OPERATORS MANUAL AND PARTS CATALOG

FOR

Onan®

ELECTRIC GENERATING PLANTS

DFD

SERIES

ONAN
2515 UNIVERSITY AVE. S. E. · MINNEAPOLIS, MINNESOTA 55414
A DIVISION OF STUDEBAKER CORPORATION
IN CANADA: ONAN GENERATORS CANADA LTD., 233 CAMPBELL ROAD, GUELPH, ONTARIO
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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.

We mean it.....

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

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

GENERAL INFORMATION

This instruction book contains information for the proper installation, operation, and maintenance of your equipment. We suggest that this book be kept handy so that it can be referred to when necessary.

This equipment is the result of proven engineering design, highest quality materials, and expert workmanship. Thorough inspection and testing assures you that this equipment will perform as expected.

If you wish to contact your dealer or the factory regarding this equipment, be sure to supply the complete MODEL and SPEC. NO., and the full serial number of the equipment as shown on the nameplate. This information is necessary to identify the equipment among the many basic and special optional types manufactured.

MANUFACTURER'S WARRANTY

The Manufacturer warrants, 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

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DESCRIPTION

The Onan generating plant of the DFD 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 HS-743 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, supercharged diesel (compression ignition) type. The cylinder bore is 5-1/8 inches, piston stroke 6 inches, and displacement is 743 cubic inches. The engine is rated 240-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. Some models are designed to permit reconnection for different output voltages, if proper procedure is followed. 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. Some models are provided with a panel mounted rheostat control for voltage adjustment.

CONTROLS

The plant control box is mounted on the generator. It contains components for starting, controlling, and stopping the plant. Instruments to indicate engine and generator performance are flush mounted on the operator's panel of the control.

The engine is started through a run-stop switch, a fuel solenoid relay, cranking limiter, a pilot relay, a series-parallel solenoid, and a starter motor. Cranking alternates in 10 second cranking cycle and 5 second rest cycle on models prior to Spec. F until the engine starts or the cranking limiter opens. A start disconnect relay stops the cranking when the engine starts.

Engine performance is indicated by a water temperature gage, an oil pressure gage, and a battery charge ammeter. The engine is protected from high water temperature, low oil pressure, and overspeed, all operating through an emergency latch relay. A latched relay is indicated by a red light on the control panel and by a protruding button which has to be manually reset. There is a terminal block in the control for connecting wires to a remote control switch. Other controls are used in conjunction with accessories specified by the purchaser.

WARNING

AN OVERSPEED PROTECTIVE SWITCH IS BUILT INTO THE OUTER END OF THE GENERATOR SHAFT. THIS OVERSPEED DEVICE AUTOMATICALLY SHUTS OFF THE ENGINE IF THE SPEED REACHES 2100 RPM. UNDER NO CIRCUMSTANCES SHOULD THE OVERSPEED SWITCH BE BY PASSED OR DISCONNECTED. EXTENSIVE GENERATOR DAMAGE WILL RESULT FROM OVERSPEED.

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

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

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, and should be consulted.

LOCATION. - In the average installation, the location has been pre-selected. However, there are certain basic requirements for a statisfactory location. The ambient temperature should be warm enough to assure easy starting. A plant used for emergency standby service should be installed where the ambient temperature will not fall below 50°F. unless special heating accessories are used. Many specifications or local regulations require a minimum of 65°F. Special starting aids are required for temperatures below 32°F.

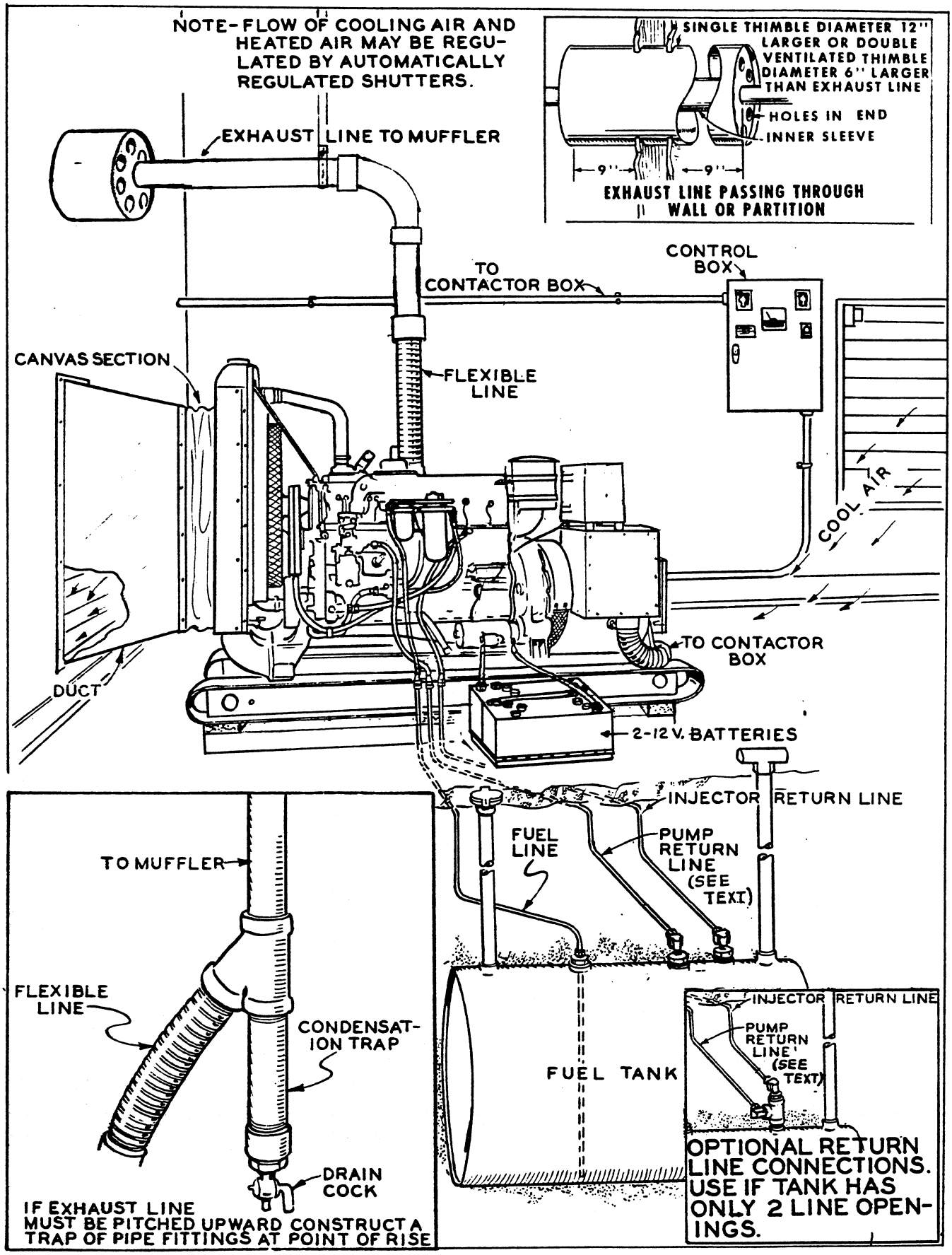
Extremely high ambient temperatures can create cooling problems. A radiator cooled plant is usually limited to an ambient temperature below 120°F. See COOLING AND VENTILATION.

