INSTALLATION
&
OPERATING INSTRUCTIONS

FOR

ONAN ELECTRIC GENERATING PLANTS

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DFH

SERIES

8-59

D V. ONAN & SONS INC. • MINNEAPOLIS 14, MINN.

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GENERAL INFORMATION

THE PURPOSE OF THIS BOOK. This instruction book is furnished so that the operator may learn of the characteristics of the plant. A thorough study of the book will help the operator to keep the plant in good operating condition so that it will give efficient service. An understanding of the plant will also assist the operator in determining the cause of trouble if it occurs.

KEEP THIS BOOK HANDY. Such simple mistakes as the use of improper oil, improper fuel, or the neglect of routine servicing may result in failure of the plant at a time when it is urgently needed. It is suggested that this book be kept near the plant so that it may be referred to when necessary.

SERVICE. If trouble occurs and the operator is unable to determine the cause after a thorough study of this book, or if he is unable to determine what repair parts are required, needed information will be furnished upon request. WHEN ASKING FOR INFORMATION, BE SURE TO TO STATE THE MODEL, SPEC., AND SERIAL NUMBERS OF THE PLANT. THIS INFORMATION IS ABSOLUTELY NECESSARY AND MAY BE OBTAINED FROM THE NAMEPLATE ON THE PLANT.

MANUFACTURER'S WARRANTY

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

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

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

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

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

IMPORTANT

RETURN WARRANTY CARD ATTACHED TO UNIT.

TABLE OF CONTENTS

DESCRIPTION

The Onan generating plant of the DFH 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 purchaser.

The electrical characteristics of the plant vary according to the particular model, and are noted on the Onan nameplate attached to the unit. When the plant is used for standby service, optional controls for starting, load transfer, and stopping may be connected during installation. 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 occurred in shipment. Any such damage must be repaired before putting the plant in operation.

ENGINE

The engine is a Cummins basic model ~~NH-220~~ described in the Cummins manual. The specific engine used may have variations due to optional features of the generating plant, type of cooling, etc. specified by the plant purchaser. Basically, the engine is a 6 cylinder water cooled, diesel (compression ignition) type. The cylinder bore is 5-1/8 inches, piston stroke is 6 inches, and displacement is 743 cubic inches. The engine is rated 200 horsepower at 1800 rpm. The standard oil capacity is 7 U.S. gallons. A 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.

The standard engine cooling system uses a radiator and pusher type fan. Optional cooling systems use "city" water, or similar separate pressure source of water supply. When the water supply is very alkaline or otherwise unsuitable for circulating through the engine, a "heat exchanger" system is recommended. If the water supply can safely be used directly, a "mixing" standpipe or tempering tank can be used.

GENERATOR

The generator consists of a 4 pole revolving field type alternator, and a static exciter with magnetic amplifier regulator. The alternating current output is generated in the alternator stator winding, attached directly to the rear end of the engine. The alternator's rotating field is attached to the engine flywheel, and so turns at engine speed. The speed at which the rotor turns determines the current frequency, thus the 60 cycle plant must operate at approximately 1800 rpm, and the 50 cycle plant at approximately 1500 rpm. The outer end of the rotor turns in a large ball bearing fitted into the end frame.

The exciter components are mounted inside a sheet metal enclosure attached to the alternator end frame. The design of the exciter provides for almost constant ac output voltage over a wide range of load conditions. This is particularly advantageous when the generator is called upon to start large electric motors. The static exciter is considerably smaller and lighter than a conventional dc generator type and eliminates the necessity of an external voltage regulator, through the use of a magnetic amplifier.

CONTROLS

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. A running time meter provides for recording the operating time of the plant and for checking service periods.

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. 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.

