INSTALLATION & OPERATING INSTRUCTIONS

FOR

ONAN ELECTRIC GENERATING PLANTS

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DFA

SERIES

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NOTE!!

The ONAN Manual and/or Parts Catalog only has been supplied. This model series has been out of production for a number of years. Due to reasons beyond our control we no longer stock or supply the engine manufacturers Manual or Parts Catalog. However we believe they are available direct from the engine manufacturer providing you furnish the SERIAL NUMBER and SPEC from the engine manufacturers nameplate on the engine. Refer to Parts Catalog and order from manufacturer as indicated under "Instructions for Ordering Repair Parts".

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

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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.

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

TABLE OF CONTENTS

The Onan generating plant of the DFA series is a complete unit consisting of a diesel type engine driving a self excited generator, and such controls and accessories as are specified by the plant purchaser.

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

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

The plant is rated as indicated on the Onan nameplate. The rating is based on an .8 power factor electrical load. When rated for standby service, the plant is intended to serve as an emergency source of electric power with operation confined to a few hundred hours per year.

When the plant is used for standby service, optional controls can be installed for automatic starting, transfer of load, and stopping. If ambient temperatures are low, special precautions must be taken. The plant is designed for normal starting in ambient temperatures of 50°F. or above.

ENGINE

The engine is a Cummins basic model HRC-4 and is described in the Cummins manual. The specific engine used may have variations due to optional features of the generator plant, type of cooling, etc., specified by the plant purchaser. Basically, the engine is a 4 cylinder, water cooled, diesel (compression ignition) type. The cylinder bore is 5-1/8 inches, piston stroke 6 inches, and displacement is 495 cubic inches. The engine is rated 115 horsepower at 1800 rpm. The standard oil capacity is 4 U.S. gallons. A combination 12/24 volt battery system is used for energizing the starting and control circuits. Accessories, safety devices, etc. vary according to the model and purchaser options.

GENERATOR

Models ending with Spec. Letter A. - The generator consists of a 4 pole revolving field type alternator and an integral direct current generator exciter. The alternator rotating field and the exciter armature are directly connected to the engine flywheel, and so turn at engine speed.

The exciter current is used to create the magnetic field in the alternator rotor. A separate voltage regulator controls the exciter current according to the demands of the alternator, thus keeping the ac output voltage stable under various load conditions. Emergency manual voltage control is provided for in case of regulator failure.

Models ending with Spec. Letter B, C, etc. - Beginning with models ending with spec. letter B (and later) the generator consists of a 4 pole revolving field type alternator and a "static" (stationary) type exciter, with magnetic amplifier voltage regulation. The alternator's rotating field is attached to the engine flywheel and so turns at engine speed. Because the speed at which the rotor turns determines the current frequency, the 60 cycle plant must operate at approximately 1800 rpm, and the 50 cycle plant at approximately 1500 rpm.

The static exciter components are mounted on a metal frame attached to the outer end of the generator. The exciter design provides for approximately 2% voltage regulation from no load to full load, with stable operating conditions established within approximately 2 seconds after any change in the load. A rheostat control on the control panel of models ending with spec. letter C or later provides for plus or minus 5% adjustment of output voltage.

CONTROLS

The engine uses 24 bolt battery current for starting purposes only. All control circuits, battery charging, etc. are 12 volt. A special series-parallel switch automatically provides 24 volt connections for starting.

Electrical meters and controls, and engine indicating gauges and controls vary according to the plant model and purchaser options. Refer to the wiring diagrams supplied. Electrical meters provide for checking the generator output. Relays, etc., provide for proper sequence of events during starting, operation, and stopping. Provision is made for operation with automatic line transfer equipment for standby service. Engine indicating gauges provide for checking engine performance. Various safety devices provide for automatic stopping under unusual or dangerous operating conditions.

Installation of the generating plant involves its location, connection of fuel source, connection of exhaust system, starting battery installation, connection to the load wiring, and for some special models connection to a source of cooling water. Each installation must be considered individually - use these instructions as a general guide. Typical installations are shown, and by following the principles outlined a proper installation can be made. Local regulations (building code, fire ordinance, etc.) may affect some installation details.

LOCATION. - In the average installation, the location has been pre-selected. For the average standby installation a warm indoor site is usually required. If automatic unattended starting is required, the ambient temperature must be high enough to assure positive starting. Check local regulations. The location should be dry, well ventilated, and reasonably dust free. Normally, the plant should be located near the main power line switch. Provide sufficient clearance (at least 24 inches recommended) on all sides for convenience in servicing the plant.

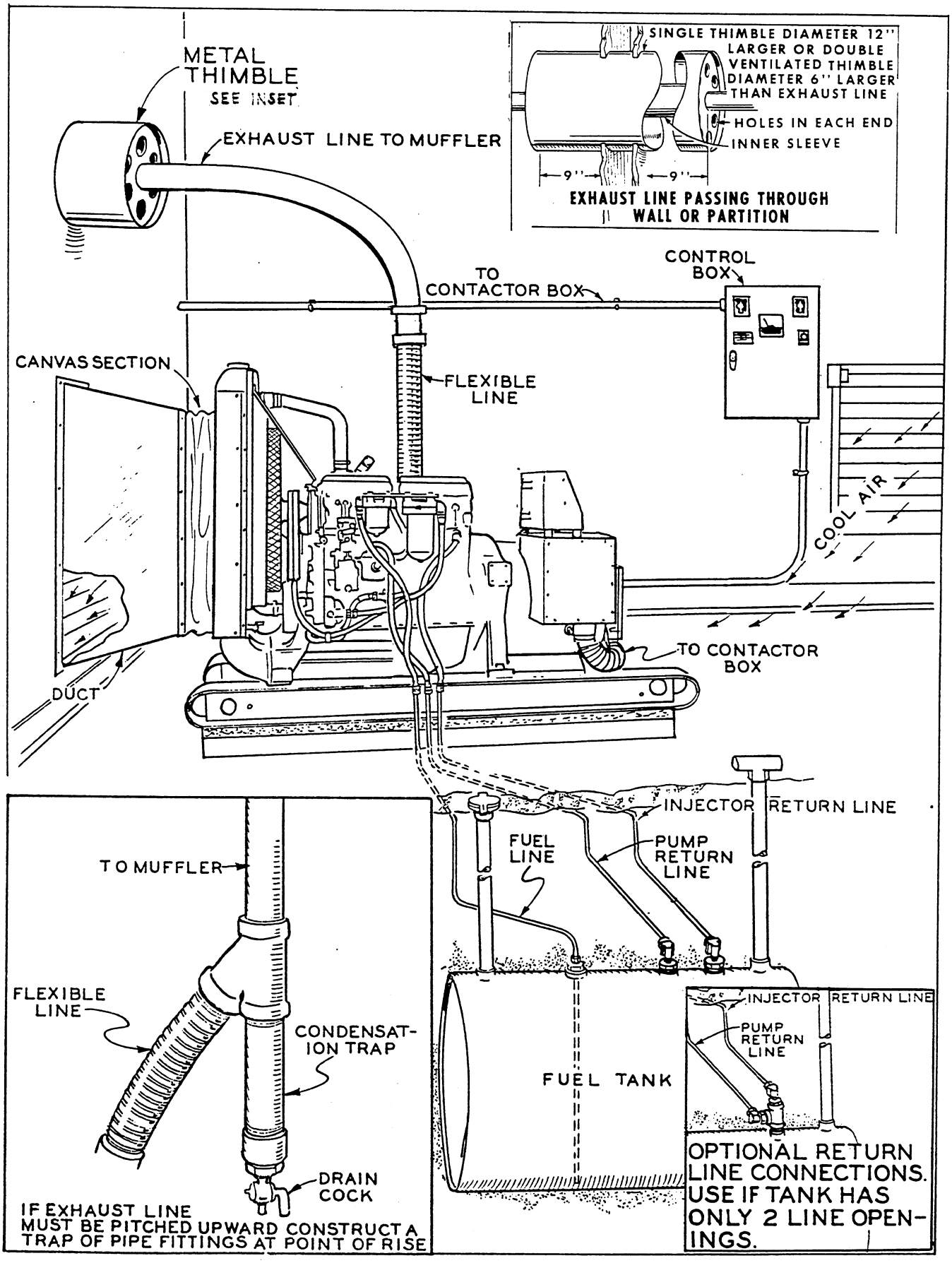
MOUNTING. - Refer to the installation outline drawing. The plant is mounted on a rigid skid base which provides proper support. However if additional vibration dampeners, raised pedestals, etc. are employed it may be necessary to provide special footings or other support as necessary to carry the load.

VENTILATION. - For radiator cooled units, proper ventilation is of vital importance. Under normal operating conditions, approximately 10, 600 cubic feet of air per minute will provide proper cooling. In a small room installation this may require installation of an auxiliary fan connected to operated at any time the plant is running. Separate air inlet and outlet openings are necessary.