The plant location should be dry, and reasonably dust free. Provide for at least 24 inches space on all sides, for convenience in servicing the plant.

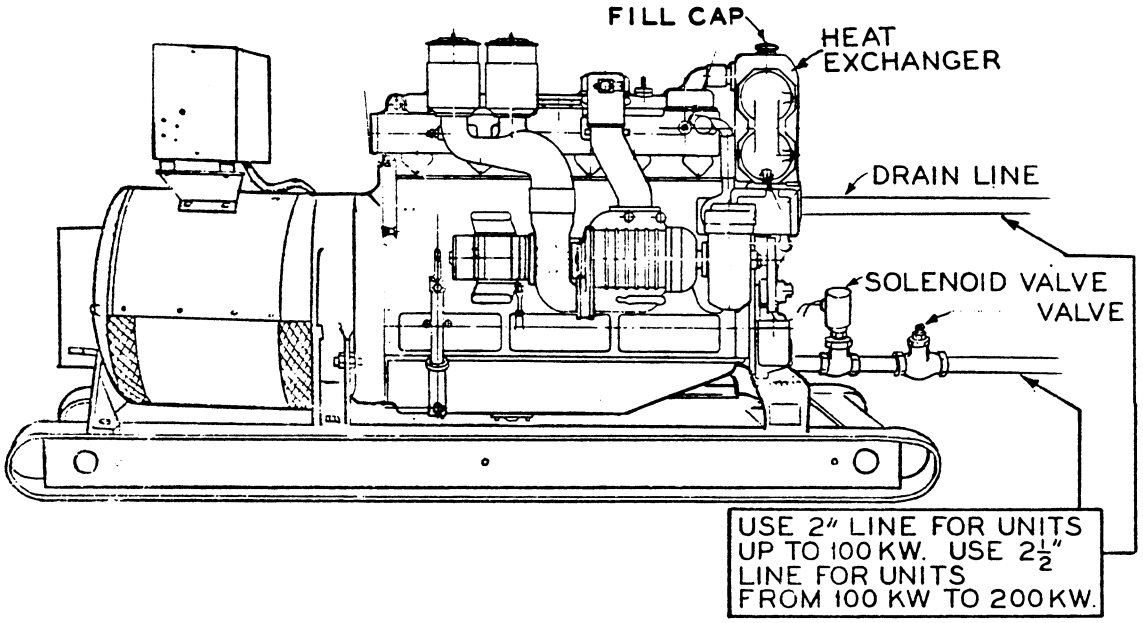
MOUNTING. - The plant is mounted on a rigid skid base that provides proper support. If additional vibration dampers, raised pedestals, etc. are employed, it may be necessary to provide special footings or other support as necessary to carry the load. Refer to the separate outline drawing for mounting dimensions, etc.

COOLING AND VENTILATION. - Proper ventilation is of vital importance, particularly for a radiator cooled unit. Under normal operating conditions, approximately 14, 200-cubic feet of air per minute will provide for proper cooling. For a "city water" cooled unit, approximately 3, 350 cu. ft. per minute will provide sufficient air for cooling the generator and support combustion in the engine. In a small room installation this may require the installation of an auxiliary air intake fan, connected to operate only during plant operation.

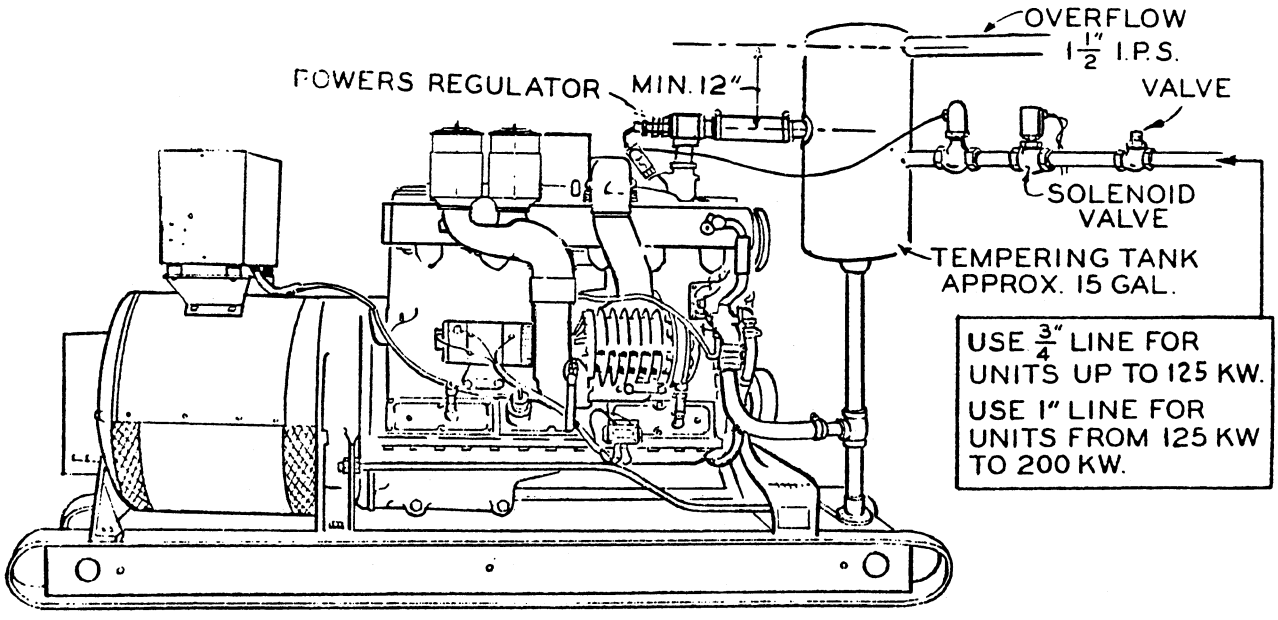
The pusher type fan used on a radiator cooled plant forces the heated air out through the front of the radiator. The usual method of exhausting the heated air from a room or compartment is to construct a sheet metal duct from the front of the radiator to an outside wall. Use a short canvas section next to the plant to reduce transmission of noise and vibration. The air inlet opening should be located to prevent recirculation of heated air or exhaust fumes, and at least as large in area as the air outlet. If the engine is cooled by the "city water" method, ventilation is seldom a problem, but sufficient air movement and fresh air must be available to properly cool the generator, and to support combustion in the engine.