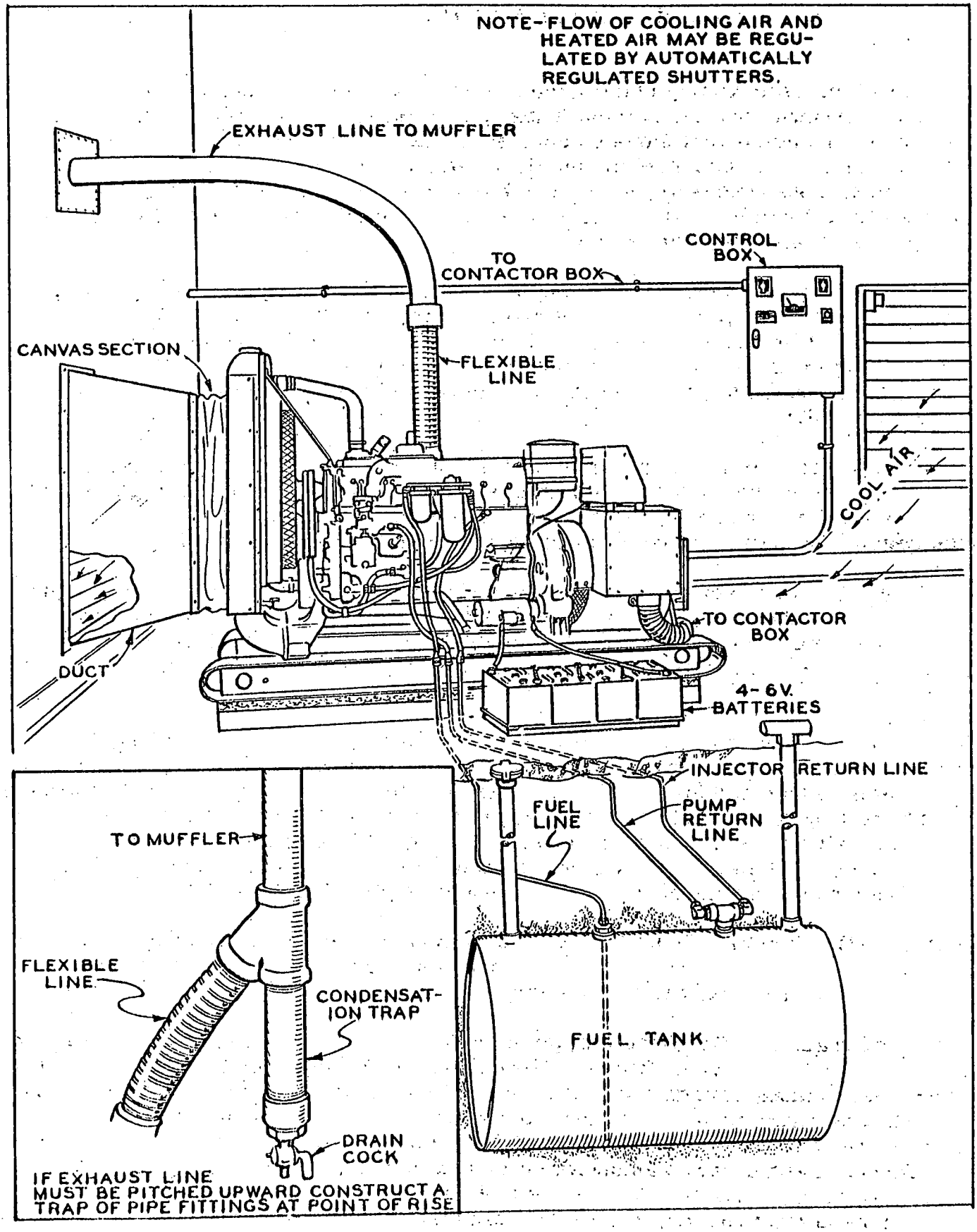
MOUNTING. - Refer to the installation outline drawing. The plant is mounted on a rigid skid base which provides proper support. However if additional vibration dampeners, raised pedestals, etc. are employed it may be necessary to provide special footings or other support as necessary to carry the load.

VENTILATION. - For radiator cooled units, proper ventilation is of vital importance. Under normal operating conditions, approximately 13,400 cubic feet of air per minute will provide proper cooling. In a small room installation this may require installation of an auxiliary fan connected to operate at any time the plant is running.

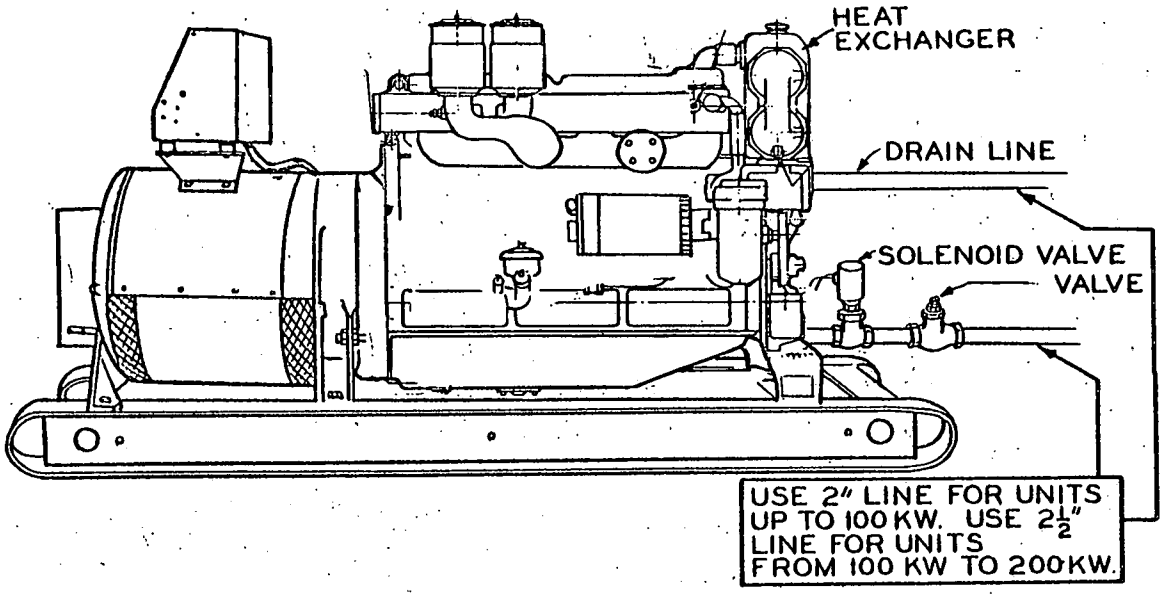
The pusher type fan used forces the cooling air out through the front of the radiator. The usual method of exhausting the heated air is to construct a duct from the front of the radiator to an outside wall. In cold climates, provision must be made to prevent any back-flow of cold outside air during periods of shut down. 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.