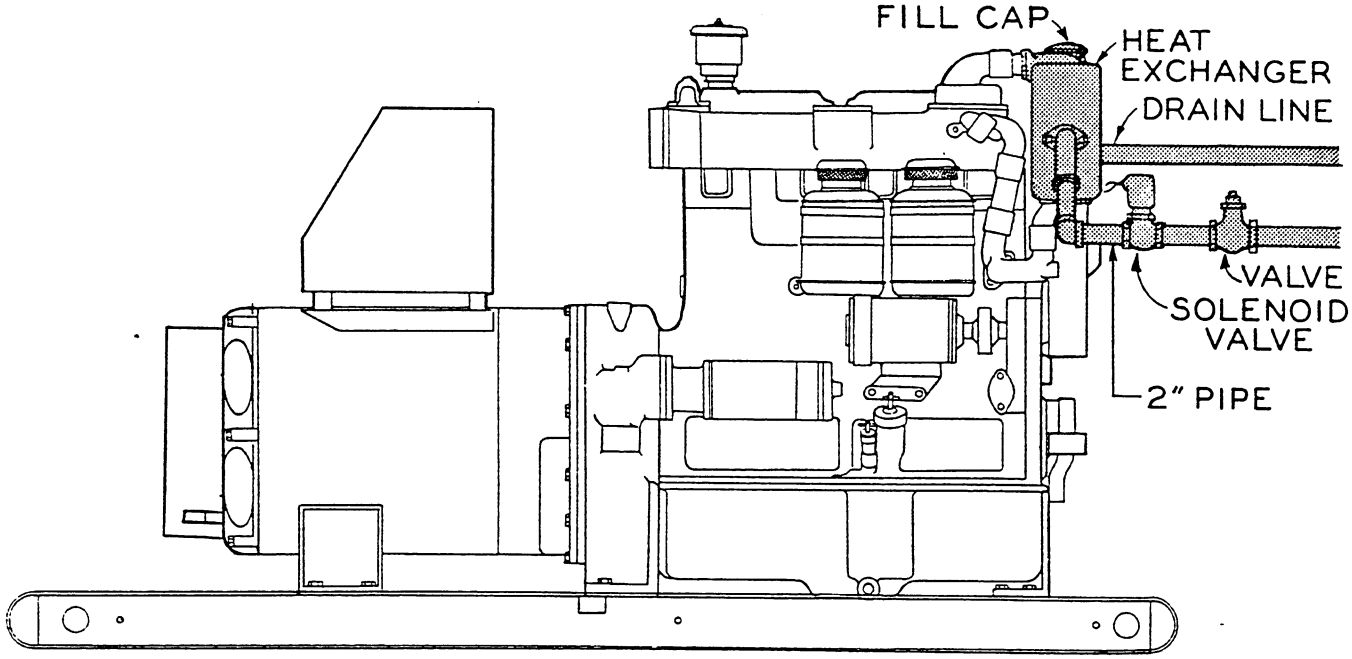
The pusher type fan used forces the cooling air out through the front of the radiator. The usual method of exhausting the heated air is to construct a duct from the front of the radiator to an outside wall. In cold climates, provision must be made to prevent any back-flow of cold outside air during periods of shut down. Automatic, motor controlled shutters for the air inlet and outlet openings may be necessary. If the engine is cooled by city water, using a heat exchanger or stand pipe system, ventilation is seldom a problem. However, sufficient air movement and fresh air must be available to properly cool the generator and to support combustion in the engine.

OPTIONAL "CITY" WATER COOLING. - Two types of cooling modifications using a constantly changing water flow are optional in place of the conventional radiator cooling.

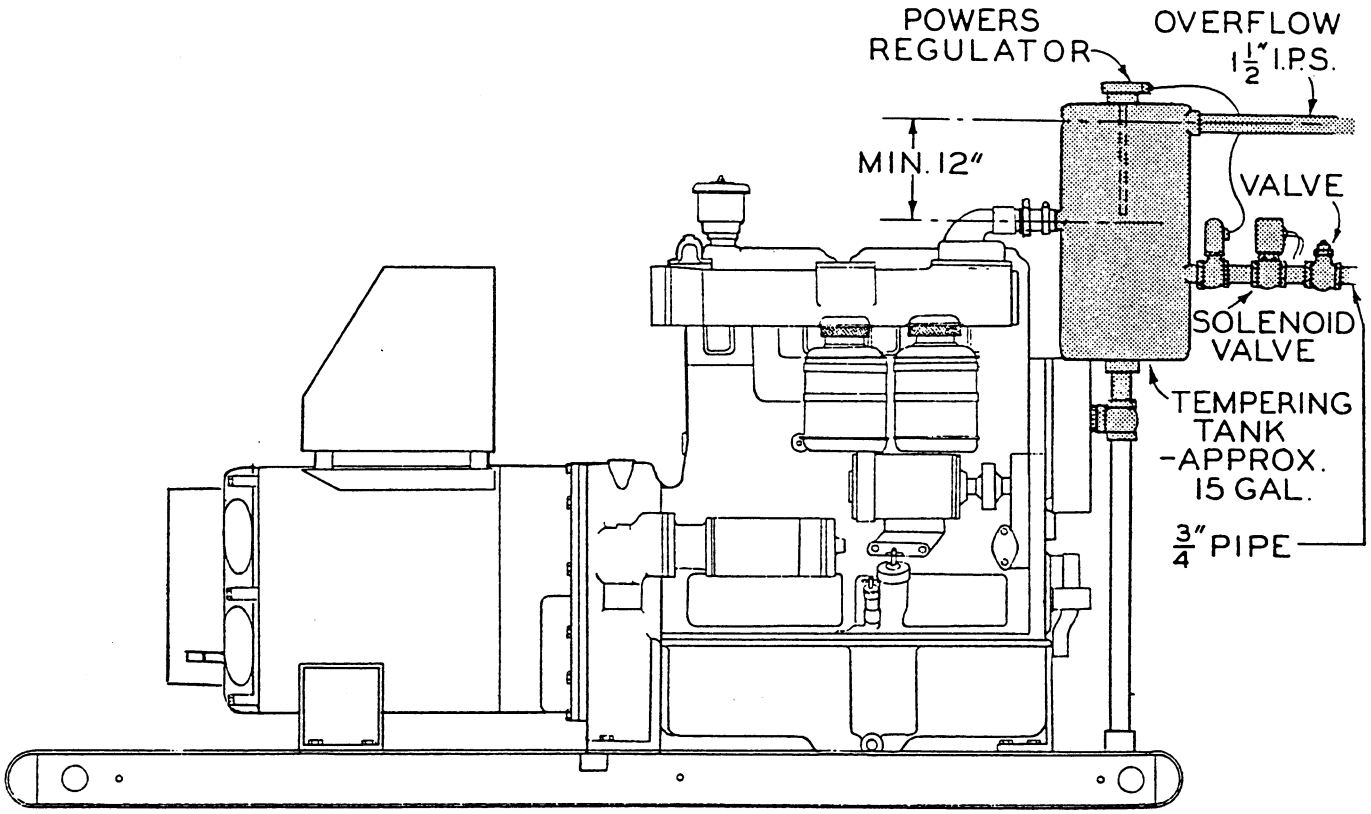
1. Heat Exchanger. - The heat exchanger installation provides for a "closed" engine water system. The engine coolant circulates through a tubed chamber. A separate and constantly changing flow of "raw" or city water surrounds the cooling tubes and is drained off. An electrically operated valve (solenoid type) opens the water flow when the plant is operating, and shuts off the