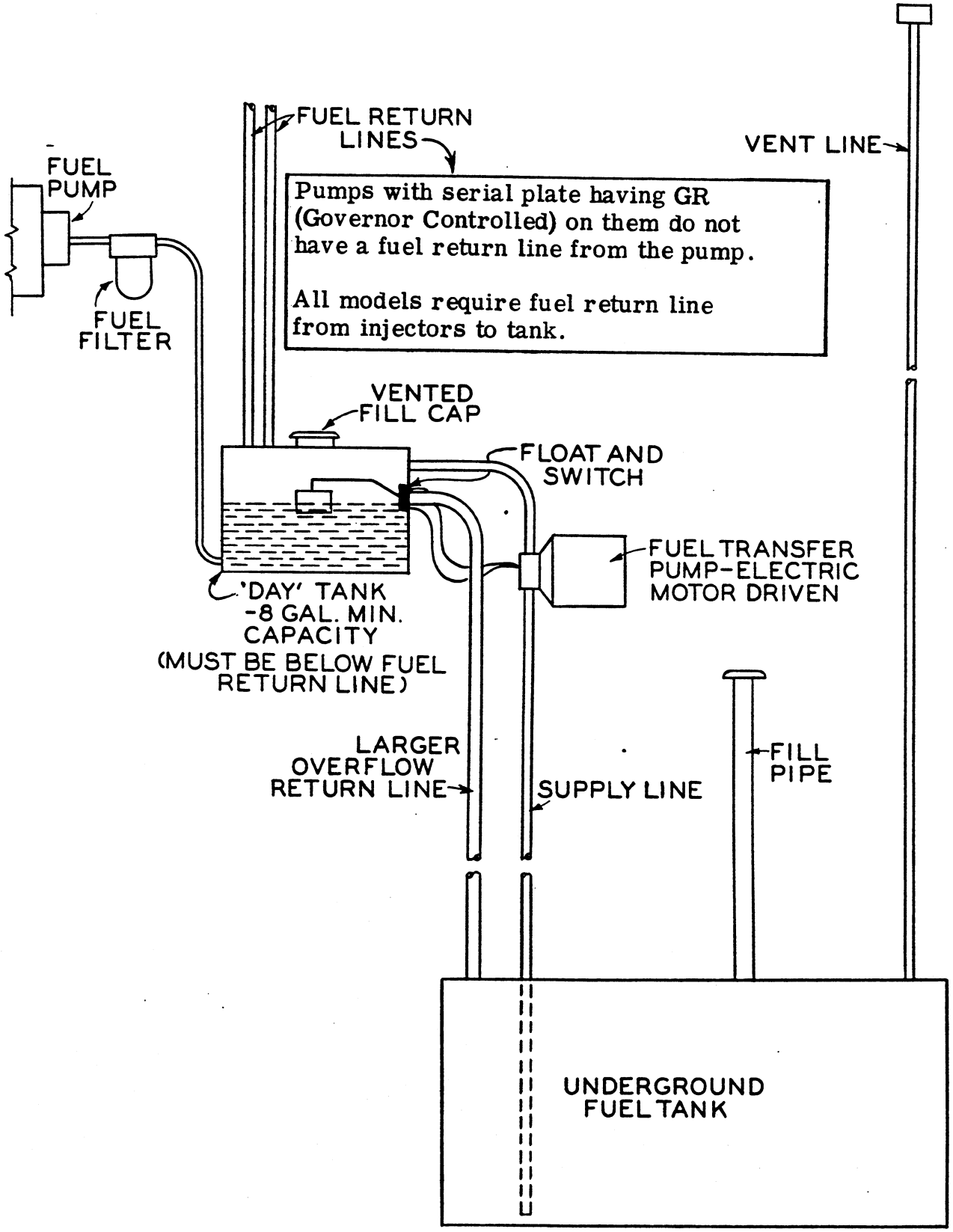
TYPICAL STANDBY INSTALLATION



CITY WATER HEAT EXCHANGER COOLING



CITY WATER STANDPIPE WITH POWERS REGULATOR



'DAY' TANK INSTALLATION

Two types of "city water" cooling modifications are optional. The conventional radiator is not used, and a constantly changing water flow cools the engine.

1. Heat Exchanger. - The heat exchanger cooling system provides a "closed" engine water system. The engine coolant circulates through a tubed chamber. A constant flow of fresh cool water surrounds the cooling tubes and is piped out to a convenient drain. An electrically operated valve (solenoid type) opens the water flow when the plant starts, and shuts off the water flow as the plant stops. The solenoid valve is connected as shown on the engine control wiring diagram. Rate of water flow is controlled by either a hand valve or an optional automatic regulator. If rate of flow is hand adjusted, refer to the water flow table, showing the approximate minimum water required at the loads listed. Use pipe size, for connections, as indicated on the installation outline drawing supplied. Do not use pipe smaller than indicated.

MINIMUM WATER FLOW, HEAT EXCHANGER COOLING

ELECTRICAL LOAD	WATER TEMP.	MIN. FLOW-GAL./MIN.
100 KW	40°F.	25
	60°F.	40
	80°F.	50
125 KW	40°F.	31
	60°F.	50
	80°F.	62
140 KW	40°F.	33
	60°F.	54
	80°F.	66

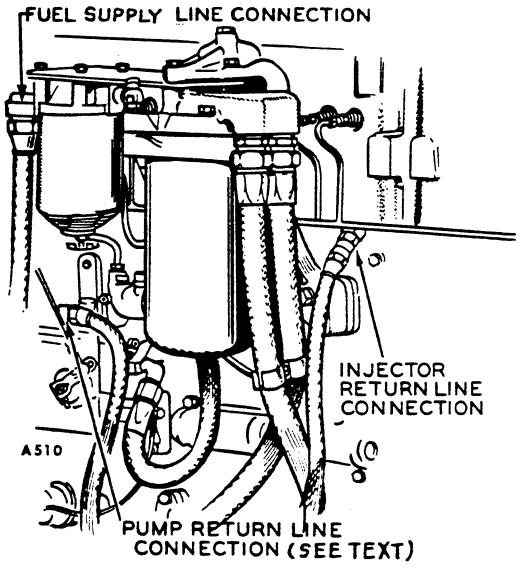
2. Tempering Tank. - The tempering tank (standpipe) system uses a mixing tank - the engine cooling water mixes with the incoming fresh water, and is then piped to a convenient drain. An electrically operated valve (solenoid type) opens the water flow when the plant starts, and shuts off the flow as the plant stops. The solenoid valve is connected as shown on the engine control wiring diagram. Rate of water flow is controlled by either a hand valve or an optional automatic regulator. If the hand valve is used, refer to the water flow table, showing the approximate minimum water required at the loads listed.

MINIMUM WATER FLOW, TEMPERING TANK COOLING

ELECTRICAL LOAD	WATER TEMP.	MIN. FLOW-GAL./MIN.
100 KW	40°F.	8.
	60°F.	11.5
	80°F.	14.5
125 KW	40°F.	10.
	60°F.	15.
	80°F.	19.
140 KW	40°F.	11.
	60°F.	17.
	80°F.	21.5

INSTALLATION

FUEL CONNECTIONS. - Use 5/8" tubing for the fuel supply line; the inlet fitting on the fuel filter is threaded for a 5/8" SAE flared fitting. Use 1/2" tubing for the fuel return line from the injector manifold; the fitting in the injector manifold is threaded for a 1/2" SAE flared fitting. A third line is required as a pump drain for units with a pressure-regulator controlled injection pump, which is identified by letters PR on the serial plate and a fitting on top of the pump. Use 3/8" tubing and connect to the 3/8" SAE flared fitting on the injection pump. The governor controlled type of pump, which has GR on its serial plate and a pipe plug on top, does not require a drain line.