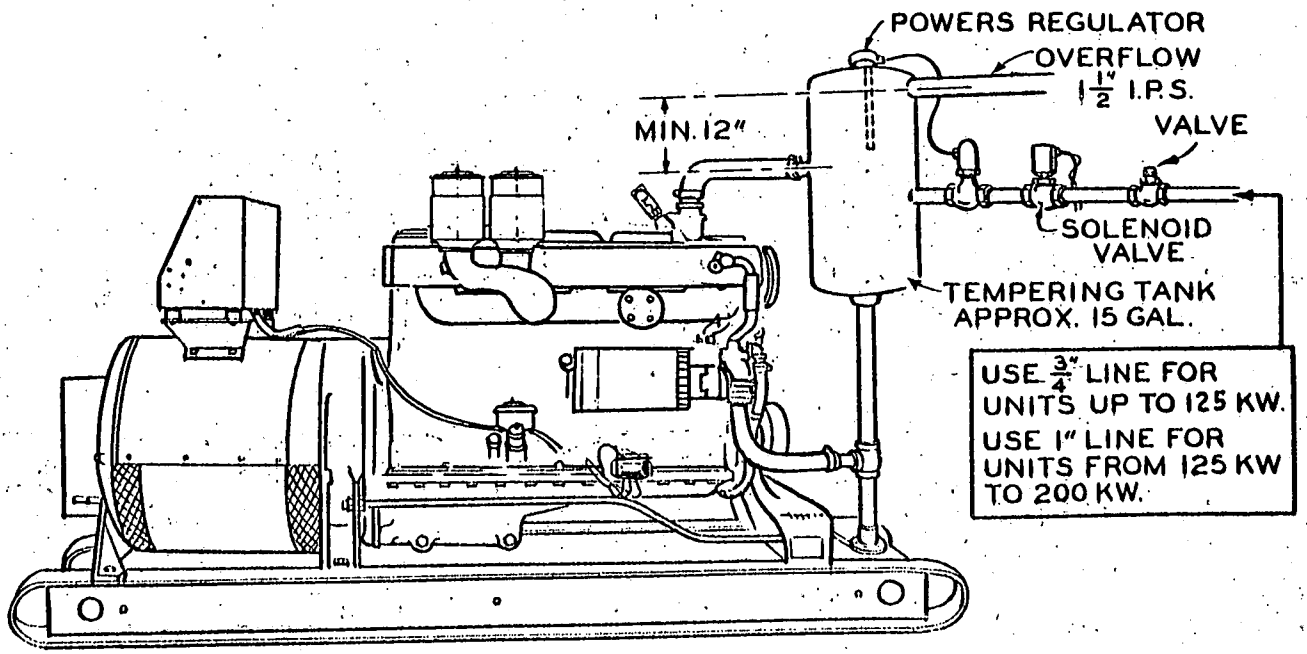
1. Heat Exchanger. - The heat exchanger installation provides for a "closed" engine water system. The engine coolant circulates through a tubed chamber. A separate and constantly changing flow of cool water surrounds the cooling tubes and is drained off. An electrically operated valve (solenoid type)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