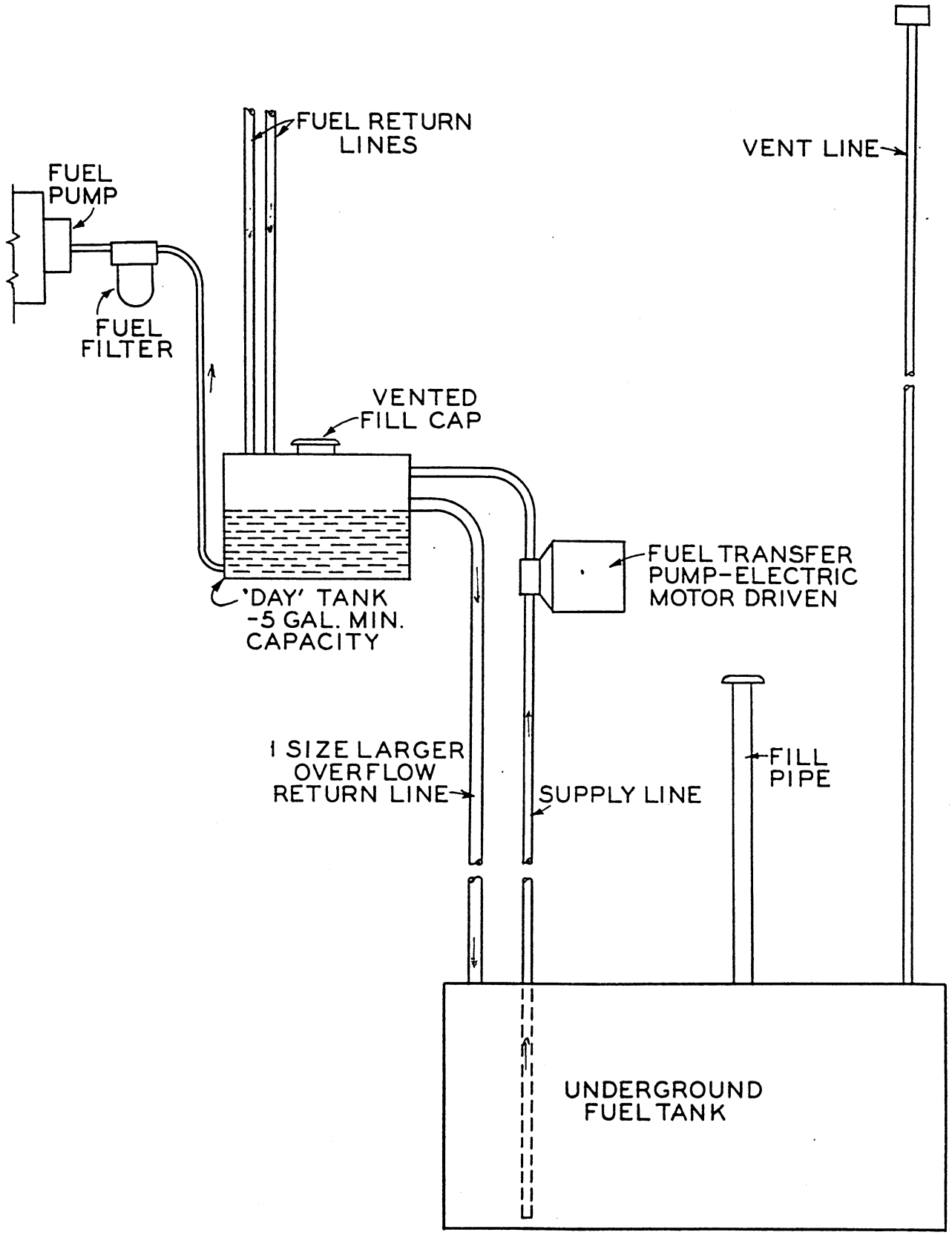
TYPICAL STANDBY INSTALLATION



CITY WATER HEAT EXCHANGER COOLING



CITY WATER STANDPIPE WITH POWERS REGULATOR



'DAY' TANK INSTALLATION

water flow when the plant stops. Connect the solenoid as shown on the engine control wiring diagram. Rate of flow is controlled by either a hand valve or by an optional automatic regulator. If rate of flow is hand adjusted, refer to the water flow table, which shows the approximate minimum water required at the loads listed. Use 2 inch pipe, for connections, as illustrated. The "closed" chamber section must be filled with coolant before operation.

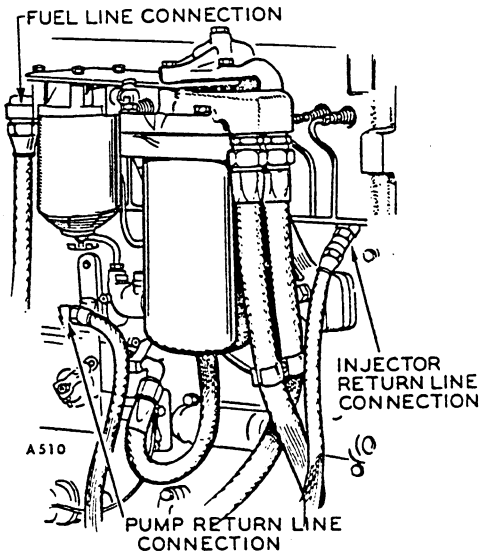
MINIMUM WATER FLOW - HEAT EXCHANGER COOLING

ELECTRICAL LOAD	WATER TEMP.	MIN. FLOW-GAL/MIN.
50 KW	40°F.	15
	60°F.	23
	80°F.	30
60 KW	40°F.	17
	60°F.	26
	80°F.	34

2. Tempering Tank. - The tempering tank (stand pipe) system uses a mixing or tempering tank. The engine cooling water mixes with a constantly flowing source of cool water. An electric solenoid type valve opens the water flow when the plant is operating, and shuts off the water flow when the plant stops. Connect the solenoid as shown on the engine control wiring diagram. Rate of flow is controlled by either a hand valve or by an optional automatic regulator. If rate of flow is hand adjusted, refer to the water flow table, which shows the approximate minimum water flow required at full load. Use 3/4 inch pipe for the supply line, and 1-1/2 inch pipe for the overflow line. Pipe the overflow to a convenient drain point.

MINIMUM WATER FLOW - TEMPERING TANK COOLING

ELECTRICAL LOAD	WATER TEMP.	MIN. FLOW-GAL/MIN.
50 KW	40°F.	3
	60°F.	5
	80°F.	6
60 KW	40°F.	4
	60°F.	6.5
	80°F.	7.5



FUEL CONNECTIONS. - Three fuel line connections are required. Use a length of approved flexible line between the engine connection points and any rigid wall tubing. Minimum fuel line sizes are: 5/8 inch tubing for the fuel supply line; 3/8 inch tubing for the fuel return from the fuel pump; and 1/2 inch tubing for the fuel return from the injector manifold. The inlet fitting on the fuel filter is threaded for a 5/8 inch SAE flared fitting. The fuel pump return fitting is threaded for a 3/8 inch SAE flared fitting. The fuel return fitting of the injector manifold is threaded for a 1/2 inch SAE flared fitting.

Check local regulations regarding the installation of a fuel supply tank, lines, etc. Lift of fuel should not exceed 8 feet. If the installation requires a greater lift, an auxiliary "DAY" tank of at least 5 gallon capacity will be necessary. An electrically driven fuel transfer pump is then installed to feed the auxiliary tank.

An underground tank usually has connections at the top, requiring a drop or suction tube extending to within an inch or two of the tank bottom. All supply line connections must be air tight to assure that the fuel pump will lift fuel from the tank. The tank must have an approved vent cap. If both return lines must be brought to one return opening, be sure the manifold return line has the most direct route.

NOTE

In any diesel installation, fuel system cleanliness is of utmost importance and cannot be over emphasized. Make every effort to prevent entrance of any contaminating matter, moisture, etc. Do not use fittings of galvanized material.

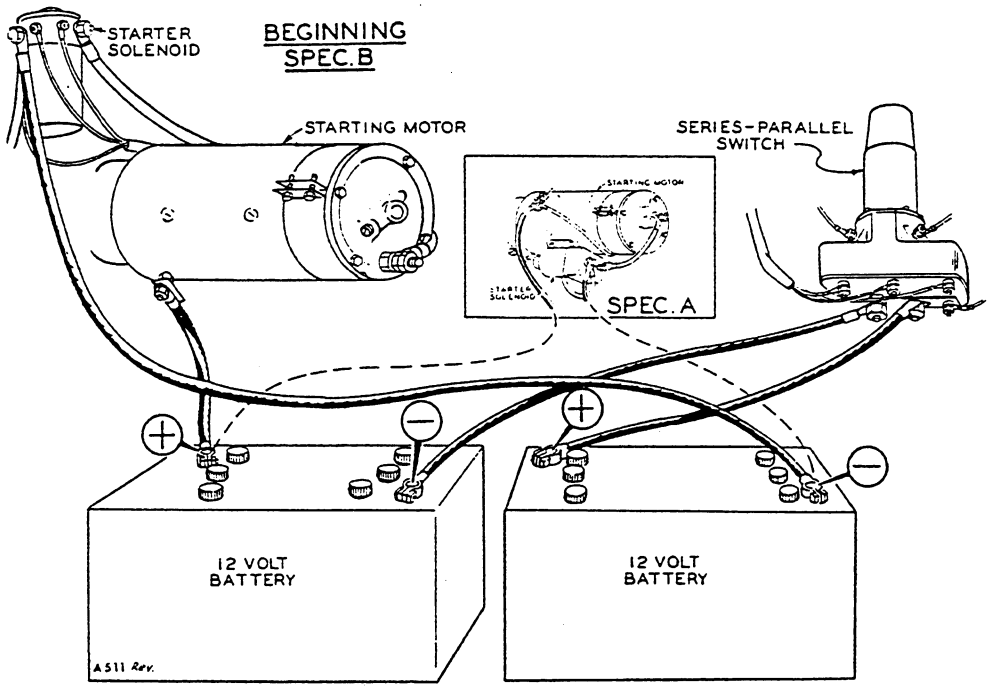
EXHAUST. - Pipe the exhaust gases outside any enclosure. Use pipe at least as large as the 2-1/2 inch pipe size outlet of the engine exhaust. Increase the pipe diameter one size for each additional 10 feet in length. Use a flexible connection to the engine exhaust manifold. Avoid using sharp elbow turns - use sweeping type elbows to keep back pressure to a minimum. If the exhaust line runs upward at any point, install a condensation trap at the low point, with provision for periodic draining. Shield or insulate the line if there is danger of personnel contact. Combustible walls and partitions through which exhaust pipes pass must be protected with a metal thimble similar to the one shown in the typical installation illustration. Install a suitable muffler to the exhaust line.

WATER JACKET HEATER (Optional). - The water jacket heater keeps the engine coolant warm during periods of shut down, thus promoting easier starting when the ambient temperature is low. Connect the heater to a normally energized power source, making sure that the line voltage is correct for the rated voltage of the heater. Refer to the heater nameplate.