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 8 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 4 inches space between the pipe and nearest point of the opening. Install a suitable muffler to the exhaust line.

BATTERY CONNECTION. - 24-volt battery current is required for starting purposes. Use two 12-volt, type 8D batteries for a normal installation. Connect the batteries in series (negative post of first battery to positive post of second). Connect to the magnetic (solenoid) switch located on the opposite side of the engine from the starter. Some models have the solenoid mounted near the

starter. Note a small wire connected to one of the two large terminals of the magnetic switch. Connect the battery positive cable to this switch terminal. Connect the battery negative cable to a good (paint free) ground on the engine. Service the batteries as required.

Infrequent use of the plant (as in standby service) may allow the battery to self discharge to the point where the battery may not be able to start the plant in an emergency. If the load transfer switch does not provide a trickle charging circuit, a separate charger should be used.

CONTROL CONNECTIONS. - Automatic Load Transfer Controls operate through the plant control to start, control, and stop the plant as demanded by the application. Wiring instructions are in the manuals supplied with these automatic controls. Connections at the remote control terminal block are shown on the plant control siring diagram. The GND terminal is for a customer-supplied alarm at a remote location to warn of high water temperature, low oil pressure, and overspeed. For plants prior to Spec. D, connections are to a 5 place terminal block designated CL1, CL2, B+, GND, and START; CL1 and CL2 are for alarm circuit, B+ is for voltage to the control, GND is for Alarm Grounding, START is for starting and stopping.

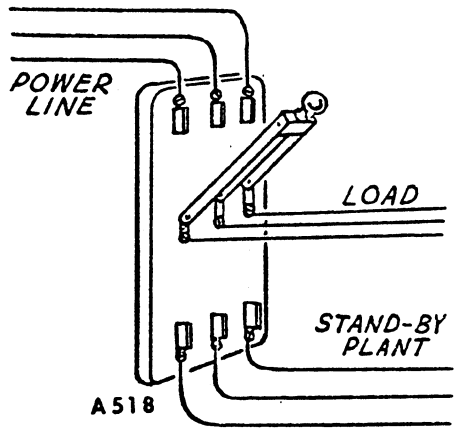
OPTIONAL SIGNALS. - Refer to the engine control wiring diagram furnished. Terminals are provided for connection of a signal light or audible alarm to indicate an emergency stop, or for failure to start automatically. Any such signals, etc. must be rated for 24-volt dc service.

AUXILIARY HEATER. - If the plant is equipped with an optional auxiliary water or oil heater, connect the device to a normally energized power source. Be sure the voltage is correct for the heater rated voltage.

LOAD CONNECTIONS. - Be sure wiring meets requirements of electrical codes in effect at the installation site. Many local regulations require that the installation be inspected and approved before operation.

If the plant is installed for standby service, a double throw load switch of the proper capacity rating 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 power source lines, nor for the normal source and generator current to be connected to the load at the same time.

Instructions for connecting an automatic switch (load transfer control) are supplied with such equipment. It is assumed that personnel connecting the generator, and any auxiliary equipment, are fully qualified.



BASIC LINE CONNECTIONS

Knock out sections are provided for entrance of load wires to the connection box at the side of the generator. Make connections according to the type of facilities provided. If large terminal posts are provided, make load wire connections directly to the posts. Some plants are "reconnectible" for different voltage (see CAUTION) and have extra leads that are pre-connected for the nameplate rated voltage.

CAUTION

Reconnection, for different output voltage than shown on the plant nameplate, will involve very extensive changes including a complete new control panel. For specific information, contact the factory. Give the COMPLETE information shown on the ONAN nameplate, and indicate the NEW voltage desired.

1. Preliminary Connections. - Each individual lead is labeled, T1 through T12. Leads are combined into groups of 2 or more as indicated on the output control wiring diagram provided. Some lead groups are further identified for load wire connections. Thus on a 4-wire, 3-phase plant, there may be a group of 12 leads identified as T0 for the load neutral wire connection. Other groups will be identified in a similar manner.

a. Use commercially available cable connectors to connect the leads of each group.

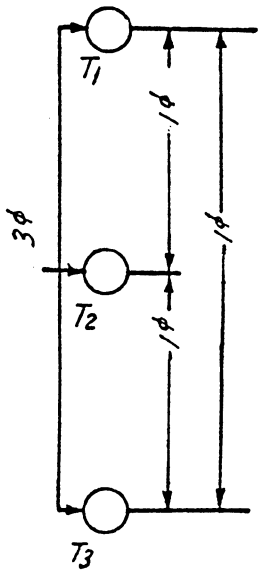
b. See that the small leads (transformer, etc.) are connected to the ground post inside the connection box.

c. Select each generator lead group that is to be connected to a load wire. Connect the load wires to the proper generator wire group, as shown on the output wiring diagram. Typical connection diagrams are shown below.

d. If a "T0" (neutral) wire group is used, note that one wire of the group connects to the ground post in the connection box.

e. Tape or otherwise insulate each connection. Such insulation must be at least equal to the original wire insulation.

3-PHASE, 3-WIRE PLANT

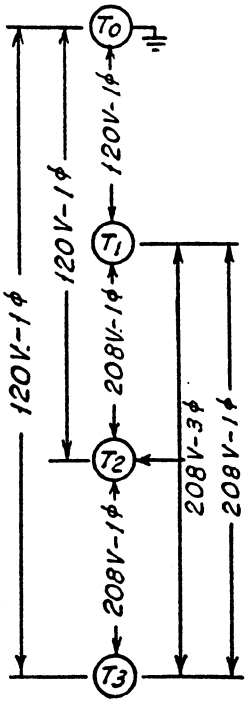


No terminal is grounded. For three phase current, connect separate load wires to each plant terminal "T1", "T2" and "T3", one wire to each terminal. Reversing the connections between any two terminals will reverse the direction of rotation of 3-phase motors. If phase sequence is important, be sure to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

3-PHASE, 4-WIRE WYE-CONNECTED PLANT
(120/208-volt example shown)

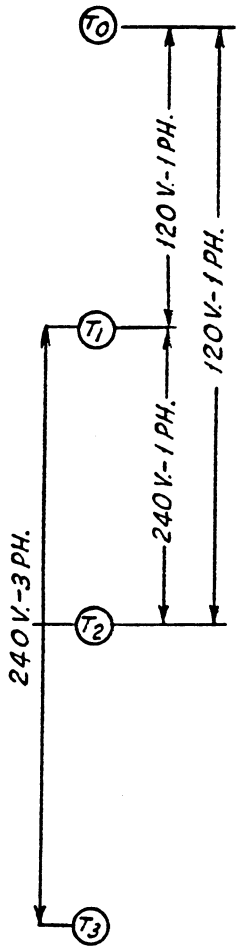


The terminal marked "T0" is grounded. For single phase current, connect the "neutral" (white) load wire to the "T0" terminal. Connect the "hot" (black) load wire to any one of the other three terminals, "T1", "T2", "T3". Three separate single phase circuits are thus available. Do not attempt to take 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 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.

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.

