Service the cleaner.
Dirty fuel filter.	Keep fuel clean. Service the filter per Periodic Service.
ENGINE MISFIRES AT ALL LOADS	
Leaky valves.	Refer to VALVE SERVICE under Maintenance and Repair.
Broken valve spring.	Replace.
Defective or dirty nozzle.	Install new nozzle.
LOW OIL PRESSURE	
Defective oil pressure gauge.	Replace.
Oil too light or oil badly diluted, caused by leaking transfer pump diaphragm.	Drain. Refill with proper oil. Repair or replace transfer pump.
Oil too low.	Add oil.
Oil relief valve not seating.	Clean by-pass. Replace if needed.
Badly worn bearings.	Replace.
Sludge on oil cup screen.	Remove and clean screen and oil reservoir.
Badly worn oil pump.	Replace.
HIGH OIL PRESSURE	
Defective oil pressure gauge.	Replace.
Oil too heavy.	Drain. Refill with proper oil.
Clogged oil passages.	Clean all lines and passages.
Oil relief valve stuck.	Clean by-pass. Replace if needed.

POSSIBLE CAUSE	REMEDY
EXCESSIVE OIL CONSUMPTION - LIGHT BLUE SMOKY EXHAUST	
Poor compression. Usually due to worn piston, rings, or cylinder.	Refinish cylinder. Install oversize piston and rings.
Oil too light or diluted.	Drain. Refill with proper oil.
Too large bearing clearance.	Replace bearings necessary.
Engine misfires. Usually due to leaky valve or broken valve spring.	Reseat or replace as needed.
Faulty injection timing.	Check injection pump timing.
Too much oil in cylinder block.	Drain excess oil.
Crankcase breather valve sticking.	Free up disc. Replace valve if necessary.
Air leak at oil fill cap gasket.	See that cap fits tightly and gasket is OK.
BLACK SMOKY EXHAUST - EXCESSIVE FUEL CONSUMPTION - POSSIBLE LACK OF POWER UNDER LOAD	
Generator overloaded. Black smoky exhaust normal condition with overload.	Reduce load to within rated capacity. If smoky condition does not clear up, stop the unit at once and check for further trouble. Serious damage may result if trouble is not corrected.
Poor compression.	Tighten cylinder head, grind or replace valves, replace piston rings - as needed.
Poor grade or dirty fuel.	Use only clean recommended fuel.
Injection pump or nozzle not operating properly.	Install new nozzle or injection pump.
Faulty injection timing.	Check injection pump timing.

POSSIBLE CAUSE	REMEDY
ENGINE RACES	
Too much fuel being injected. NOTE: stop unit at once and determine cause.	Check condition and adjustment of governor, injection pump and nozzle.
Governor linkage disconnected.	Replace linkage. Tighten mounting nut securely.
ENGINE STOPS UNEXPECTEDLY	
Empty fuel tank.	Refill fuel tank as often as needed to prevent running out of fuel.
Dirt in fuel system.	Use only recommended fuel. Service the filter per Periodic Service section. Clean fuel tank. Fill with clean fuel. Bleed fuel system. If trouble still not corrected, nozzle or injection pump may need replacing.
Decompression solenoid defective, improperly adjusted at rocker arm, or open solenoid circuit (Remote-Starting Plants only).	Operate solenoid manually or repair, adjust or replace parts needed. Check for adequate oil pressure.
Oil pressure failure. Pressure switch has opened (Remote-Starting Plants Only).	See Low Oil Pressure.
LIGHT POUNDING KNOCK	
NOTE: DO NOT CONFUSE WITH NORMAL KNOCK FROM FIRING OF FUEL.	
Loose connecting rod.	Adjust clearance or replace.
Low oil supply.	Add oil. Change if necessary.
Oil badly diluted.	Drain. Refill with proper oil.
Low oil pressure.	See Low Oil Pressure.

POSSIBLE CAUSE	REMEDY
VOLTAGE LOW AT FAR END OF LINE BUT NORMAL NEAR UNIT	
Too small line wire used for load and distance.	Install larger or extra wires or reduce load.
MOTORS RUN TOO SLOWLY AND OVERHEAT AT FAR END OF LINE BUT RUN OK NEAR UNIT	
Too small line wire used for load and distance.	Install extra or larger wires or reduce the load.

PREPARING UNITS FOR STORAGE OR EXTENDED OUT-OF-SERVICE PERIODS

Electrical generating plants are often taken out of service for extended periods of time. Plants remaining out-of-service more than 30 days should be protected against rust, corrosion, or the elements.

If the lubricating oil is dirty, drain it while hot, install a new filter element and attach a warning tag.

Remove the glow plug to pour two tablespoonfuls of rust inhibitor oil (or SAE 50 as alternate) into the cylinder. Slowly crank the engine to lubricate the cylinder, then stop at top center. Replace the glow plug.