BATTERY CONNECTIONS. - The plant uses 12/24 volt battery current. An automatic series-parallel switch provides the necessary 24 volt circuit for starting, and 12 volt circuit for charging and control purposes.

Two 12 volt, type 8D batteries are recommended for normal installations. If 6 volt batteries are used, connect the batteries in pairs to form two 12 volt units, using a jumper cable to connect the positive post of one battery to the negative post of a second battery for each 12 volt unit.

The following instructions apply to units with a separate series-parallel switch and starter solenoid (prior to Onan serial number 661047).



PRIOR TO ONAN SERIAL NUMBER 661047

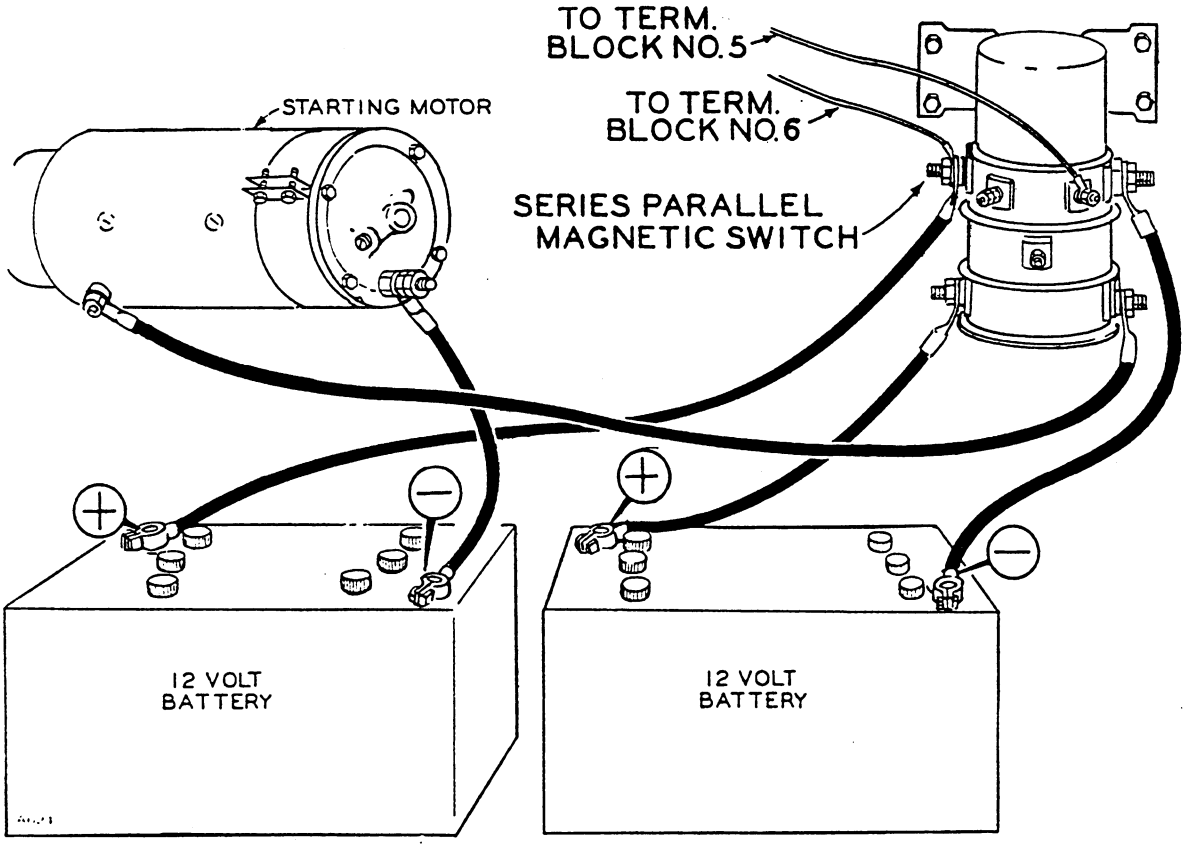
1. Connect the positive post of one 12 volt battery to the forward terminal of the series-parallel switch.

2. Connect the negative post of the same battery to the grounded terminal of the start solenoid.

3. Connect the positive post of the second 12 volt battery to the terminal on the side of the engine starting motor.

4. Connect the negative post of the same battery to the rear terminal of the series-parallel switch.

The following instructions apply to units with a combination series-parallel magnetic switch (effective Onan serial number 661047).



EFFECTIVE ONAN SERIAL NUMBER 661047

1. Connect the positive terminal of one battery to the lower left terminal on the series-parallel magnetic switch.

2. Connect the negative terminal of the same battery to the upper right terminal on the series-parallel magnetic switch.

3. Connect the positive terminal fo the second battery to the upper left terminal on the series-parallel magnetic switch.

4. Connect the negative terminal of the second battery to the starter ground terminal.

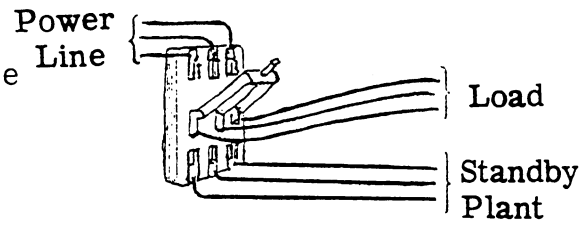
5. Connect the lower right terminal on the series-parallel magnetic switch to the field terminal on the starter.

Service the batteries as necessary.

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

ELECTRICAL CONNECTIONS. - Most local regulations require that wiring connections be made by a licensed electrician, and that the installation be inspected and approved before operation. Be sure that wiring meets requirements of electrical codes in effect at the installation site.

When the plant is used for standby service, a double throw switch must always be used. This switch (either manual or automatic type) must be connected so that there is no possibility for the generator current to be fed into the normal source of power lines, nor for the normal source and generator to be connected at the same time.



BASIC LINE CONNECTIONS

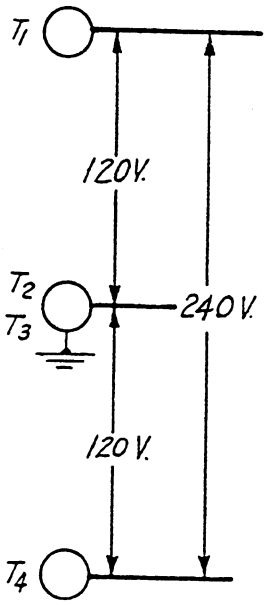
It is assumed that personnel connecting the generator to the load, either directly or through a transfer switch, are fully qualified and understand the problems involved in balancing the circuits, grounding the plant, etc.

An automatic transfer switch includes a circuit for automatic control of starting and stopping. Connect the control circuit wires from the automatic control to the "remote operation" terminal block indicated on the engine control wiring diagram. The B + terminal supplies 12 volt battery current for energizing the control circuit. Terminal 1 is grounded, terminal 2 serves as an extension of the stop circuit, and terminal 3 serves as an extension of the start circuit.

Connections for auxiliary warning signal lights or alarms are indicated on the wiring diagram.

CONNECTING THE LOAD WIRES. - The ac output terminals are located inside a sheet metal enclosure at the side of the generator. Knock out openings are provided. The terminal studs are marked as designated on the output control wiring diagram.

120/240 VOLT, SINGLE PHASE, 3 WIRE PLANT



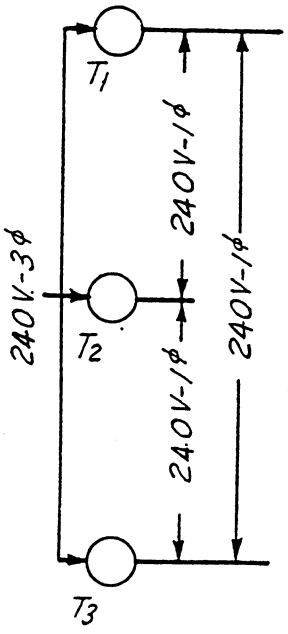
The terminal post marked "T2, T3" is grounded. For 120 volt current, connect the "NEUTRAL" (white) load wire to the "T2, T3" terminal. Connect the "hot" (black) load wire to either the "T1" or "T4" terminal. Two 120 volt circuits are thus available, with not more than one half the rated capacity of the plant available on each circuit. Balance the load as closely as possible between the two circuits.

For 240 volt current, connect one load wire to terminal "T1" and the other load wire to terminal "T4", leaving terminal "T2, T3" unused.

If both 120 and 240 volt current are used at the same time, use care not to overload either side of the circuit.

3 PHASE, 3 WIRE PLANT

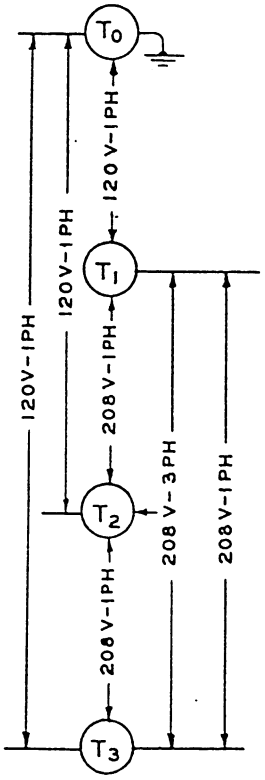
No terminal is grounded. For three phase current, connect separate load wires to each plant terminal "T1", "T2", and "T3", one wire to each terminal. Reversing the connections between any two terminals will reverse the direction of rotation of 3 phase motors. If phase sequence is important, be sure to check the phase sequence before connections are completed.