3-PHASE, 4-WIRE, DELTA-CONNECTED PLANT
(120/240-volt example shown)



This type of generating plant is specially designed so that two types of loading can be applied to the generator: regular 3 phase, 3-wire operation; or combination 3-phase, 3-wire and 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.

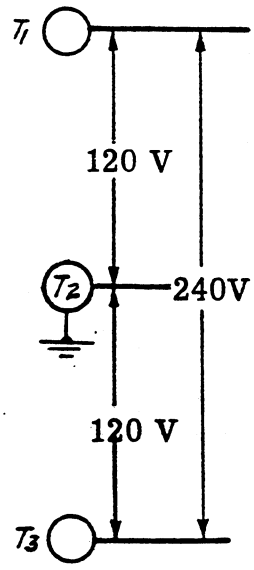
For 3-phase 3-wire operation connect the three load wires to the three terminals T1, T2, T3, one wire to each terminal. For 3-phase 3-wire operation the T0 terminal is not used.

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

For 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).

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.

120/240-VOLT, SINGLE PHASE PLANT



The T2 output terminal is the neutral (grounded) connection point. Connect the neutral (white) load wire to the T2 terminal. Connect the "hot" (black) load wires to terminals T1 and T3. Two 120-volt circuits are thus available T2-T1, and T2-T3. One half the plant rated capacity is available on each 120-volt circuit. For 240-volt current, use terminals T1 and T3.

CRANKCASE OIL. - Refer to section 3 of the Cummins manual. Note that for average operating conditions, MIL-L-2104A military specification oil is recommended. Many oils designated for MS or DG service meets these requirements. Check with the oil supplier.

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. - During the initial run have the field circuit breaker OFF so the unit can run at no load. To start the unit, move the run-stop switch to the RUN position and leave it there. The unit will run as long as the switch is at that position. The cranking motor will be disconnected by the start disconnect relay when the engine comes up to speed. If the unit fails to start within 45-seconds the cranking limiter disconnects the cranking circuit. Reset after 1-minute.

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. - As soon as the engine starts, check the oil pressure gauge and the battery charge ammeter. As the engine warms up, check the water temperature gauge. When the engine reaches operating temperature, as indicated by the oil pressure and water temperature gauges, energize the generator by moving the field circuit breaker to ON. Then check the voltmeter for the correct output voltage. A voltage adjustment of 5% can be made with the rheostat on the control panel. If a voltage adjustment is necessary, wait until the voltage remains at a stable level. Should the voltage tend to wander from the stable point, a governor sensitivity adjustment may be required. Operating instructions for an Automatic Load Transfer Control are in separate manuals.

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 operating conditions permit, disconnect the electrical load and allow the plant to run at no load to prevent an excessive temperature rise. To stop the plant, move the run-stop switch to the STOP position.

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 Latch Relay PUSH TO RESET button must be reset before the plant can be restarted.

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.

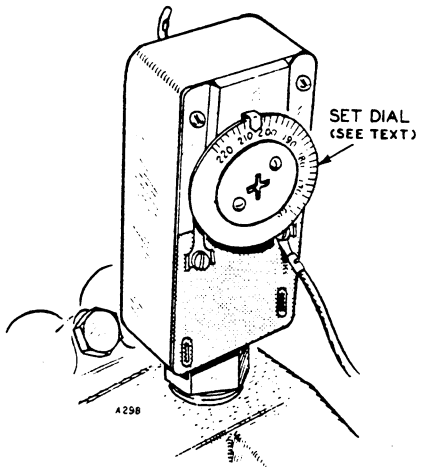
2. -Over Speed Cut-Off. - A centrifugal weight type switch is attached to the outer end of the generator shaft and is not adjustable. The switch operates to stop the plant if the engine speed should accidentally rise to a dangerous point. Under no circumstances should the plant be operated if the switch is disconnected or otherwise made inoperative. Excessive speed could cause extensive generator damage.

If the switch stops the plant, check the governor system to make sure it is adjusted correctly and operating freely. If the governor is correctly adjusted and engine is otherwise functioning properly, the plant still shuts down, the switch may not be operating properly. Do not attempt to adjust the switch, replace with a new one.

3. High Water Temperature Cut-Off. - Early models have an adjustable thermostatic cut-off switch. Late models have a non-adjustable thermostatic cut-off switch. Both types of switches cause the engine to stop in a high water temperature condition. Water temperature must drop $10^{o}F.$ before the engine can be restarted.

Set the dial so the cut-off switch operates several degrees below the boiling point of the coolant, taking into account the altitude. Lower the setting $3^{o}F.$ for each 1000-feet above sea level. Later models have a non-adjustable switch fixed to close at about 202 plus or minus $2^{o}F.$

Do not set the switch to operate before the engine reaches operating temperature.



HIGH WATER TEMPERATURE
CUT-OFF SWITCH
(EARLY MODELS ONLY)

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 $165^{o}F.$ to $185^{o}F.$

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 LATCH RELAY. - The emergency latch relay is energized by battery voltage when a ground is provided by one of the engine safety devices. A red light comes on and a button protrudes from the control panel to indicate a latched relay.

RUN-STOP SWITCH. - A SPDT, center off switch functions as a manual control for starting and stopping and as a selector when a switch is installed for remote control.

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.

VOLTAGE ADJUSTMENT RHEOSTAT. - The voltage adjustment rheostat provides for adjusting the ac output voltage under normal operation conditions. Turn clockwise to increase the voltage - counterclockwise to decrease the voltage. The rheostat provides for approximately plus or minus 5% adjustment.

CIRCUIT BREAKER. - The circuit breaker protects the generator from damage from an extreme overload. If the breaker trips automatically from an overload condition, it must be reset manually after correcting the overload 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 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.

PERIODIC SERVICE

GENERAL. - Follow a definite schedule of inspection and servicing. Use the running time meter to keep a record of service operation. 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.