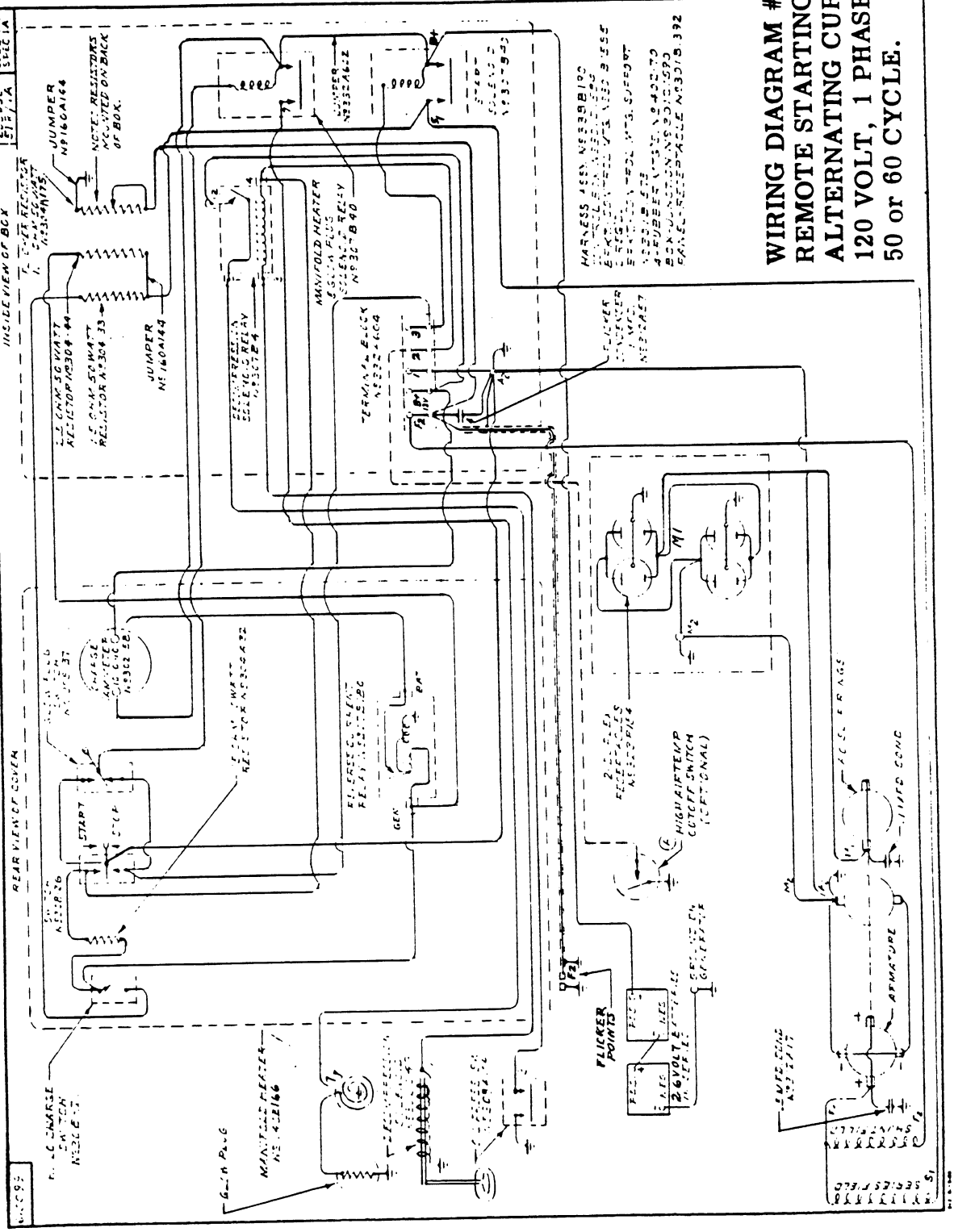
Wipe all exposed parts clean and coat with a film of grease all such parts liable to rust.

Disconnect the battery from the plant. An idle battery should be stored away from freezing temperatures and should be given a refreshening charge about every 40 days.

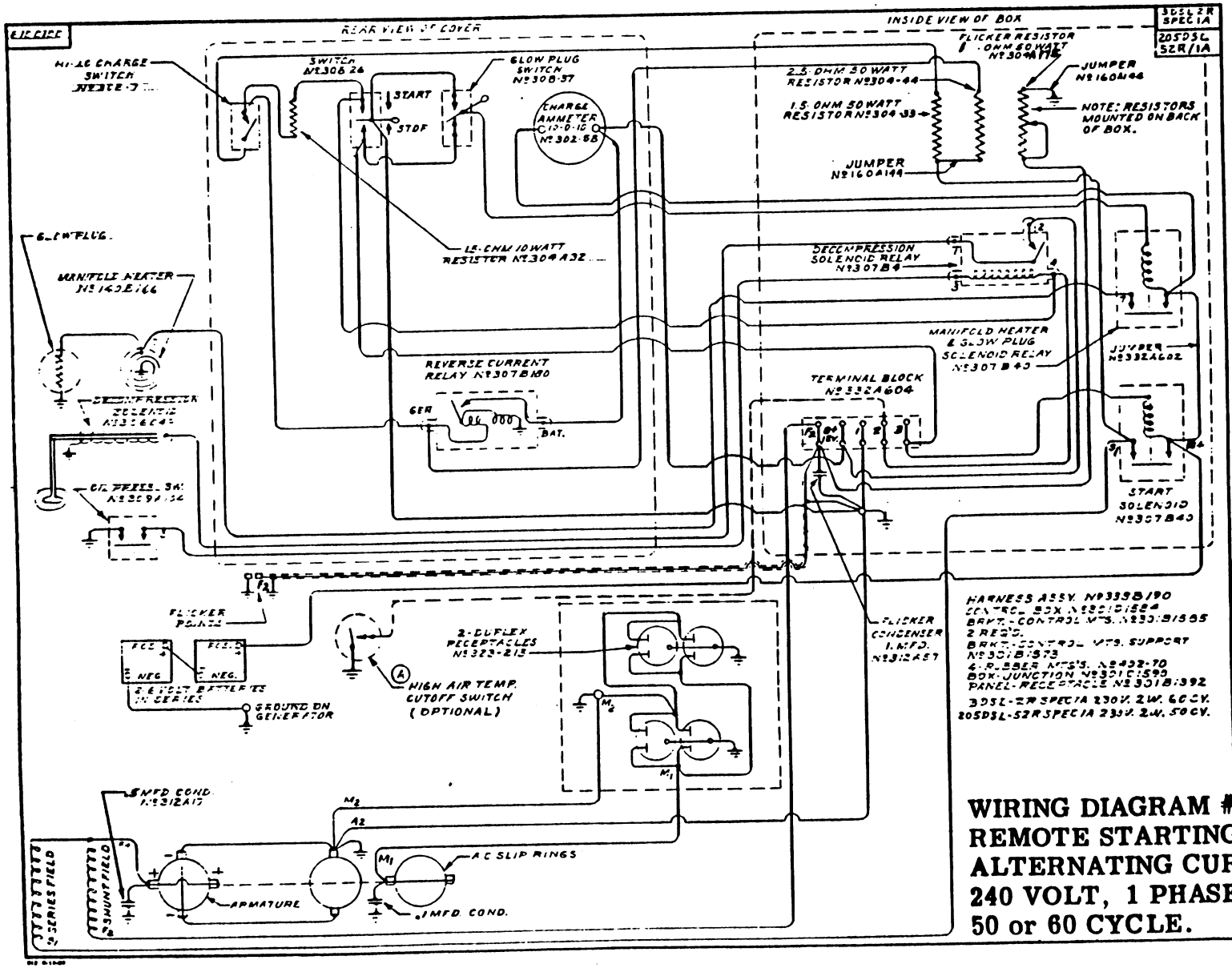
Clean generator brushes, brush holders, commutator and collector rings by wiping with a clean cloth. DO NOT coat with lubricant or other preservative!

The fuel supply and fuel system should be left filled but any possibility of fuel syphoning should be guarded against.