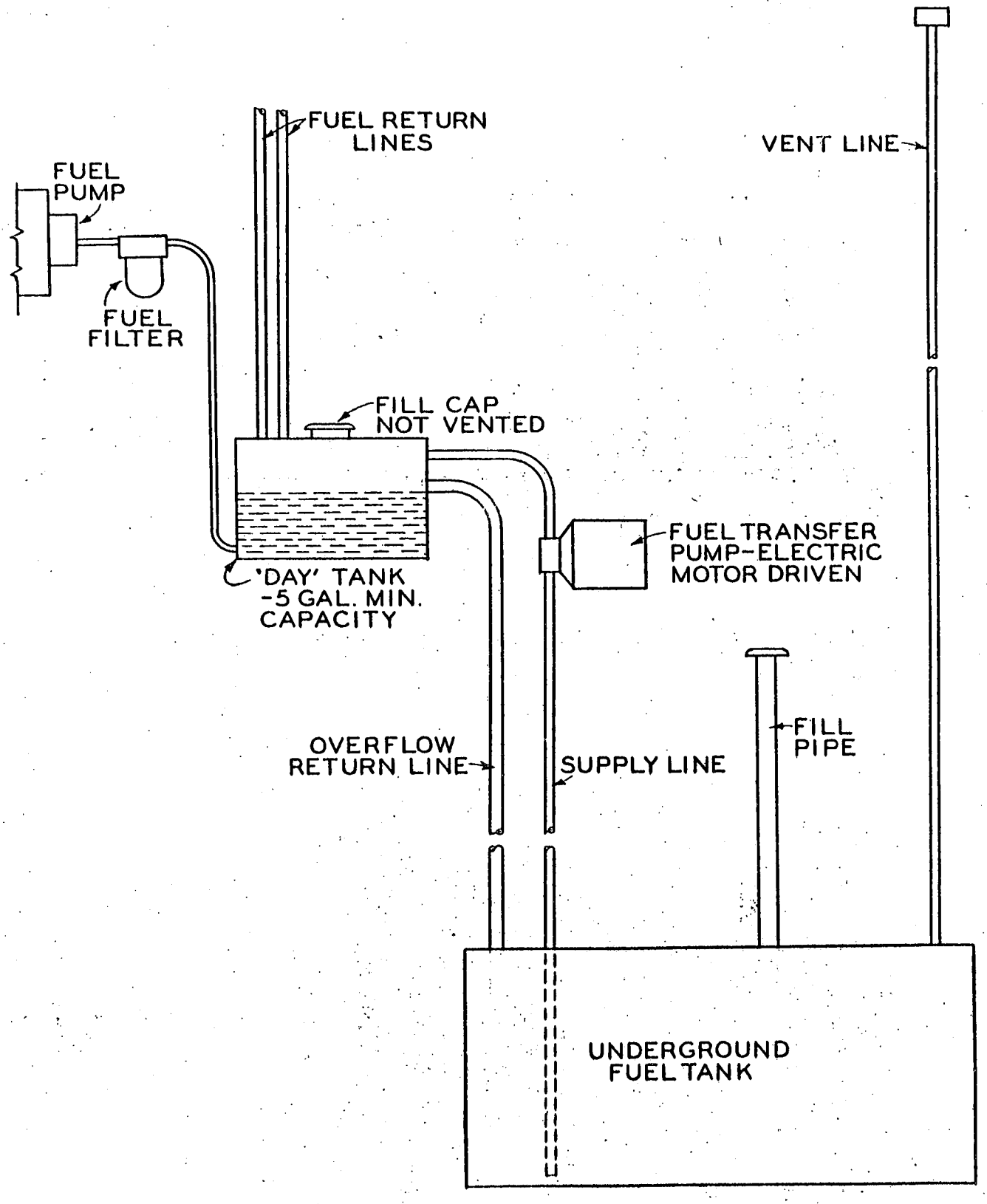
TYPICAL STANDBY INSTALLATION



CITY WATER HEAT EXCHANGER COOLING



CITY WATER STANDPIPE WITH POWERS REGULATOR



'DAY' TANK INSTALLATION

MINIMUM WATER FLOW, HEAT EXCHANGER COOLING

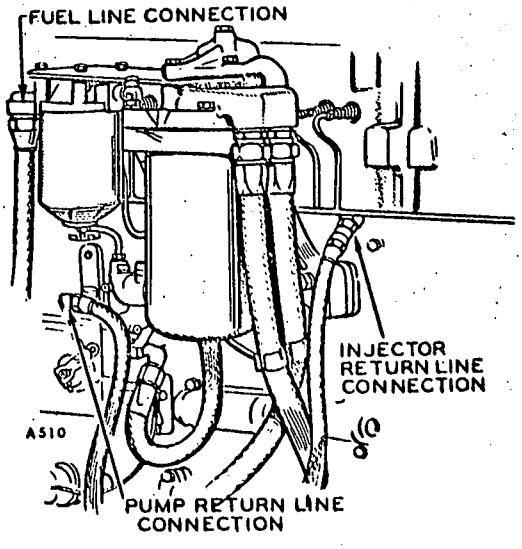
ELECTRICAL LOAD	WATER TEMP.	MIN. FLOW-GAL. /MIN.
90 KW	40°F.	23
	60°F.	37
	80°F.	46
100 KW	40°F.	25
	60°F.	40
	80°F.	50
115 KW	40°F.	28
	60°F.	45
	80°F.	56

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 electrically operated valve (solenoid type) 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 valve. If rate of flow is hand adjusted, refer to the water flow table, which shows the approximate minimum water required at the loads listed. Water inlet and outlet pipe sizes are shown on the illustration.