To obtain single phase current, connect separate load wires to each of any two plant terminals. Three single phase circuits are thus available, with not more than 1/3 of the plant rated capacity for each circuit. Balance the load as closely as possible among the circuits.

If both single phase and three phase current is to be used at the same time, use care not to overload any one circuit. Subtract the amount of the 3 phase load from the rated capacity of the plant. Divide the remainder by 3, and this is the maximum load that can be taken from any one circuit for single phase current use. For example, a 50, 000 watt plant is used, with a 20, 000 watt 3 phase load connected. This leaves 30, 000 watts available for single phase use. Divide the 30, 000 watts by 3, giving 10, 000 watts available on each single phase circuit. Do not attempt to take all 30, 000 watts in this example off one circuit, as over-loading of the generator will result.

120/208 VOLT, 3 PHASE, 4 WIRE Y CONNECTED PLANT



The terminal marked "T0" is grounded. For 120 volt, single phase current, connect the "neutral" (white) load wire to the "T0" terminal. Connect the "hot" (black) load wire to any one of the other three terminals, "T1", "T2", "T3". Three separate 120 volt, single phase circuits are thus available. Do not attempt to take more than 1/3 the rated capacity of the plant from any one circuit. Balance the load as closely as possible between the three circuits.

For 208 volt, three phase current, connect a separate load wire to each of the plant terminals "T1", "T2", and "T3", leaving the "T0" terminal unused. Reversing the connections between any two terminals will reverse the direction of rotation of 3 phase motors. If phase sequence is important, check the phase sequence before making final connections.

For 208 volt, single phase current, connect a separate load wire to each of any two terminals "T1", "T2", or "T3". Do not use the "T0" terminal. Three separate single phase circuits are available: "T1" and "T2", "T1" and "T3", "T2" and "T3". Do not attempt to take more than 1/3 the rated capacity of the plant from any one circuit. Balance the load as closely as possible between the three circuits.

If both single and three phase current is used at the same time follow the principles of load distribution as given for the 3 phase, 3 wire plant.

220/380 VOLT, 3 PHASE, 4 WIRE, Y CONNECTED PLANT
277/480 VOLT, 3 PHASE, 4 WIRE, Y CONNECTED PLANT

Follow the principles of connection as given for the 120 volt, single phase/208 volt, 3 phase, 4 wire plant.

120/240 VOLT, 3 PHASE, 4 WIRE, DELTA-CONNECTED PLANT

This type of generating plant is specially designed so that two types of loading can be applied to the generator: 240 volt, 3 phase, 3 wire operation only; or in combination with 120/240 volt, 1 phase, 3 wire service.

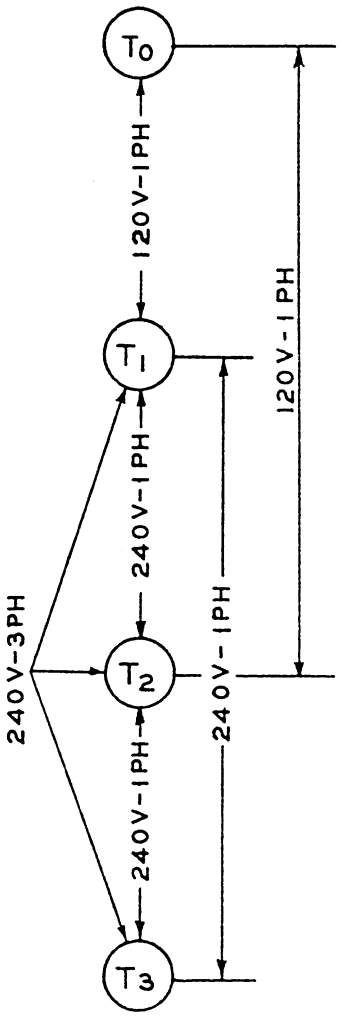
The load terminals are marked T1, T2, T3 and T0. The T0 terminal is the generator center tap between T1 and T2. The T0 terminal of the generator is not grounded.

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

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

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

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



CRANKCASE OIL. - Refer to section 3 of the Cummins engine manual. Note that for average operating conditions, MIL-L-2104A (military specification) oil is recommended. Most oil suppliers market such an oil for heavy truck service. Many oils designated for MS or DG service meet MIL-L-2104A requirements.

The capacity of the engine oil pan is 4 U.S. gallons. However, an extra amount may be required for the oil filter or other accessories. Check the level after 10 to 15 minutes of the initial run.

Use oil of the recommended viscosity according to the ambient temperature. Do not use a multi-viscosity oil, such as 10W-30, or other oils designated for ordinary automotive use. Do not mix brands (nor grades of the same manufacturer) of lubricating oil.

GOVERNOR OIL. - The standard engine is equipped with the hydraulic governor. Be sure the governor case is properly filled to the full mark on its dip stick gauge. Use the same viscosity and quality oil as that used in the crankcase.

AIR CLEANER. - Service the air cleaner according to the type supplied. If the cleaner is of the oil bath type, fill to the level indicated with oil of the same viscosity as that used in the crankcase. However, a non-detergent (straight mineral) oil is recommended.

BREATHER AIR CLEANER. - The standard engine is equipped with a small air cleaner at the top of the cylinder block, as a crankcase breather. Service in the same manner as the main oil bath type.

COOLANT. - For units which use a radiator, fill the cooling system with clean soft water. The standard radiator and block capacity is 10.9 U.S. gallons. Use a good rust and scale inhibitor. If there is any possibility of a radiator cooled plant being exposed to freezing temperatures, use antifreeze solution in the proper proportion. On the initial run check the coolant level several times and add coolant if necessary to compensate for any air pockets which may have formed during filling.

If the plant is equipped for "city" water cooling, either heat exchanger or tempering tank type, see that the water supply is turned on.

If the plant has the heat exchanger type cooling, be sure the "closed" chamber portion is properly filled with clean soft water. A fill cap is provided at the top of the chamber.

FUEL. - Refer to section 3 of the Cummins engine manual for fuel oil specifications. Check with the fuel supplier for assurance that the fuel supplied meets the specifications. Make every effort to keep the fuel supply clean. Ordinarily no preliminary priming or "bleeding" of the fuel system is necessary.

STARTING. - For the initial run, see that the control panel circuit breaker is at its OFF position. If an automatic line transfer switch is installed, set its selector switch temporarily for manual control.

To start the plant, push the START-STOP switch to its START position, holding in contact to crank the engine. Release the START switch, to its center position, as soon as the plant starts.

The engine is designed for normal starting procedures in temperatures of 50°F. or above. A cycle cranking circuit stops prolonged cranking in case of failure to start, with increasingly shorter cranking cycles.

CHECKING OPERATION. - Allow the engine to warm up, observing indicating gauges for proper operation. For the initial run, check the entire installation and operation very carefully. A minor correction or change at this time may insure long and satisfactory future service. Throw the panel circuit breaker to its ON position and check the electrical output.

If an automatic line transfer control is connected, check its operation according to its instructions.

WATER FLOW. - If the plant is city water cooled, but without the optional flow regulator, check the rate of water flow. At installation, an adjustable valve was connected in the water supply line. With the key provided, adjust the valve to provide a flow of water sufficient to keep the water temperature gauge within the range of 165°F. to 185°F. Excessive water flow is wasteful and expensive - too little flow will cause a rise in coolant temperature and automatic shut down by the high temperature safety switch. To avoid unauthorized tampering after proper adjustment, remove and store the adjusting key.

STOPPING. - If conditions permit, disconnect the electrical load and allow the plant to run a few minutes without load. This will allow the engine to cool slightly and prevent an excessive temperature rise when the plant stops and ventilation ceases. Push the control panel switch to its STOP position to stop the plant.

NORMAL OPERATING FUNCTIONS

SAFETY STOPPING DEVICES. - In addition to the ac circuit breaker (which does not stop the plant) the plant is equipped with safety devices that stop the engine under conditions that could cause severe damage.

NOTE

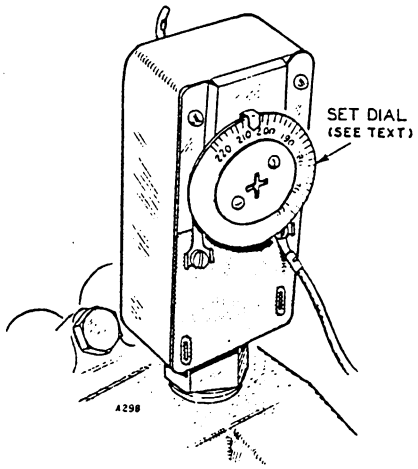
If one of the safety stopping devices operates to stop the plant, the EMERGENCY STOP RELAY "PUSH TO RESET" button must be pushed in before the plant can be started again.

1. Low Oil Pressure Cut-Off. - A pressure operated switch mounted on the engine stops the plant if the engine oil pressure drops dangerously low. The switch is not adjustable.