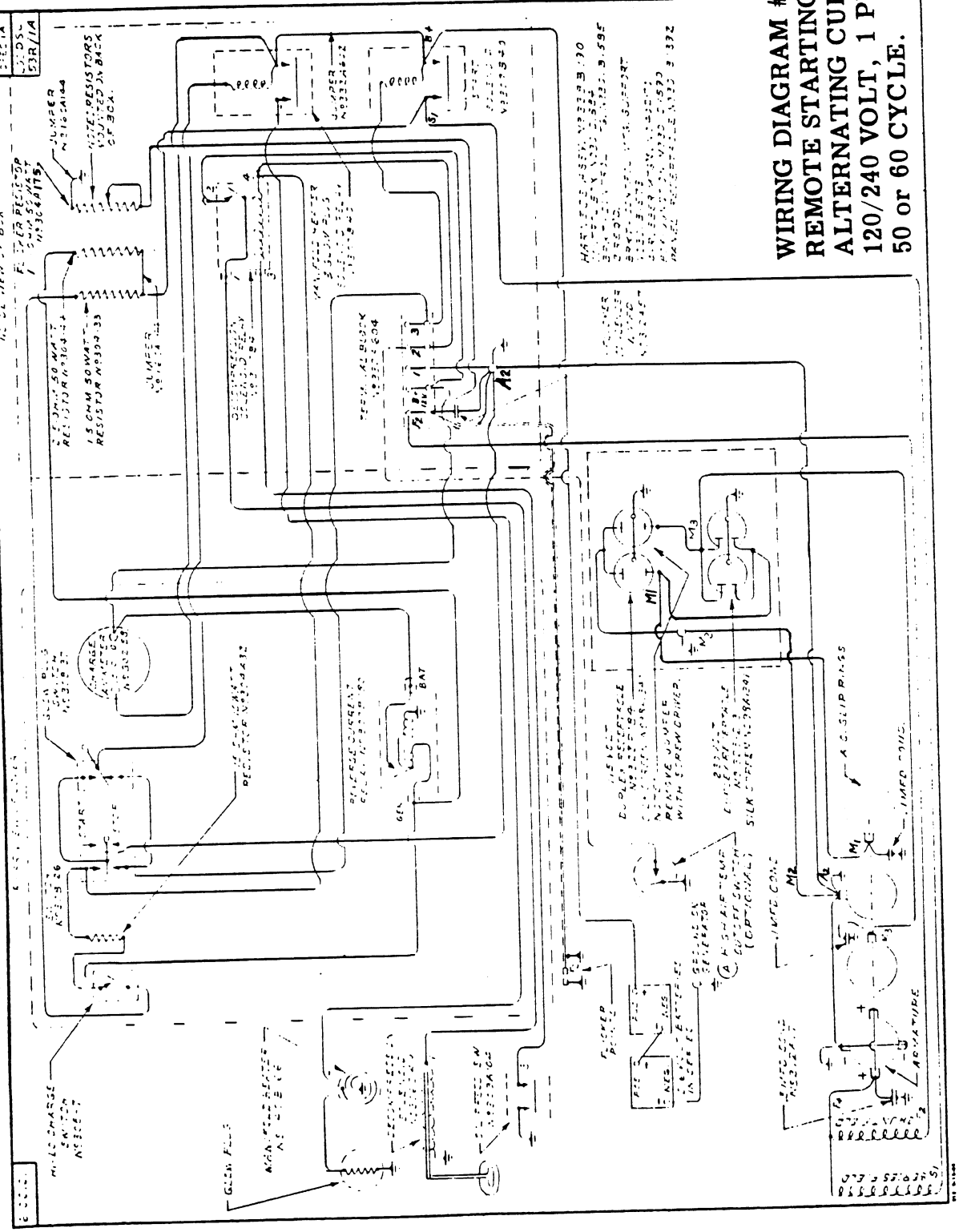
Plants being returned to service should be prepared according to preparation instructions for a new plant.



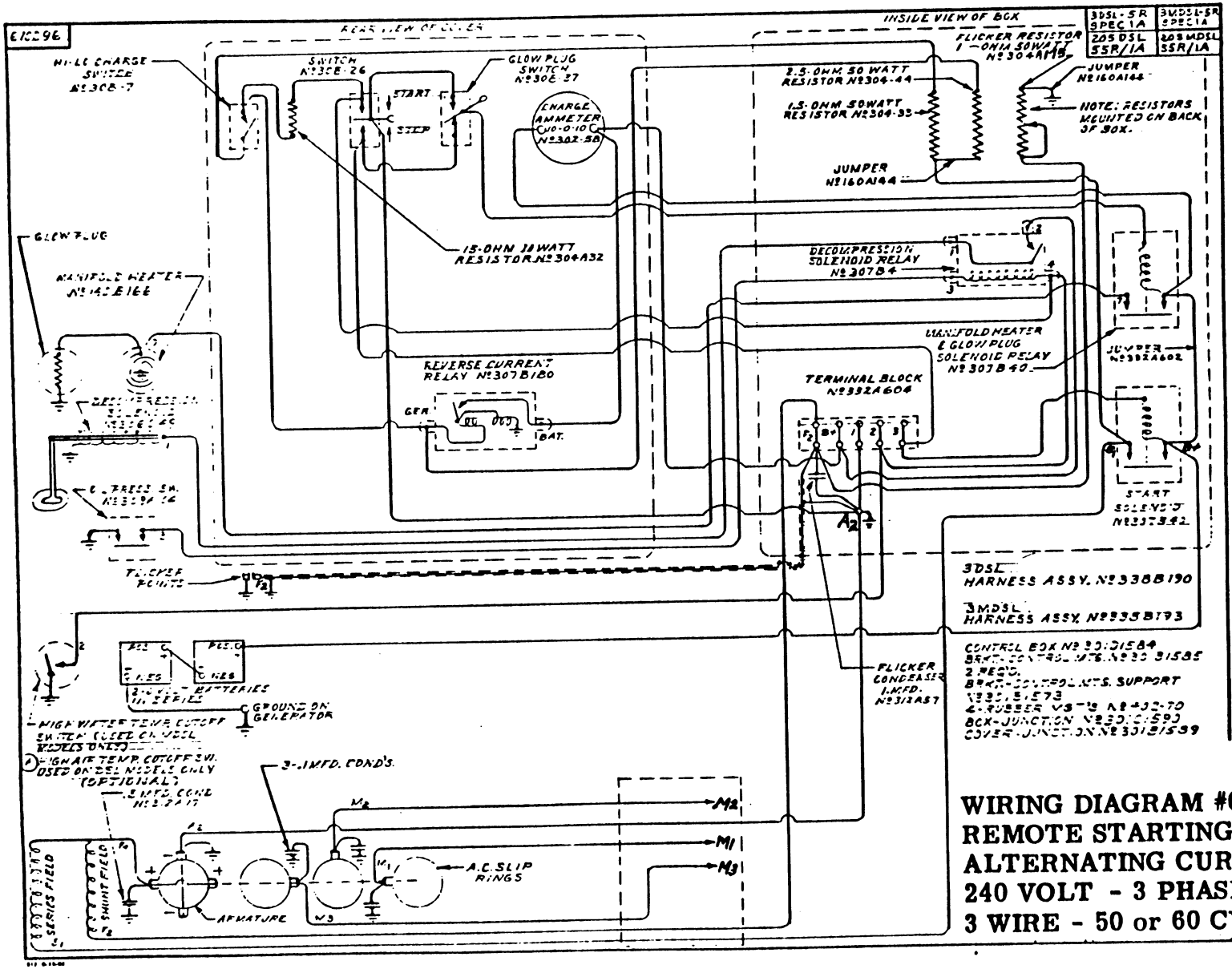
WIRING DIAGRAM #610C99
REMOTE STARTING -
ALTERNATING CURRENT -
120 VOLT, 1 PHASE, 2 WIRE,
50 or 60 CYCLE.