MINIMUM WATER FLOW, TEMPERING TANK COOLING

ELECTRICAL LOAD	WATER TEMP.	MIN. FLOW-GAL. /MIN.
90 KW	40°F.	7.5
	60°F.	10.5
	80°F.	13.
100 KW	40°F.	8.
	60°F.	11.5
	80°F.	14.5
115 KW	40°F.	9.
	60°F.	13.5
	80°F.	17.

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 on the fuel filter is threaded for a 1/2 inch pipe thread fitting. The fuel



pump return opening 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.

NOTE

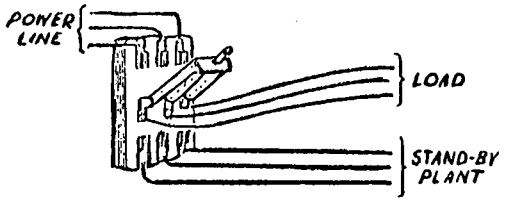
In any diesel installation, fuel system cleanliness is of utmost importance and cannot be over emphasized. Make every effort to prevent entrance of any contaminating matter, moisture, etc. Do not use fittings of galvanized material.

EXHAUST. - Pipe the exhaust gases outside any enclosure. Use pipe at least as large as the 4 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. If the line passes through a combustible wall or partition, the opening must provide for at least 2 inches space between the pipe and nearest point of the opening. Install a suitable muffler to the exhaust line.

BATTERY. - 24 volt battery current is required for starting purposes. Two 12-volt, type 8D batteries are recommended for normal installations. Connect the batteries in series - the negative post of one battery to the positive post of the next battery. Connect the start solenoid cable of the engine starter to the remaining positive post. Connect the grounded battery cable to the remaining negative post. 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 connected.

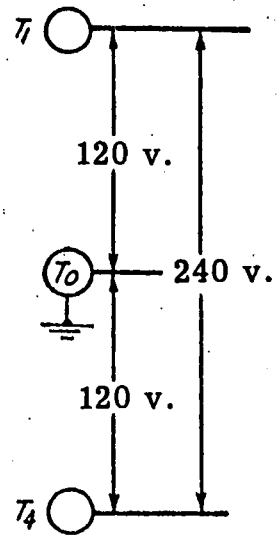
ELECTRICAL CONNECTIONS. - Most local regulations require that wiring connections be made by a licensed electrician, and that the installation be inspected and approved before operation. Be sure that wiring meets requirements of electrical codes in effect at the installation site. When the plant is used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



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. The plant should be properly grounded.

An automatic transfer switch includes a circuit for automatic control of starting and stopping. Connect the control wires to the "remote operation" terminal block indicated on the engine control wiring diagram. The B+ terminal supplies 24 volt battery current for energizing the control circuit, and the "START" terminal serves as an extension of the "run-stop" circuit. The "GND" terminal serves as a grounded connection point for auxiliary equipment (warning signals, etc.). Refer to the engine control wiring diagram for connection of any such auxiliary equipment.

The generator ac output terminals are large studs inside a sheet metal enclosure at the side of the generator. The terminal studs are marked as designated on the output control wiring diagram. A T0 terminal, if used, is neutral. Terminals T1, T2, and T3 are "hot".

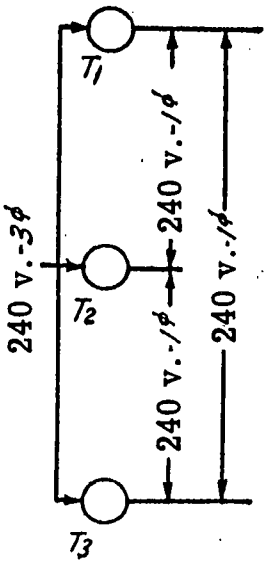


120/240 VOLT, SINGLE PHASE PLANT

The T0 output terminal is the neutral (grounded) connection point. Connect the neutral (white) load wire to the T0 terminal. Connect the "hot" (black) load wires to terminals T1 and T2. Two 120 volt circuits are thus available T0-T1, and T0-T2. One half the plant rated capacity is available on each 120 volt circuit. For 240 volt current, use terminals T1 and T2.