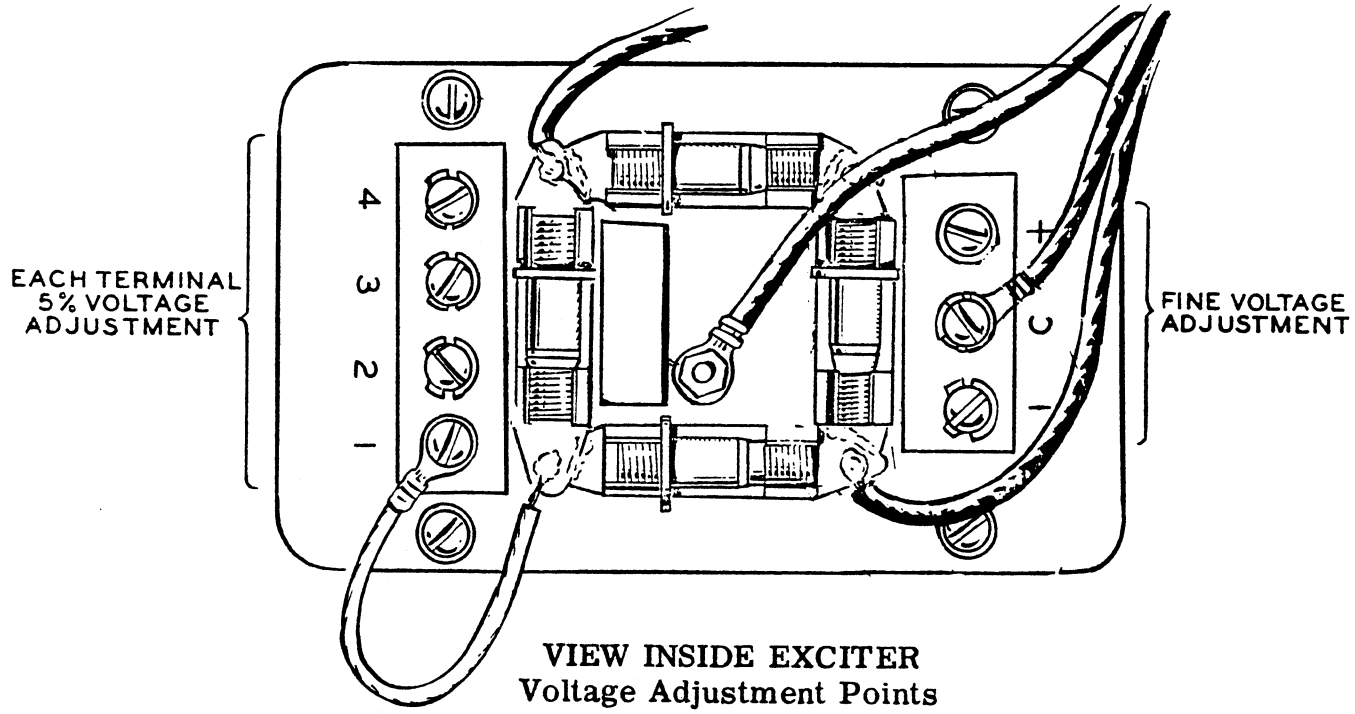
It is normal for the slip rings to acquire a dark brown glossy surface. Do not attempt to keep a bright metallic appearance. Clean with a dry, lint free cloth. Slight roughness can be remedied by light sanding with #00 sandpaper.

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

GOVERNOR. - Basic principles of governor adjustment are given in the engine manual. The purpose of the governor is to control the engine speed, under various load conditions, to keep the generator output current stable.

The governor should control the engine speed so that the frequency at full load is within 2 to 3 cycles of the no load frequency. A momentary surge beyond the 3 cycle limit is normal when the load is changed, but the frequency should stabilize within a few seconds. Normal frequency at no load is approximately 61 cycles for a 60 cycle plant, but may be as high as 63 cycles if necessary to obtain the correct voltage. The frequency at full load should not drop below 59 cycles.

OUTPUT VOLTAGE, PLANTS PRIOR TO SPEC. LETTER C. - Ordinarily, if the governor is properly adjusted, the output voltage will be correct. The exciter was connected for rated output during the factory test run. However, minor voltage adjustments are possible by changing exciter connections. Refer to the illustration.



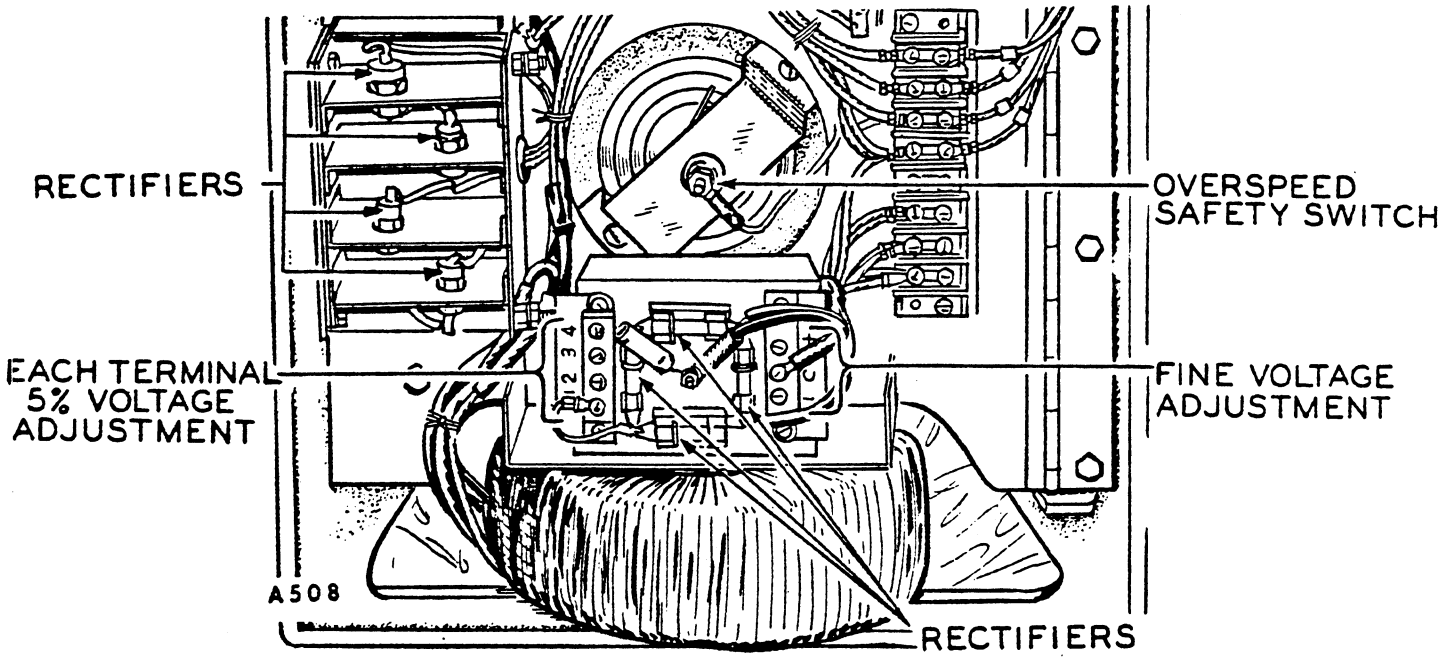
VIEW INSIDE EXCITER
Voltage Adjustment Points

1. Be sure the governor is properly adjusted for correct current frequency, 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 a like amount.

4. If a greater 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, etc.) 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.



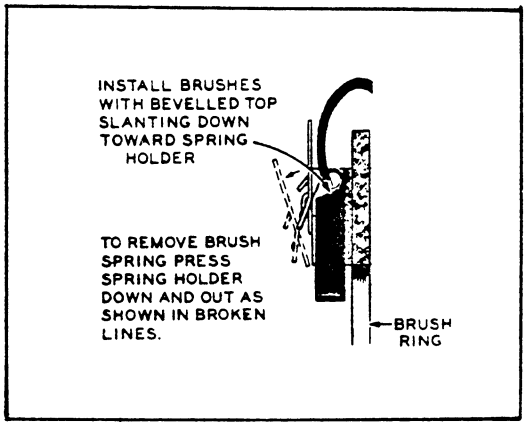
Exciter-prior to plant models ending with Spec. Letter C.

GENERATOR

The ac generator normally requires very little servicing. Periodic inspection, to coincide with engine oil changes, will assure continued good performance.