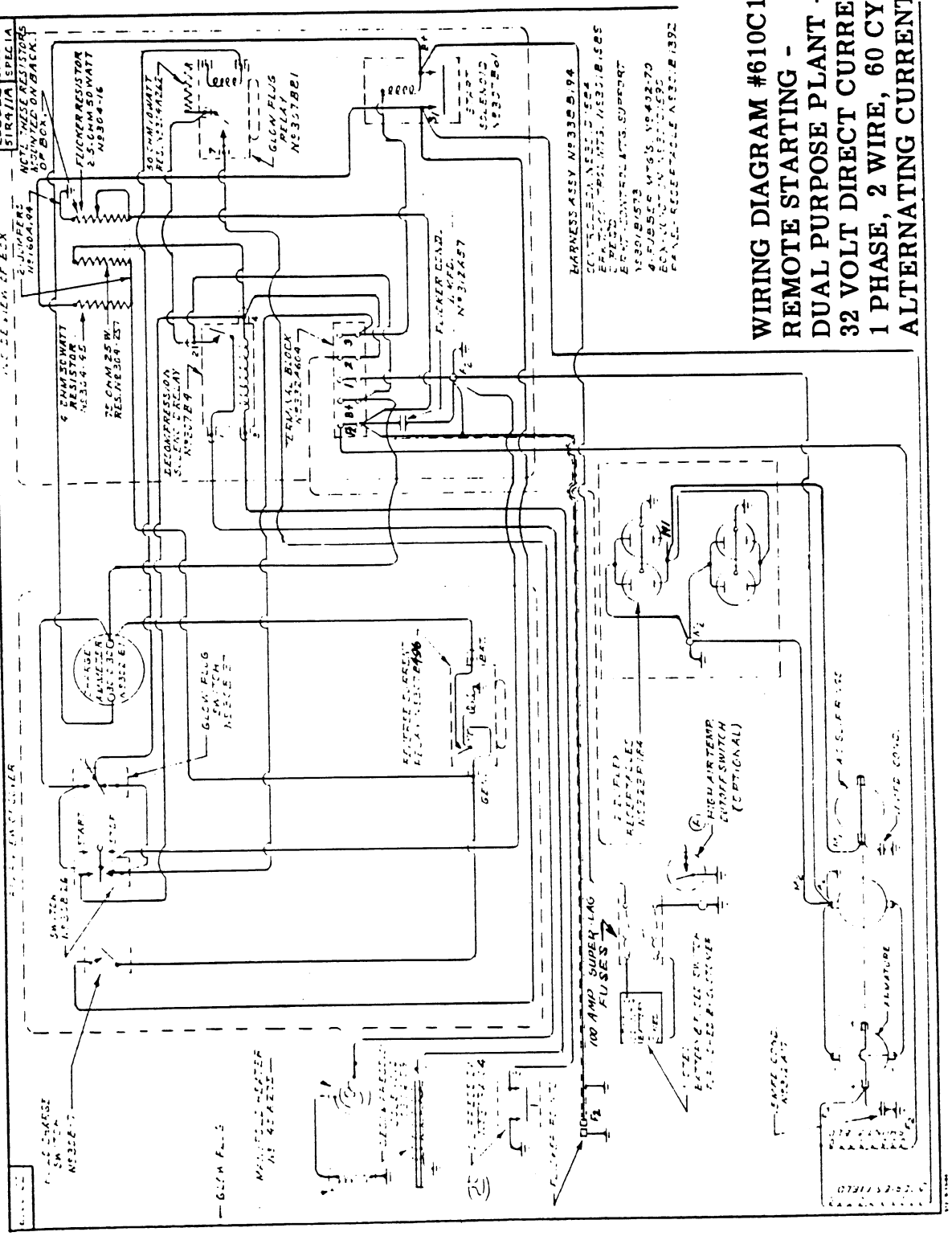
WIRING DIAGRAM #610C100
REMOTE STARTING -
ALTERNATING CURRENT -
240 VOLT, 1 PHASE, 2 WIRE,
50 or 60 CYCLE.