240 VOLT, 3 PHASE, 3 WIRE PLANT

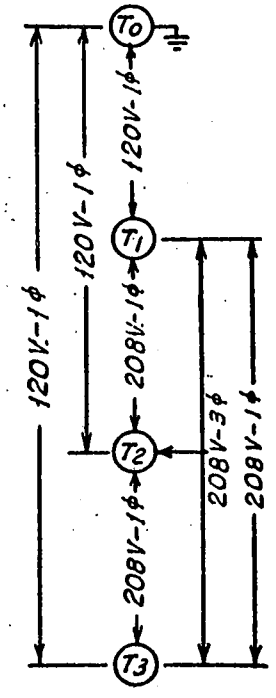
No terminal is grounded. For three phase current, connect separate load wires to each plant terminal "T1", "T2" and "T3", one wire to each terminal. Reversing the connections between any two terminals will reverse the direction of rotation of 3 phase motors. If phase sequence is important, be sure to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



To obtain 240 volt, single phase current, connect separate load wires to each of any two plant terminals. Three 240 volt 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 are 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.

120/208 VOLT, 3 PHASE, 4 WIRE WYE-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", "T2" 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 are used at the same time, follow the principles of load distribution as given for the 3 phase, 3 wire plant.

480 VOLT OR 600 VOLT, THREE PHASE, THREE WIRE PLANT

Follow the principles of connection as given for 240 volt, 3 phase, 3 wire plant.

220 VOLT, SINGLE PHASE/380 VOLT, THREE PHASE, 4 WIRE 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: regular 240 volt, 3 phase, 3 wire operation; or combination 240 volt, 3 phase, 3 wire and 120/240 volt, 1 phase, 3 wire operation.

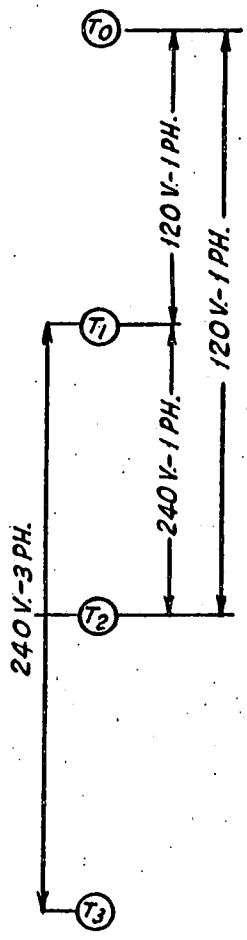
The load terminals are marked T1, T2, T3 and T0. The T0 terminal is the generator center tap between T1, and T2. The T0 terminal of the generator is not grounded.

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.

When 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.

Any 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 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.

The capacity of the oil pan is approximately 7 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 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. Use oil of the same viscosity and quality as that used in the crankcase.

AIR CLEANER. - If the engine is equipped with an oil bath type air cleaner, 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.

CRANKCASE BREATHER AIR CLEANER. - Service the crankcase breather air cleaner in the same manner as for the main combustion intake air cleaner.

COOLANT. - For units which use either a radiator or heat exchanger (city water cooled), fill the cooling system with clean soft water. The standard radiator and block capacity is 21.7 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 liquid if necessary to compensate for any air pockets which may have formed during filling.

If the plant is equipped for "city" water cooling, see that the water supply is turned on.

FUEL. - Refer to section 3 of the Cummins 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. Throw the control panel toggle switch to its RUN position. The plant will crank and start running.

The standard engine is designed for normal starting in temperatures of 50°F. or higher. Optional equipment is available if operation in lower temperatures is required.

CHECKING OPERATION. - Allow the engine to warm up, observing indicating gauges for proper operation and electrical output.

For the initial run, check the entire installation very carefully. A minor correction or change at this time may insure long and satisfactory future service.

WATER FLOW. - If the plant is city water (pressure) 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 reading 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 off slightly and prevent an excessive temperature rise when the plant stops and ventilation ceases. Throw the control panel toggle switch to the STOP-AUTO. 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 several safety devices that stop the engine under conditions that could cause severe damage.

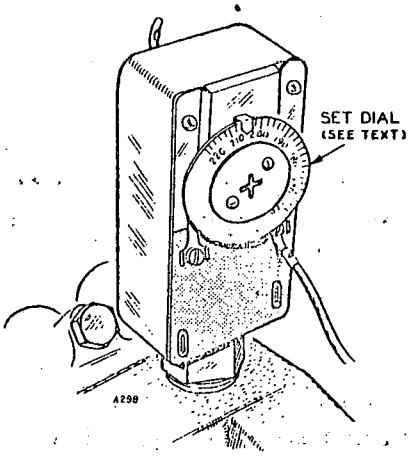
NOTE

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. Over Speed Cut-Off. - 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. Under no circumstances should the plant be operated if the switch is disconnected or otherwise made inoperative. Excessive speed could cause extensive generator damage.