2. High Water Temperature Cut-Off. - An adjustable thermostatic switch is mounted on the engine. If the coolant temperature rises above the dial setting, the switch acts to stop the plant. The coolant temperature must drop approximately 10°F. before the plant can be started again.

The dial setting should be several degrees below the boiling point of the coolant used.

Lower the setting 3 degrees F. for each 1000 feet above sea level. Do not set the switch to operate at a temperature so low as to shut off the plant before it reaches operating temperature.



HIGH WATER TEMPERATURE CUT-OFF SWITCH

3. Overspeed Cut-Off Switch. - A centrifugal weight type switch is attached to the outer end of the generator shaft. The switch operates to stop the plant if the engine speed should accidentally rise to a dangerous point.

OIL PRESSURE GAUGE. - The oil pressure gauge indicates the engine oil pressure while the engine is operating. Normal oil pressure at operating temperature is within a range of 30 - 75 psi. Pressure will be high until the engine warms up.

WATER TEMPERATURE. - The panel temperature gauge indicates the coolant temperature during operation. Normal operating temperature is 165°F. to 185°F.

CHARGE AMMETER. - The small dc ammeter indicates the battery charging current. An automatic regulator controls the charge rate, and it will vary according to the charge condition of the batteries. The charge rate will be comparatively high when the plant first starts, but should fall gradually to almost zero as the batteries become fully charged.

EMERGENCY STOP RELAY. - If a plant safety device operates to stop the plant, the emergency stop relay PUSH TO RESET button must be pressed before the plant can be started again. Always be sure to correct the condition that caused the emergency stop.

START-STOP SWITCH. - The start-stop switch is a momentary contact type. Push up to start the plant - down to stop the plant. Always be sure the switch returns to its center position.

CIRCUIT BREAKER. - The circuit breaker protects the generator from damage in case of an extreme overload. The circuit breaker can be used as a connect-disconnect output switch. If the breaker trips automatically from an over load condition, it must be reset manually after correcting the over load condition that caused it to trip.

METER SELECTOR SWITCH. - The position of the switch handle indicates which phase of the generator output is shown on the ac ammeter and voltmeter. Turn the handle to the desired position. Single phase models are not equipped with the switch.

VOLTAGE REGULATOR RHEOSTAT. - The voltage regulator rheostat provides for adjusting the ac output voltage under normal operating conditions. Turn clockwise to increase the voltage - counter-clockwise to decrease the voltage. For models with spec. ending with letter A, the voltage rheostat has no effect if the combination field rheostat and voltage regulator switch is not at its extreme counterclockwise position.

COMBINATION FIELD RHEOSTAT AND VOLTAGE REGULATOR SWITCH. - The (Applies only to models ending with spec. letter A) combination field rheostat and switch is provided for emergency manual voltage control, in case of accidental voltage regulator failure. When the rheostat is turned to its extreme counterclockwise position, a built-in switch provides for voltage regulator operation. When the rheostat is turned slightly clockwise, the switch cuts out the voltage regulator and output voltage must be manually controlled. Any substantial change in the electrical load will require a readjustment of the field rheostat. Turn the rheostat clockwise to increase voltage, counterclockwise to decrease voltage.

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

AMMETER. - The ac ammeter indicates the amount of load connected to the phase indicated by the position of the selector switch. Single phase models have two ammeters and no selector switch.

VOLTMETER. - The ac voltmeter indicates the voltage of the same phase as the amperage shown, according to the selector switch position. On single phase models (no selector switch) and four wire, 3 phase models, the voltage shown will always be the higher nameplate voltage.

FREQUENCY METER (Optional). - The frequency meter indicates the frequency of the output current in cycles per second. Vibrating reed indicators show the exact frequency.

TACHOMETER (Optional). The tachometer indicates the engine operating speed in revolutions per minute.

EXERCISE PERIOD. - If the plant is used infrequently, as in standby service, it should be started and operated at least once a week. Operate long enough (15 to 30 minutes) to thoroughly warm up the engine. Such an exercise period will help to keep oil distributed on engine parts, fuel system full, etc., and promotes easier starting and longer engine life.

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

1. Fully charge the battery.
2. With the battery still on charge, draw off all the electrolyte above the plates in each cell. DO NOT ATTEMPT TO POUR OFF! Use a hydrometer or filler bulb. Avoid skin or clothing contact with the electrolyte, and dispose of it in a safe manner.
3. Refill each cell with approved water, to the recommended level.
4. Continue charging for 1 hour at a 4 to 6 ampere rate.
5. Test each cell. If the specific gravity is still above 1.225, repeat steps 2, 3 and 4 until the reading is reduced to 1.225. Usually, repeating steps twice is sufficient.

PARALLEL OPERATION. - If the plant is to be operated in parallel with another plant, special equipment and operating procedures are necessary. Parallel operation demands that the operator clearly understands the many requirements and proper procedure.

Plants designed for parallel operation usually have a special control panel with synchronizing lights, governor speed control, cross current compensating circuit, etc. Plants not originally so equipped may be altered as necessary. Consult the factory for specific information.

GENERAL. - Follow a definite schedule of inspection and servicing. Use the running time meter to keep a record of service operations. Service periods are based on normal service and operating conditions. For continuous heavy duty, extreme temperatures, or other unusual operating conditions, service more frequently. For light duty, periods of little use, etc., service periods can be lengthened accordingly.

ENGINE. - Refer to the Cummins engine manual, section 3, for the servicing schedule and details of service procedure.

BATTERIES. - Check the condition of the starting batteries at least every two weeks. See that all connections are clean and tight. A light coating of grease or asphalt paint will retard corrosion at terminals. Keep the electrolyte at the proper level above the plates by adding clean water that is satisfactory for battery use.

AC GENERATOR. - In addition to the engine service operations scheduled under the "C" column in the Cummins engine manual, check the condition of the ac generator.

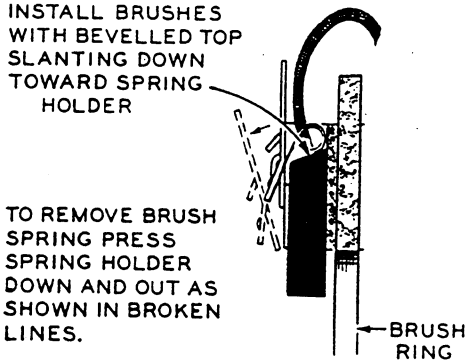
1. Commutator. - The commutator of the generator type exciter acquires a glossy brown appearance, which is a normal condition. Do not attempt to maintain a bright, newly machined metallic finish. Clean as necessary with a dry, lint-free cloth or light canvas. Slight roughness can be remedied by lightly sanding with #00 sandpaper. Do not use emery or carborundum cloth or paper. Blow out all sanding and brush dust.

2. Slip Rings. - Give the alternator slip rings the same servicing procedure as the exciter commutator.

3. Brushes. - See that all brushes ride freely in their guides, and make proper contact. Replace with a new one any brush which is chipped or otherwise damaged.

Install new brushes when worn to 1/2 inch in length, or so that the top of the brush is below a point midway between the top and bottom of its guide.

Note that it is necessary to remove each brush spring and plate before its brush can be removed. The spring will be kinked and damaged if the brush is pulled out past the mounted spring.



GENERATOR BEARING. - The generator ball bearing is a double sealed type, permanently lubricated. It requires no additional lubrication during its service life.

ENGINE. - Refer to sections 3 and 4 of the Cummins engine manual for details of engine maintenance. Generator performance is largely dependent upon engine performance.

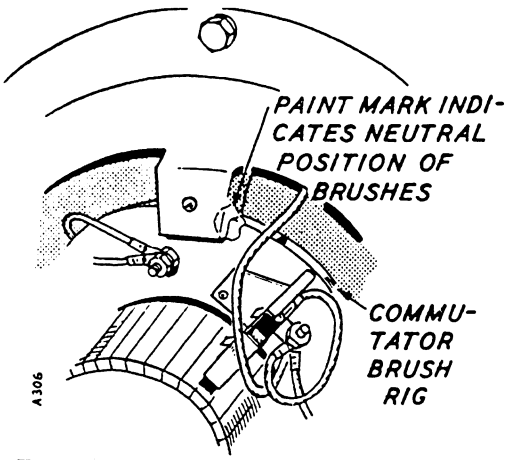
GENERATOR. - The generator normally requires no maintenance other than the periodic service. However, accident or unusual operating conditions may necessitate generator repair. Certain engine repairs require removal of the generator.

GENERATOR TYPE EXCITER - MODELS ENDING WITH SPEC. LETTER A

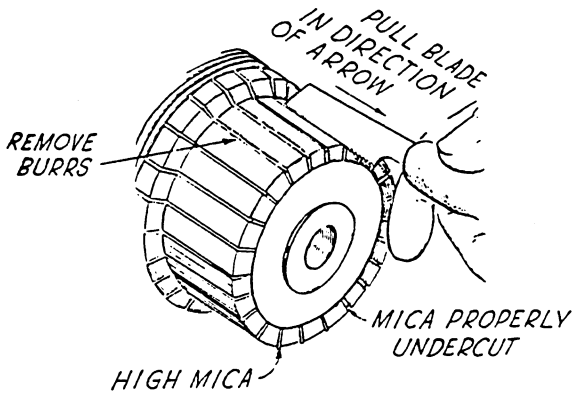
1. DISASSEMBLY. - Remove the end cover for access to the exciter brushes. Do not dismount the brush rig from the end bell. Disconnect (and mark) leads as necessary. Lift brushes from the commutator. From inside the exciter-to-alternator adapter, remove the exciter frame attaching screws. Carefully pull the exciter frame off over the armature. Remove the armature center bolt and pull the armature free of the alternator rotor shaft.