BRUSHES. - To examine the brushes, brush springs, and slip rings, remove the inspection and ventilating covers from the end bell openings. Keep the end bell, brush rig, etc. free of dust and dirt.

Brushes should be replaced when worn to approximately 1/2-inch long, or so that the lead end of the brush is below a point midway between the outer and inner end of its guide. 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 its replacement. 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.

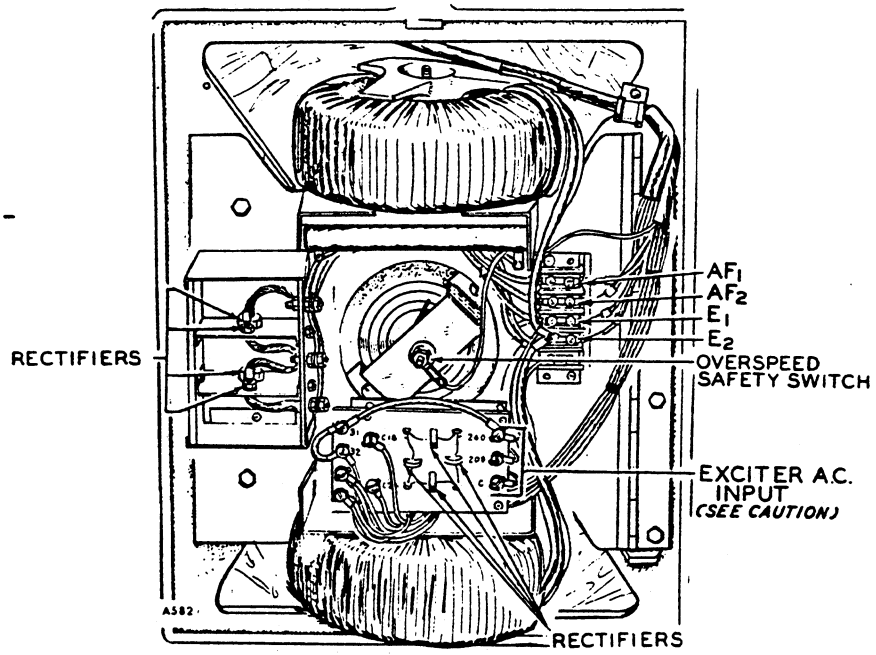


GENERATOR BEARING. - The generator bearing is prelubricated for its life and sealed. It requires no servicing.

EXCITER. - 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.

CAUTION

On some models, the exciter is operable on either 208 or 240-volt ac input, and is factory connected for the correct voltage. This exciter input voltage has no direct relationship to the generator ac OUTPUT voltage. DO NOT change the original factory exciter jumper connection unless the special instructions for reconnecting for different ac output are being followed. These special instructions are supplied on request.



Exciter-plant models begin Spec. Letter C.

1. CHECKING STATIC EXCITER. - Troubles are listed in advancing order, from no output voltage to a rated but fluctuating output voltage. The relationship between trouble and cause is not always consistent from model to model, so the following information must be used as a guide, not an absolute rule. The column entitled "step" indicates the step for testing a standard component. When the word "None" appears in that column, all the information needed to complete the check is given in the column headed "Corrective Action". Use a multimeter to check continuity, voltage, and resistance as indicated in the tests.

Note: It is imperative that the testing procedures are completely understood by the serviceman before attempting to perform corrective maintenance. Use caution when working on an operating plant.

NATURE OF TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION	STEP
Generator will not build up voltage.	Circuit breaker in "off" or "tripped" position	Reset and close breaker	None
	Open in circuit breaker	Stop plant and check breaker continuity	None
	No AC power to Magneciter	Check AC voltage at E1-E2 with the plant operating. Voltage should be five per cent of the rated voltage. If not, check continuity from E1-E2 back to the generator	None
	Partial loss of residual in Rotor	With plant operating jumper from E2 to heat sink of field rectifier Z until voltage begins to build-up. Then remove.	None
	Pair of Field Rectifiers (either W& Z or X& Y) open	Test rectifiers and replace if defective	
	Both Field Rectifiers X and Y shorted	Test rectifiers and replace if defective	

NATURE OF TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION	STEP
Output voltage slow to build up. Circuit breaker opens in about five seconds	Either Field Rectifier X or Y shorted	Test rectifiers and replace if defective	2
Output voltage slow to build up and five percent below rated voltage after build up. Voltage regulation poor.	Either Field Rectifier W or Z shorted	Test Rectifier and replace if defective	2
Output voltage slow to build up and higher than rated voltage after build up	Open circuit in one or more Control Rectifier	Test rectifier and replace if defective. Check soldered connections to rectifiers	2
Output voltage slow to build up and ten to twenty percent above rated voltage after build up	Open in one Field Rectifier	Test rectifiers and replace if defective	2
	Open circuit in Gate winding G1-G2 of Reactor A or B	If Field Rectifiers Y and Z check okay, check continuities of Gate windings G1-G2	3
Output voltage builds up normally but less than rated voltage after build up	Shorted winding in Control Reactor	Test Control Reactor and replace if defective	4
Output voltage builds up normally with slightly less than rated voltage at no load and low voltage at full load	Compound winding S1-S2 installed backward or has open circuit.	Check wiring diagram for polarity of Compound windings through Reactors A and B and test for continuity	None
Output voltage builds up normally but 20-percent above rated voltage after build up. Voltage regulation poor.	Compound winding S1-S2 installed backward through one Reactor (A or B)	Check wiring diagram for polarity of Compound winding through Reactor A or B	None
Output voltage builds up normally but is twenty five percent above rated voltage after build up	Open circuit in Control Rectifier bridge	Check continuity from the junction of Control Rectifiers W and X to the junction of Control Rectifiers Y and Z	None

NATURE OF TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION	STEP
Output voltage builds up normally but 125 to 150-percent above rated voltage after build up	Shorted turn in gate winding G1-G2 of Reactor A or B	Test Reactors A and B for shorted turns and replace if defective	3
Output voltage builds up normally but 150 to 200-percent above rated voltage after build up. No regulation possible	Control winding C1-C2 of Reactor A or B polarized incorrectly	Check circuit connections of both Reactors A and B	None
	Shorted turn in Control winding C1-C2 of Reactor A or B	Test Reactors A and B for shorted turn and replace if defective	3
	Open in Control Circuit	Check continuity from E1 to E2 through Control Circuit	None

2. Checking Rectifiers. Disconnect one lead from, or remove, each rectifier for its individual 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 observe 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. However, if both readings are low, or if both indicate an "open" circuit, replace the rectifier with a new identical part.

3. Checking Reactors "A" and "B". CAUTION: The extent to which the resistance values obtained when trouble shooting with an ohmmeter are reliable and useful is governed by the accuracy of that ohmmeter. Resistance readings of the range of values found between G_1 and G_2 cannot be read with accuracy on the multimeter.
   a. Turn the resistance range selector on the meter to the desired resistance range as given in steps b and c below.
   b. Isolate one Gate winding by disconnecting either end of Gate winding G1-G2 from its point of connection; for example, disconnect G1 at E2. Measure the resistance in the Gate winding across G1-G2. Should be 0.37.
   c. Isolate one Control winding by disconnecting either lead C1 or C2 from the terminal block. Measure the resistance in the Control winding across C1-C2. Should be 17.5.
   d. Connect one meter lead to the disconnected Gate winding lead and the other meter lead to the disconnected Control winding lead and check for continuity.