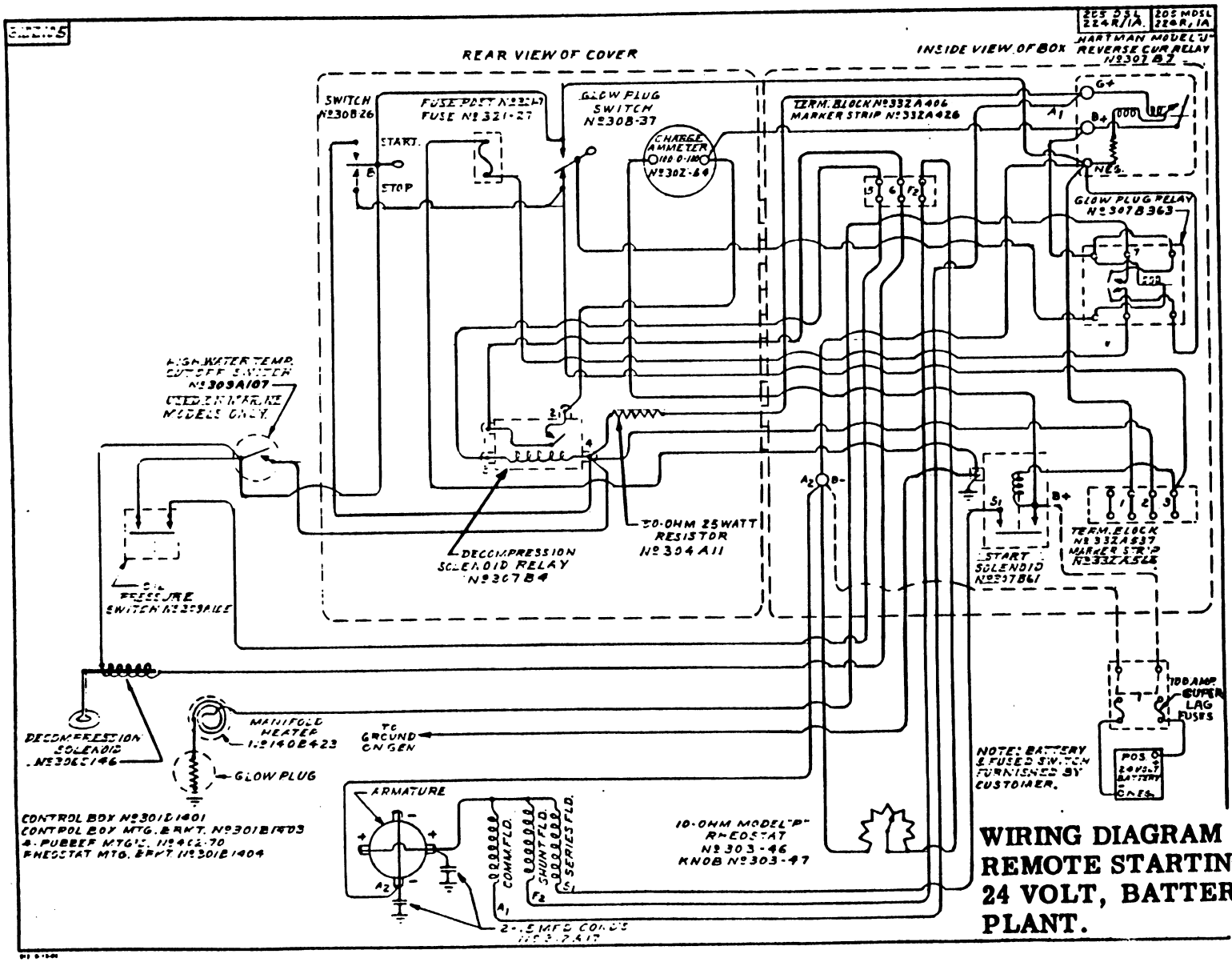
WIRING DIAGRAM #610C101
REMOTE STARTING -
ALTERNATING CURRENT -
120/240 VOLT, 1 PHASE, 3 WIRE,
50 or 60 CYCLE.



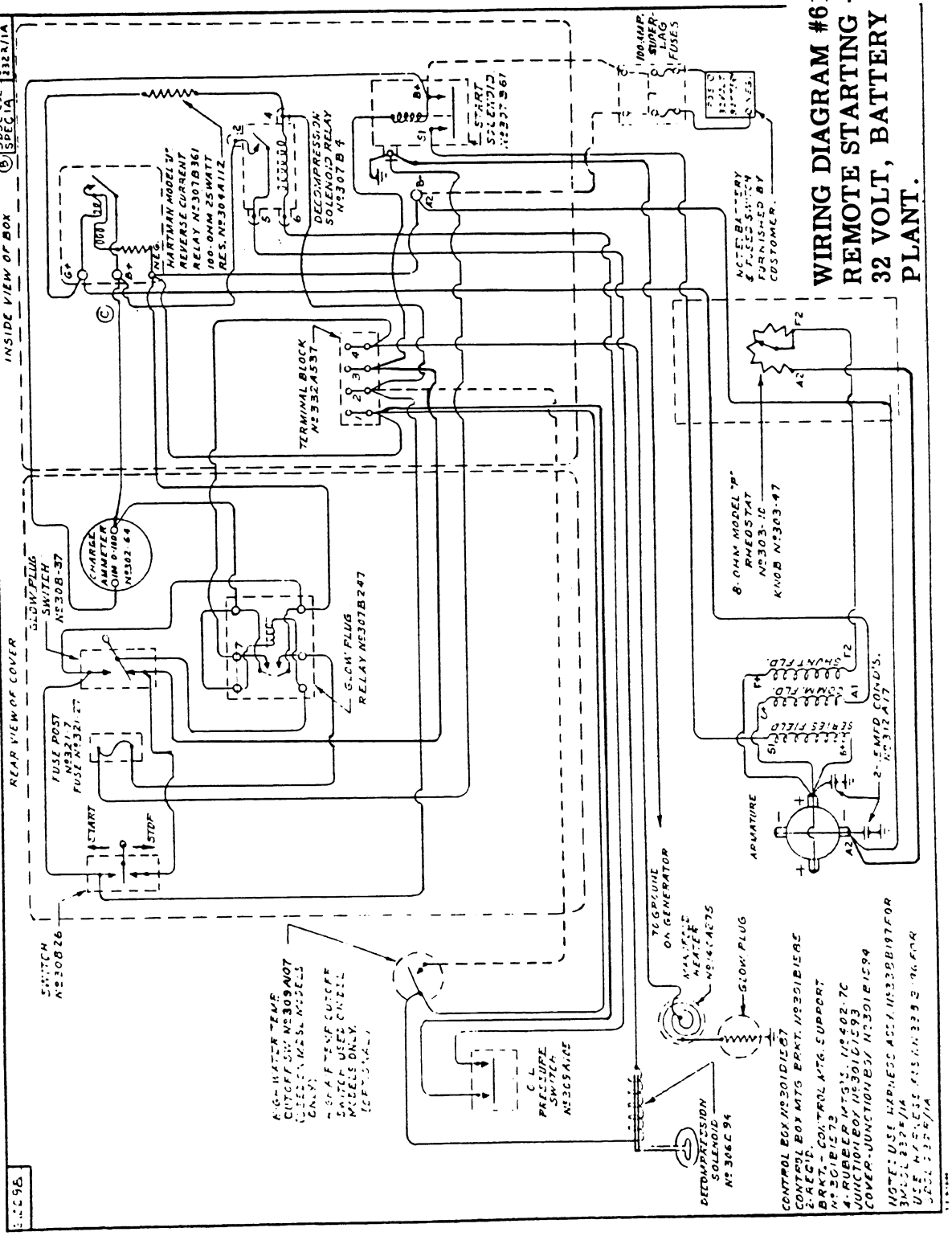
WIRING DIAGRAM #610C96
REMOTE STARTING -
ALTERNATING CURRENT -
240 VOLT - 3 PHASE -
3 WIRE - 50 or 60 CYCLE.