Remove the exciter adapter, alternator stator, and stator-to-engine adapter as an assembly. Be sure to provide proper blocking or hoist support as the alternator is loosened from the engine. Remove the rotor and its drive disc from the engine flywheel.

2. Commutator. - After a long period of service, the commutator surface may become worn level with the mica insulation between the bars. Undercut the mica to a depth of approximately 1/32 inch. Sandpaper off any burrs formed along the edges of the bars.

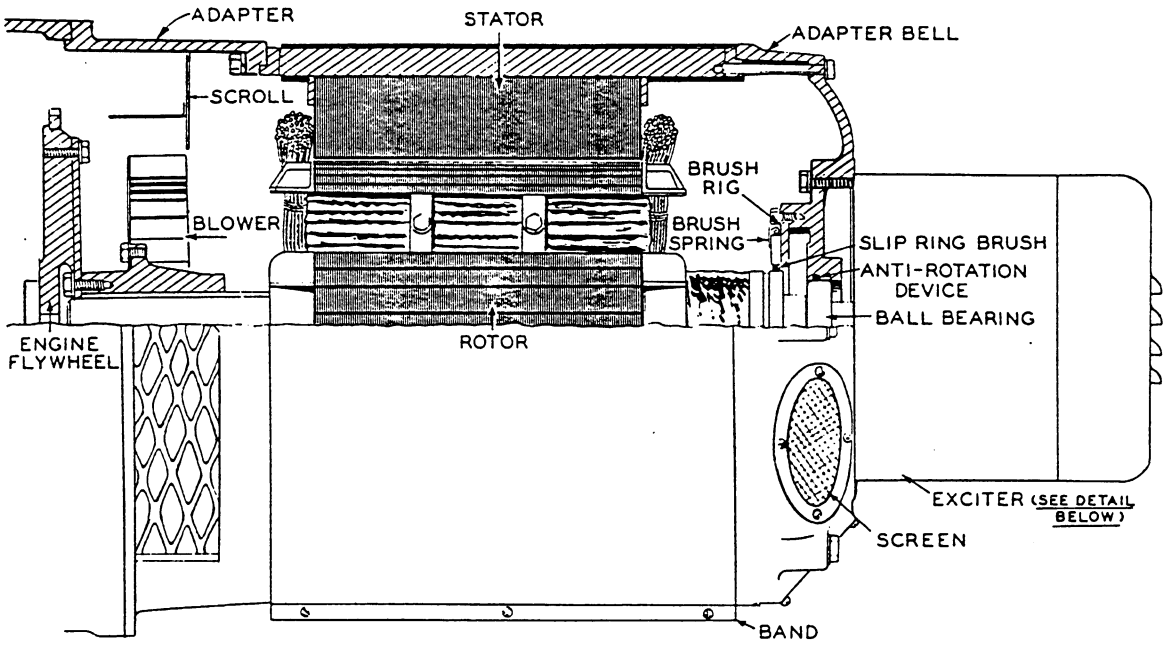


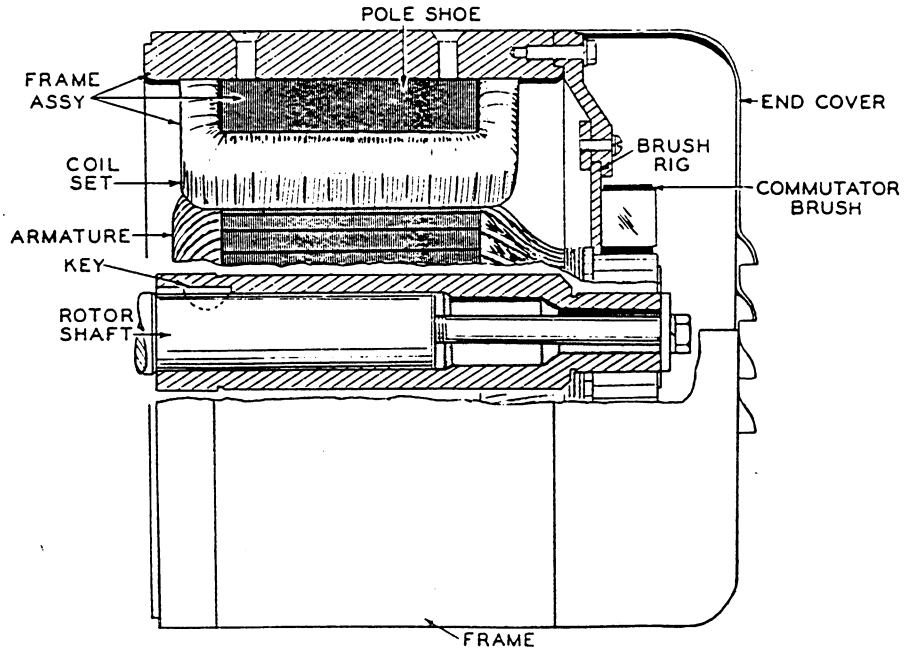
EXCITER BRUSH RIG ALIGNMENT



UNDERCUTTING MICA

If the commutator has become grooved, scratched, or otherwise damaged, true up its surface by carefully turning in a lathe. Remove only enough material to assure a true surface. Undercut the mica, as previously described, after turning.





EXCITER DETAIL

GENERATOR CROSS SECTION

Models ending with spec. letter A only.

3. Exciter Brush Rig. - The exciter brush rig position is marked during the factory test run. If the brush rig position has been disturbed for any reason, it must be realigned. The correct position is indicated by a chisel mark on the outside edge of the insulating ring, which mark must align with the edge of the marked mounting boss inside the end bell.

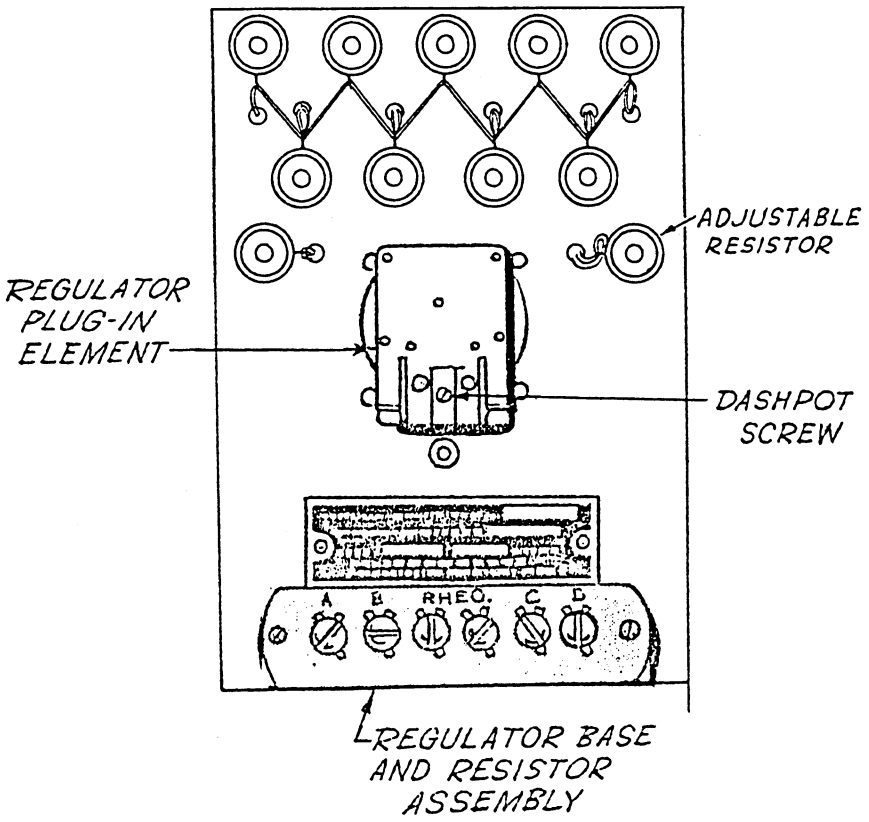
VOLTAGE REGULATOR. - The voltage regulator requires no maintenance. Except for keeping the regulator free of accumulation of dust, etc. no cleaning or lubricating materials should be used.

If a new voltage regulator or related parts is installed, some adjustment may be necessary. Refer to the wiring diagram for the plant.

1. Be sure the exciter brush rig position is set to give its highest voltage, approximately 70 v. dc. This must be done with the manual (field) rheostat in operation (regulator not in operation).

2. Turn the field rheostat to its counterclockwise position, to switch in the voltage regulator.

3. Observe the output voltage which should be adjustable, by use of the regulator rheostat, within a range of ten percent above and below the normal rated voltage.