3. 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.



HIGH WATER TEMPERATURE CUT-OFF SWITCH

The dial setting should be set 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.

OIL PRESSURE. - The oil pressure gauge indicates the engine oil pressure while the engine is running. 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 water 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 battery. The charge rate will be comparatively high when the plant first starts, but should fall to almost zero as the battery becomes fully charged.

EMERGENCY STOP RELAY. - If one of the safety devices 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.

RUN, STOP-AUTO. SWITCH. - A two position toggle switch controls starting and stopping of the plant. For manual control, throw the switch to its RUN position to start and operate. Throw the switch to its STOP-AUTO. position to stop the plant.

If the plant is to be controlled by an automatic line transfer control, or from a remote manual switch point, leave the panel switch at its STOP-AUTO. position.

CRANKING LIMITER. - If the plant fails to start, the cranking limiter acts to break the cranking circuit and its button will protrude from the panel. Wait at least one minute before pushing the reset button. Allow the starter to cool a few minutes (2-5) before re-cranking, to avoid starter damage.

METER SELECTOR SWITCH. - The selector switch handle position indicates which phase of the generator output is indicated on the ac voltmeter and ammeter. Turn the handle to the desired position.

CIRCUIT BREAKER. - The circuit breaker protects the generator from damage from an extreme over load. 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.

FREQUENCY METER. - The frequency meter indicates the frequency of the output current in cycles per second. A vibrating reed indicator shows the exact frequency.

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

AC AMMETER. - The ac ammeter indicates the amount of load connected to the phase indicated by the selector switch position.

AC VOLTMETER. - The ac voltmeter indicates the voltage of the same phase as the amperage shown. On a four wire, three phase model, the voltage shown will always be the three phase (higher) nameplate voltage.

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, start and operate at least once a week. Operate long enough (15 to 30 minutes) to thoroughly warm up the engine. This will help to keep oil distributed on engine parts, fuel system full, etc., and promotes easier starting and longer engine life.

BATTERY, 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.

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, etc., service more frequently. For light duty, periods of little use, etc., service periods can be lengthened accordingly.

ENGINE. - Refer to the Cummins engine manual for details of service operations.

BATTERIES. - Check the condition of the starting batteries at least every two weeks. See that connections are clean and tight. A light coating of grease or asphalt paint will retard corrosion at terminals. Keep the electrolyte level 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.

Replace the brushes if worn to 1/2 inch in length, or if damaged. DO NOT LUBRICATE. Refer to Generator Maintenance.

It is normal for the slip rings to acquire a dark brown glossy surface. Do not attempt to keep a bright metallic appearance. Clean with a dry, lint free cloth. Slight roughness can be remedied by light sanding with #00 sandpaper.

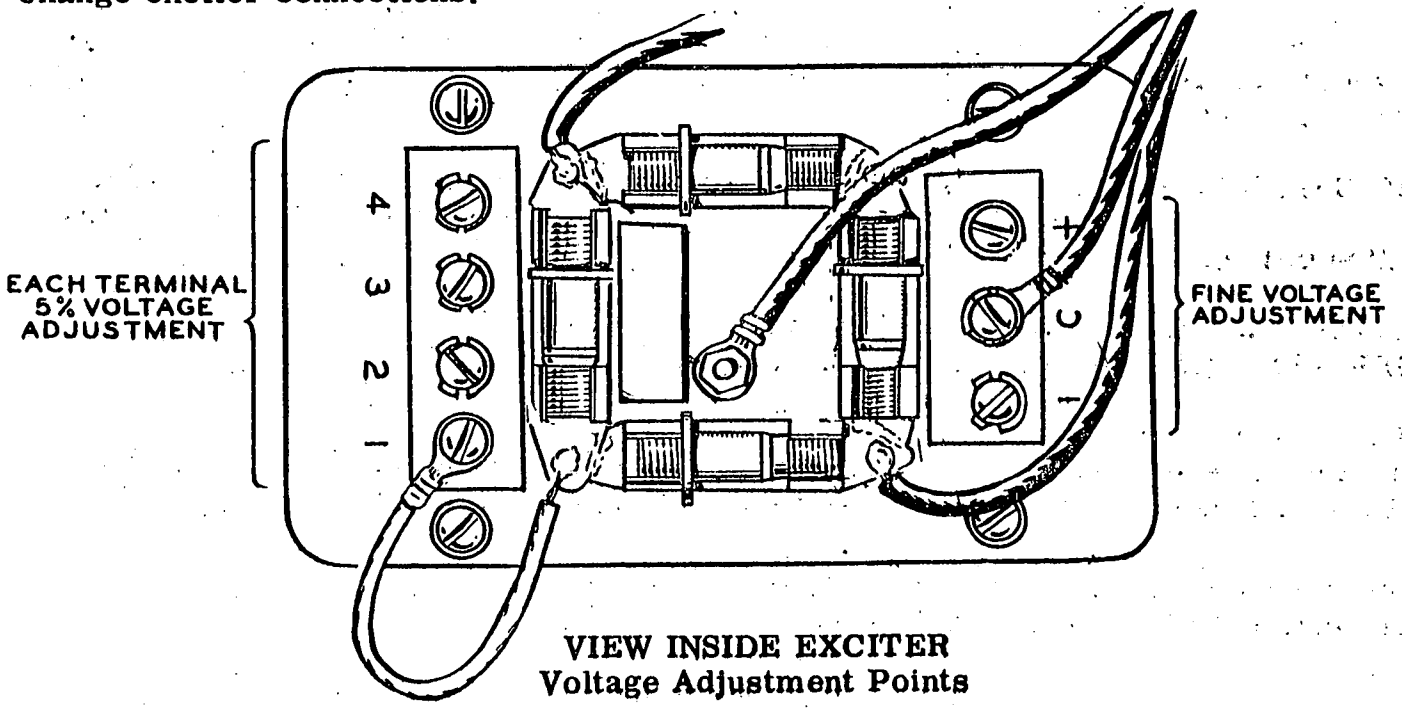
The generator bearing is pre-lubricated and sealed. It requires no additional lubrication during its service life.