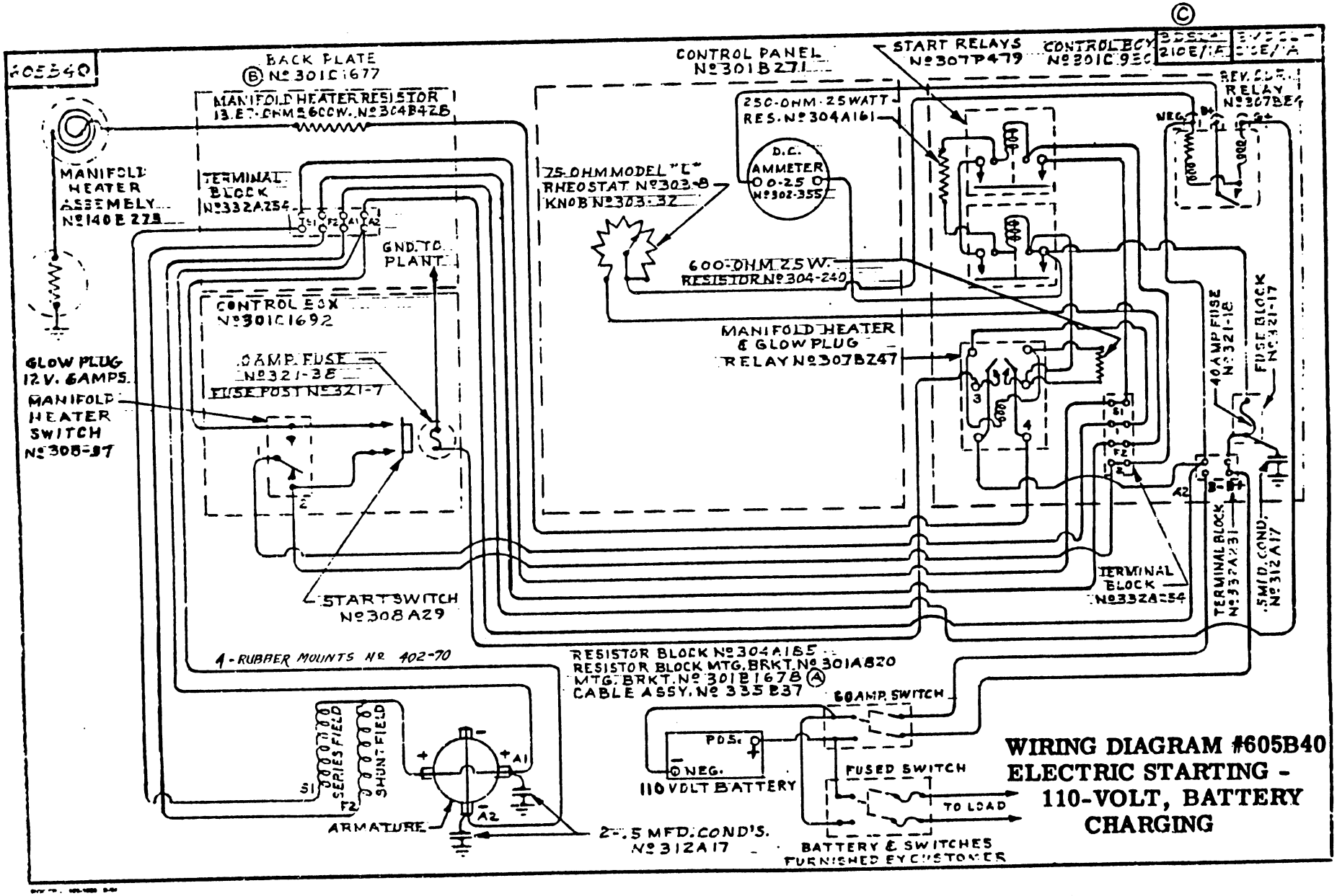


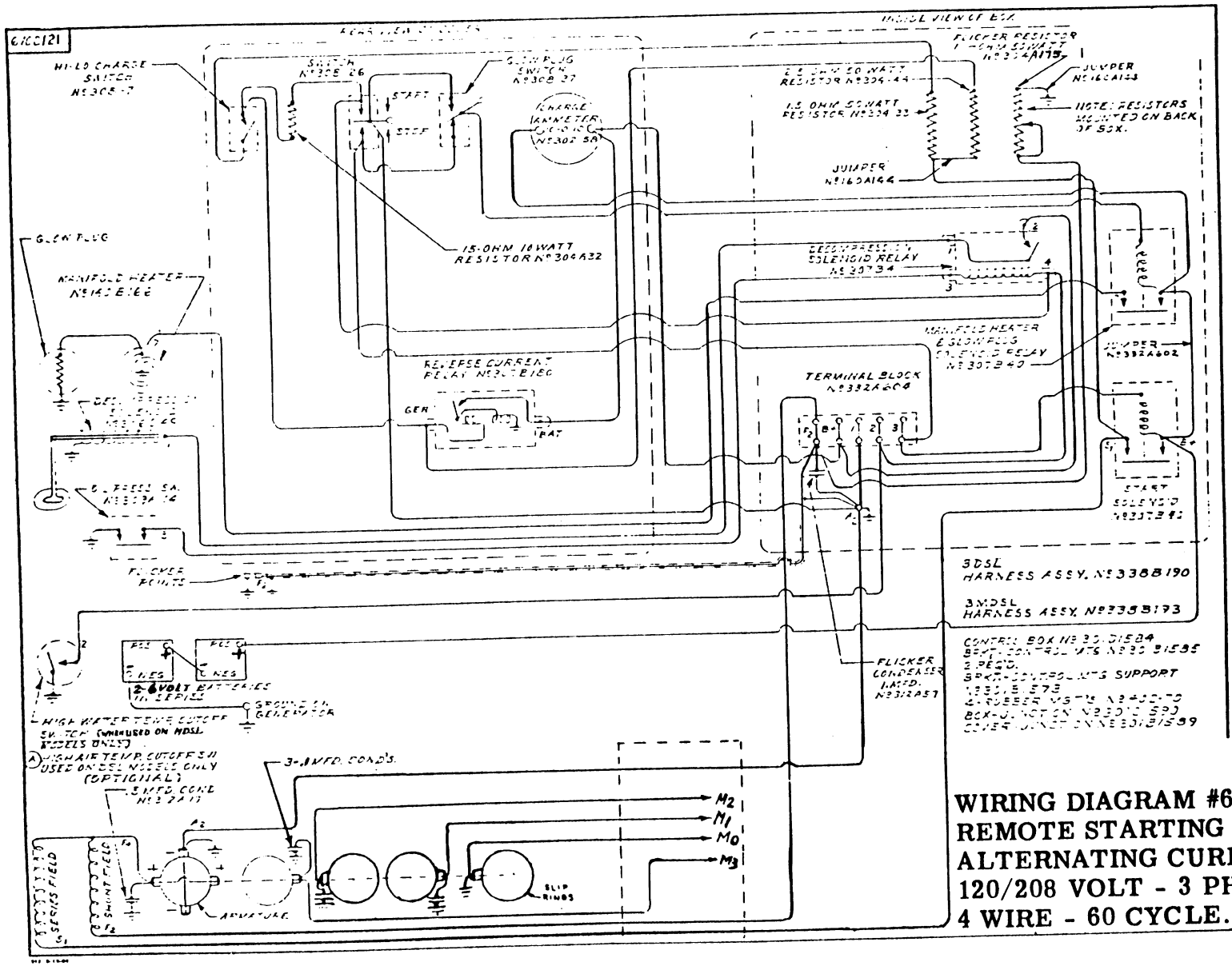
WIRING DIAGRAM #610C102
REMOTE STARTING -
DUAL PURPOSE PLANT -
32 VOLT DIRECT CURRENT / 120 VOLT,
1 PHASE, 2 WIRE, 60 CYCLE,
ALTERNATING CURRENT.