4. If the regulator rheostat does not permit the proper adjustment range, it may be necessary to adjust the regulator resistor. With the regulator rheostat at its center position, loosen and move the sliding clip on the adjustable resistor. Very little movement of the clip will be necessary to obtain the correct voltage. Retighten the clip.

5. If a fluctuating voltage condition exists only when the voltage regulator is in operation, but voltage is steady when regulated by the field rheostat, adjust the regulator dashpot screw. After removing the clamping bar holding the unit in place, remove two screws holding the cover can. Turn the slotted screw at the center slightly until the fluctuating voltage just stops.

CAUTION

DO NOT ATTEMPT REGULATOR ADJUSTMENTS OTHER THAN THOSE DESCRIBED. NEVER CHANGE THE ORIGINAL SETTINGS OF THE REGULATOR SPRINGS OR CONTACT FINGERS.

MODELS ENDING WITH SPEC. LETTER B AND LATER

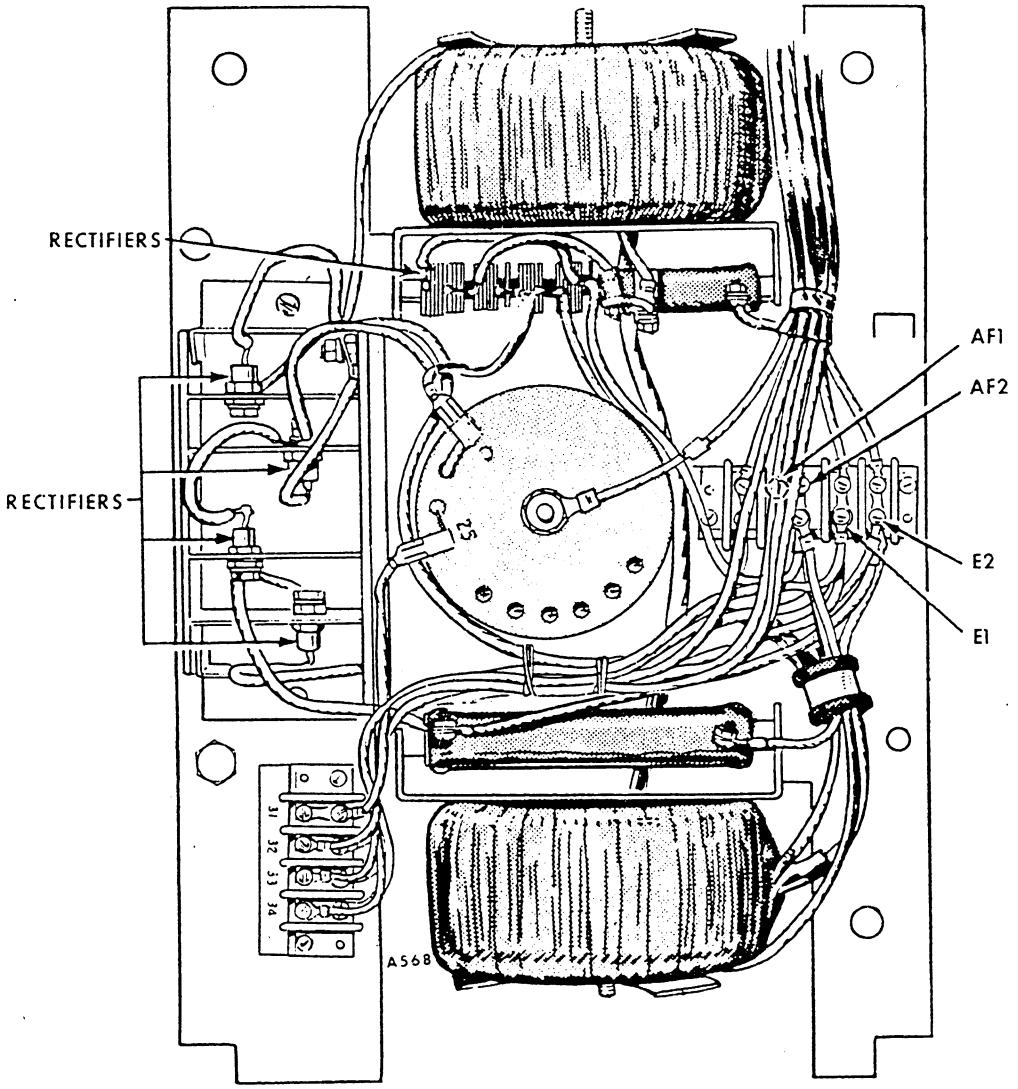
GENERATOR. - Openings in the alternator end bell permit access to the brush rig and slip rings. Remove the ventilating and inspection covers from their openings. It is seldom necessary to disturb the exciter assembly.

GENERATOR TESTS. - If the generator does not function properly, a few simple tests may isolate the cause.

1. Temporarily disconnect the two generator ac leads connected to the exciter terminals E1 and E2. Connect another source of ac power (such as the normal line when the plant is used for standby service) to the E1 and E2 terminals. Be sure that the substitute ac current is of the proper voltage as shown on the exciter wiring diagram. If, with the E1 and E2 terminals energized, there is no dc voltage across terminals AF1 (+) and AF2 (-) the exciter is not functioning.

2. With terminals E1 and E2 energized, if the dc voltage at terminals AF1 and AF2 is 25 volts or higher (no load condition), but there is no ac output at the main output terminals, check the alternator for improper operation (ground, open, etc.).

3. No terminal of the exciter should show a grounded circuit.



4. If ac voltage drops under load conditions, check the exciter rectifiers. Use a low voltage, battery powered "Multimeter" type ohmmeter. Disconnect one lead from, or remove, each rectifier for its test.

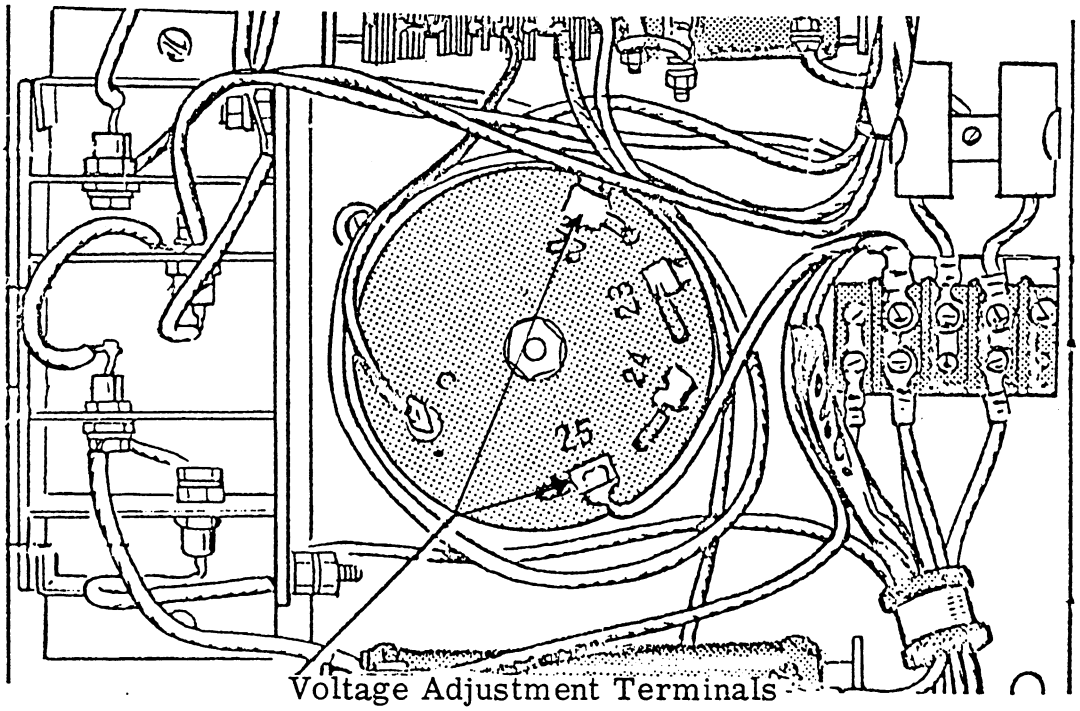
CAUTION

Note carefully the DIRECTION OF MOUNTING of any rectifier removed. It must be remounted in its original direction.

a. Connect the ohmmeter across the rectifier contacts and obtain the meter reading.
b. Reverse the connections and compare the new reading with the first reading.
c. If one reading is considerably higher than the other reading, the rectifier can be considered satisfactory. If both readings are low, or if both indicate an open circuit, replace the rectifier with a new identical part.

VOLTAGE ADJUSTMENT, MODELS ENDING WITH SPEC. LETTER B

Ordinarily if the engine is operating properly and at the correct speed, the output voltage will be correct. The exciter was connected for rated output during the factory test run. However if some local condition requires a change in the output voltage, exciter connections can be changed.



Voltage Adjustment Terminals
Models ending with spec. letter **B** only.

1. Be sure the engine governor is properly adjusted for correct current frequency (speed), sensitivity, stability, etc.

2. Stop the plant and remove the exciter cover.

3. Note a disc shaped terminal block at the center with a lead connected to one of the terminals marked 22, 23, 24, or 25. Moving this lead to an adjacent terminal (from 25 to 24, etc.) will change the generator output voltage approximately 5 percent.