MAINTENANCE

NOTE

Basic engine maintenance, minor repairs, etc. are covered in the Cummins engine manual.

OUTPUT VOLTAGE. - Ordinarily if the engine is operating properly and at approximately the nameplate indicated 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, change exciter connections.



VIEW INSIDE EXCITER
Voltage Adjustment Points

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.

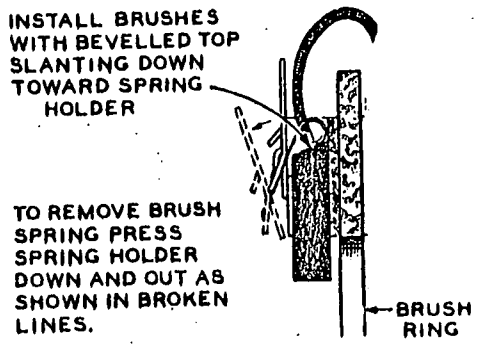
3. Note that one lead is connected to a 3 place terminal block marked +, C, and −. By moving the lead connection from the C terminal to the + terminal, output voltage will be raised approximately 3%. Moving to the − terminal will lower the voltage by approximately 3%.

4. If a greater voltage adjustment is necessary, note a second lead connected to a terminal block marked 1, 2, 3 and 4. By moving the lead to an adjacent terminal (2 to 3, 4 to 3, etc.) the voltage will be changed approximately 5%. After making such a change, start the plant and check the voltage. It may be necessary to readjust the "fine" voltage adjustment as described in step 3.

GENERATOR MAINTENANCE. - The generator normally requires little maintenance other than the periodic servicing. Inspection during periodic servicing should indicate when the slip ring brushes must be replaced.

To examine the brushes, brush springs, and slip rings, remove the exciter cover. Note that the exciter assembly mounts on a hinged plate. Remove the screws from the left side of the exciter plate and swing the assembly outward. Openings in the alternator end bell permit access to the brush rig.

Brushes should be replaced when worn to approximately 1/2 inch long, or so that the top of the brush is below a point midway between the outer and inner end of its guide. Do not use a substitute brush that may look identical but may have entirely different electrical characteristics. Be sure the brush is installed so that the short side of its taper is toward the spring and its bracket. Do not attempt to remove the brush without first removing its spring and bracket as shown. Never bend a spring back over its bracket - doing so will put a kink in it and require replacement.



BRUSH SPRING REMOVAL

The generator bearing is pre-lubricated and sealed. It requires no servicing.

The exciter contains no moving parts. Occasionally blow out any dust, etc. Check thoroughly to assure that all components are mechanically secure, and that all electrical connections are tight.

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

1. Temporarily disconnect the two 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) to the E1 and E2 terminals. If there is no dc voltage across terminals AF1 (+) and AF2 (—), the exciter is not functioning.

2. If dc voltage at terminals AF1 and AF2 is approximately 25 volts (no load condition) but there is no ac output at the main output terminals, check the alternator for a grounded or open circuit, 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 the test.

NOTE

Note carefully 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.