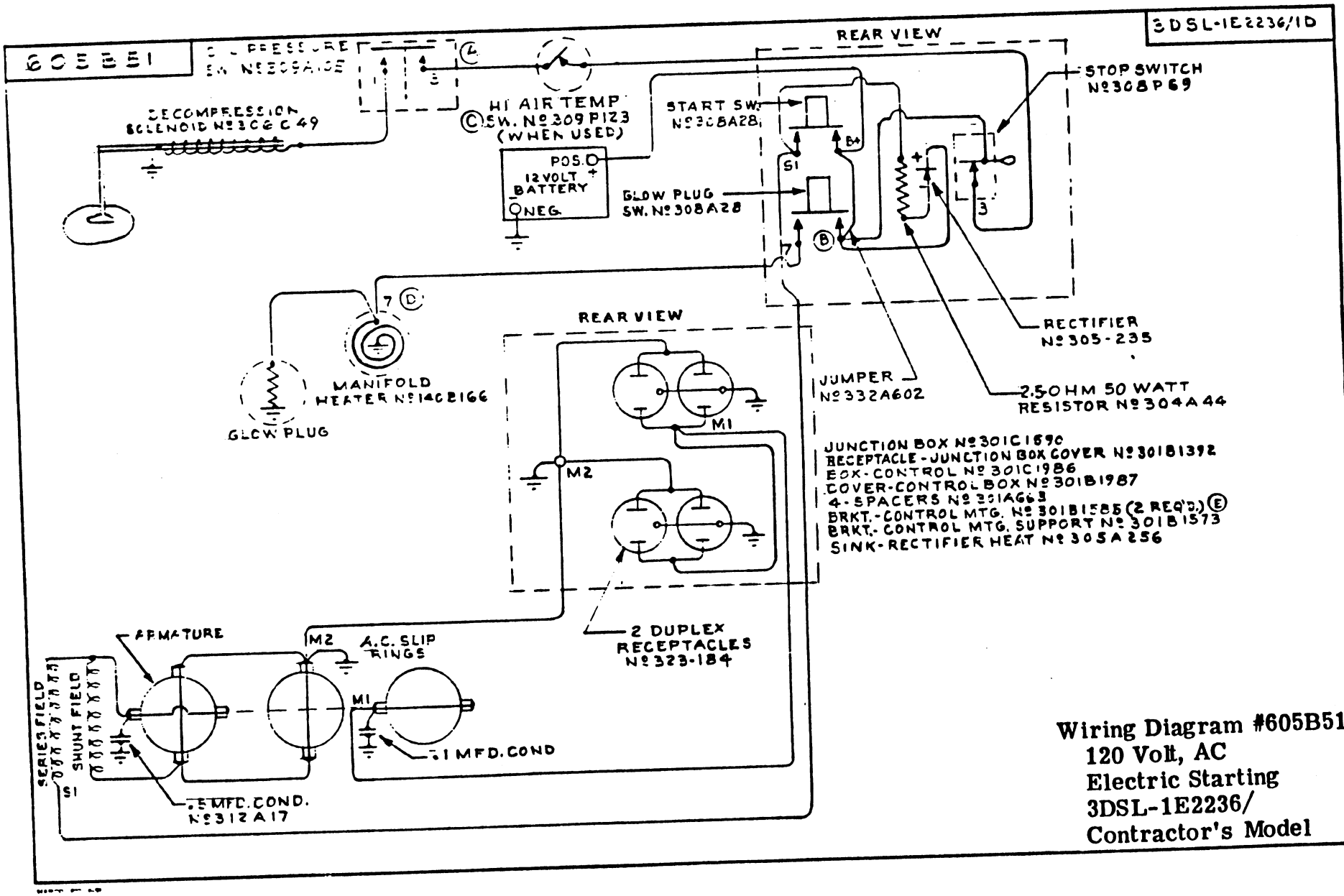
WIRING DIAGRAM #610C105
REMOTE STARTING -
24 VOLT, BATTERY CHARGING PLANT.


WIRING DIAGRAM #610C98
REMOTE STARTING -
32 VOLT, BATTERY CHARGING
PLANT.
INSIDE VIEW OF BOX
REAR VIEW OF COVER
SLOW PLUG SWITCH Nº 308-37
CHARGE AMMETER
FUSE POST Nº 3217
FUSE Nº 3217
START
STOP
SWITCH Nº 30826
HARTMAN MODEL "U" REVERSE CURRENT RELAY Nº 307B361
100-OHM 25 WATT RES. Nº 3044112
DECOMPRESSION SOLENOID RELAY Nº 307B4
TERMINAL BLOCK Nº 332A537
SLOW PLUG RELAY Nº 307B247
START SOLENOID Nº 337-361
100 AMP. SUPER-LAG FUSES
8-OHM MODEL "R" RHEOSTAT Nº 303-16
KNOB Nº 303-47
NOTE: BATTERY FURNISHED BY CUSTOMER.
2-SMP CONDS. Nº 312 A17
ARMATURE
TO GROUND ON GENERATOR
MANIFOLD HEATER Nº 1404875
GLOW PLUG
DECOMPRESSION SOLENOID Nº 306C94
PRESSURE SWITCH Nº 365A185
CONTROL BOX Nº 301D1567
CONTROL BOX MTG BRKT. Nº 301B1593
BRKT. - CONTROL MTG. SUPPORT Nº 301B1573
4 - RUBBER MTGS. 1104602-7C
JUNCTION BOX Nº 301B1594
COVER-JUNCTION BOX Nº 301B1595

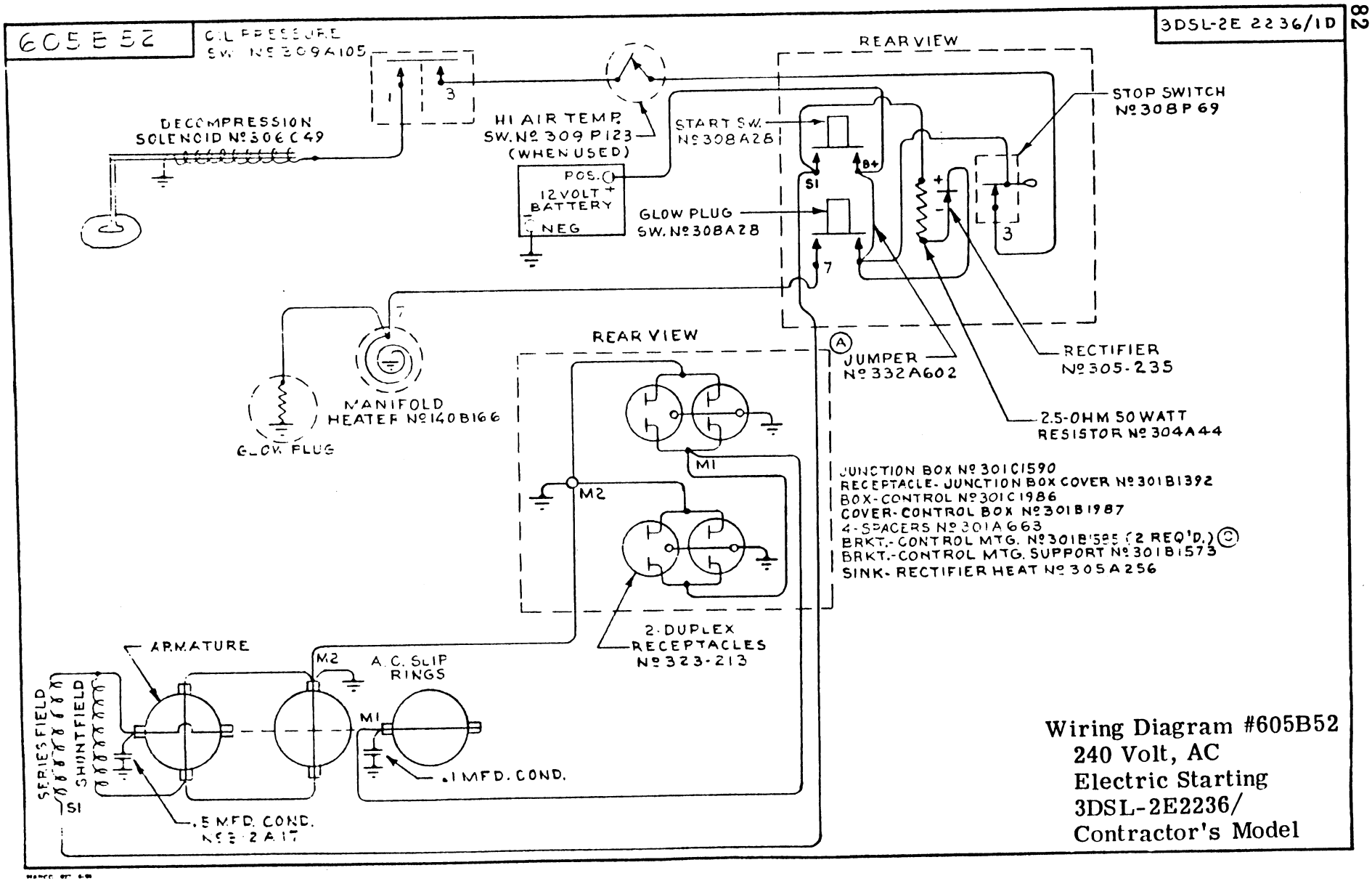

#605B40
BACK PLATE
Ⓑ Nº 301C1677
MANIFOLD HEATER RESISTOR
13.8 OHM 600W. Nº 304B428
MANIFOLD HEATER ASSEMBLY Nº 140B278
TERMINAL BLOCK Nº 332A254
GND. TO PLANT
CONTROL BOX Nº 301C1692
.6AMP. FUSE Nº 321-38
FUSE POST Nº 321-7
GLOW PLUG 12 V. 6AMPS.
MANIFOLD HEATER SWITCH Nº 308-37
START SWITCH Nº 308A29
4-RUBBER MOUNTS Nº 402-70
CONTROL PANEL Nº 301B271
START RELAYS Nº 307P479
CONTROL BOX Nº 301C930
250-OHM-25 WATT RES. Nº 304A161
D.C. AMMETER 0-0-25 Nº 302-355
25-OHM MODEL "L" RHEOSTAT Nº 303-8
KNOB Nº 303-32
600-OHM 25 W. RESISTOR Nº 304-240
MANIFOLD HEATER & GLOW PLUG RELAY Nº 307B247
REV. CUR. RELAY Nº 307BE4
40 AMP FUSE Nº 321-18
FUSE BLOCK Nº 321-17
.5 MFD. COND. Nº 312A17
TERMINAL BLOCK Nº 332A231
TERMINAL BLOCK Nº 332A254
RESISTOR BLOCK Nº 304A185
RESISTOR BLOCK MTG. BRKT. Nº 301A820
MTG. BRKT. Nº 301B1678 Ⓐ
CABLE ASSY. Nº 335B37
60 AMP. SWITCH
SERIES FIELD
SHUNT FIELD
ARMATURE
2-.5 MFD. COND'S. Nº 312A17
POS.
NEG.
110 VOLT BATTERY
FUSED SWITCH
TO LOAD
BATTERY & SWITCHES FURNISHED BY CUSTOMER
WIRING DIAGRAM #605B40
ELECTRIC STARTING - 110-VOLT, BATTERY CHARGING



WIRING DIAGRAM #610C121
REMOTE STARTING -
ALTERNATING CURRENT -
120/208 VOLT - 3 PHASE -
4 WIRE - 60 CYCLE.



Wiring Diagram #605B51
120 Volt, AC
Electric Starting
3DSL-1E2236/
Contractor's Model



Wiring Diagram #605B52
240 Volt, AC
Electric Starting
3DSL-2E2236/
Contractor's Model