   Results:

   1. REACTOR IS SERVICEABLE if resistance is within 20-percent either way of the value listed and there is no continuity between the Control and Gate windings.

   2. REACTOR IS DEFECTIVE if there is an open circuit in either the Gate or the Control windings. Continuity between the Gate and the Control windings is also an indication of a defective Reactor. In either case, the Reactor should be replaced.

4. Checking Control Reactor.

   a. Isolate the Control Reactor by disconnecting common lead "C" from its point of connection and carefully measure the resistance from this lead to the numbered lead on the Control Reactor. Should be 150.0

   Results:

   1. CONTROL REACTOR IS SERVICEABLE if resistance is within 10 percent of the value specified.

   2. CONTROL REACTOR IS DEFECTIVE if no continuity is indicated between the common lead "C" and the numbered lead, indicating the presence of an open circuit.

5. Checking Resistors:

   The resistors must be checked with a multimeter adjusted to the appropriate range of resistances. See wiring diagram for correct values.

   a. Isolate the Resistor by disconnecting one end from its point of connection and carefully measure the resistance.

Results:

1. RESISTOR IS SERVICEABLE if the measured resistance falls within 20 percent of the value specified in the wiring diagram.

2. RESISTOR IS DEFECTIVE if there is no indication of continuity through the resistor or if the measured resistance exceeds the percent limits either way.

GENERATOR RECONNECTION. - The "reconnectible generator" is designed to provide for conversion to a different type of output than the original nameplate rated output voltage.

IMPORTANT

BEFORE ATTEMPTING TO RE-CONNECT A GENERATOR-CONTACT THE ONAN FACTORY FOR REQUIRED INSTRUMENT CHANGES, NEW WIRING DIAGRAMS, NEW PLANT NAMEPLATE WITH PROPER SPECIFICATION NUMBER AND VOLTAGE.

When shipped - the generators are connected to deliver the voltage specified on the order. The plant nameplate will show *only* the single specified voltage for which the generator is connected. The output instruments on the plant (such as voltmeters, ammeters, transformers, frequency meters, and running time meters) are intended for use with the specific nameplate voltage.

Some plants may include an optional re-connection terminal block which allows safe and simple voltage changes. The generator leadwires terminate at the optional re-connection block or in the junction box on the generator side. The junction box also contains the ammeter current transformers (some plants have the current transformers in the control box) which may require replacement when changing to different output voltages. Instruments, which may require changes per new output voltages, are accessible by tipping out the control box front panel.

The generator is a basic coded type (either 2X, 5X, 6X) as identified by the generator data number on the plant nameplate. Example - 150UK2XN1A, 150UK5XN1A, 150UK6XN1A. Each type can be connected for output voltages shown in **Table 1.**

All generator wires have wire tags for identification. The output leads to load are T0, T1, T2, T3. The generator winding leads, which are joined to form the output leads, are marked 1 through 12. See **Figure 1.** for 100 to 230 KW generators. All numbered leads are joined in various combinations to the output leads for the different voltages.

Instruments and their related parts may require changes because of different voltages and current. New instruments are selected by the new voltage and current ratings of the plant. Refer to Table 2 for voltage rated instruments and select according to the new voltage output. Always size the instrument so the plant output will not exceed instrument rating.

To determine if current rated instruments (ammeters and current transformers) must be changed, refer to Table 4 and find the correct ampere rating of the plant after re-connection. After determining current rating, refer to Table 3 for the proper size ammeter and current transformers.

Instrument wiring is essentially the same for all plants. Connect new instruments in the same manner as the old ones were connected. Wiring diagrams, supplied by ONAN after the re-connection registration, provide additional instructions and part numbers required to complete the plant wiring.

WARNING

SEVERE DAMAGE WILL RESULT IF LEADS ARE INCORRECTLY CONNECTED OR IMPROPERLY INSULATED. USE EXTREME CARE IN CHECKING LEADS TO ASSURE PROPER CONNECTIONS.

TABLE 1. (100-250 KW ONLY)

CODE	VOLTAGE	OUTPUT
	"2X" GENERATOR	
4R	120/208	3ph Wye
7XR	240/416	3ph Wye
5DR	120/240	3ph Delta (Note 2)
	240/480	1ph "Zig-Zag" (Note 1)
7R	220/380	3ph Wye "Dog-Leg"
	"5X" GENERATOR	
7XR	240/416	3ph Wye
5R	240	3ph Delta
6DR	240/480	3ph Delta (Note 2)
	240	1ph Delta (Note 1)
	"6X" GENERATOR	
4XR	277/480	3ph Wye
	138/240	3ph Wye
7XR	240/416	3ph Wye "Dog-Leg"

NOTE 1: Usable output is 2/3 of normal 3ph. rating.

NOTE 2: Delta-one phase center tapped. If no 3ph output is being used, usable 1ph output is up to 2/3 of normal 3ph rating but, 1ph output must be balanced between the two output legs.

TABLE 2. VOLTAGE RATED INSTRUMENTS

AC VOLTMETER VOLTAGE	RESISTOR	METER PART NO.
150	None	302P420
300	None	302P421
600	None	302P422
750	None	302P423
RUNNING-TIME METER		
120-240 (1ph)	None	302P465
120-208 (3ph)	None	302P465
220-380 (3ph)	None	302P466
277-480 (3ph)	None	302P467
FREQUENCY METER		
120	None	302P213
208	None	302P221
240	None	302P221
240 (5R connection	304A125	302P213
220-380 (3ph)	304A125	302P213
277-480 (3ph)	304A305	302P213
480	304A305	302P213

TABLE 3. CURRENT RATED INSTRUMENTS

AC AMMETER CURRENT (AMPS)	CURRENT TRANS.	METER PART NO.
30	None	302P418
50	None	302P419
80	None	302P458
100	302P78	302P408
150	302B79	302P410
200	302B106	302P411
300	302B107	302P413
500	302B372	302P414
750	302B385	302P415

TABLE 4. NOMINAL AMPERE RATINGS

ALWAYS USE KVA RATINGS WHEN SHOWN OR KNOWN		ONAN CODE	SINGLE PHASE		THREE PHASE				
			-1	-3	-4	-5 -5D	-7	-4X -6	-9
POWER FACTOR									
80%		UNITY	120-V	120/240-V	120/208-V	240-V 120/240-V	220/380-V	480-V 277/480-V	600-V
KW	KVA	KW/KVA	AMP	AMP	AMP	AMP	AMP	AMP	AMP
125.0	156.25	156.25	1302	651	435	376	238	188	150
140.0	175.0	175.0	1458	729	486	421	266	211	169
150.0	187.5	187.5			521	452	285	226	181
155.0	193.75	193.75			538	468	295	234	187
165.0	206.25	206.25			575	498	314	248	199
170.0	212.5	212.5			591	513	324	256	204
175.0	218.75	218.75			609	527	333	263	211

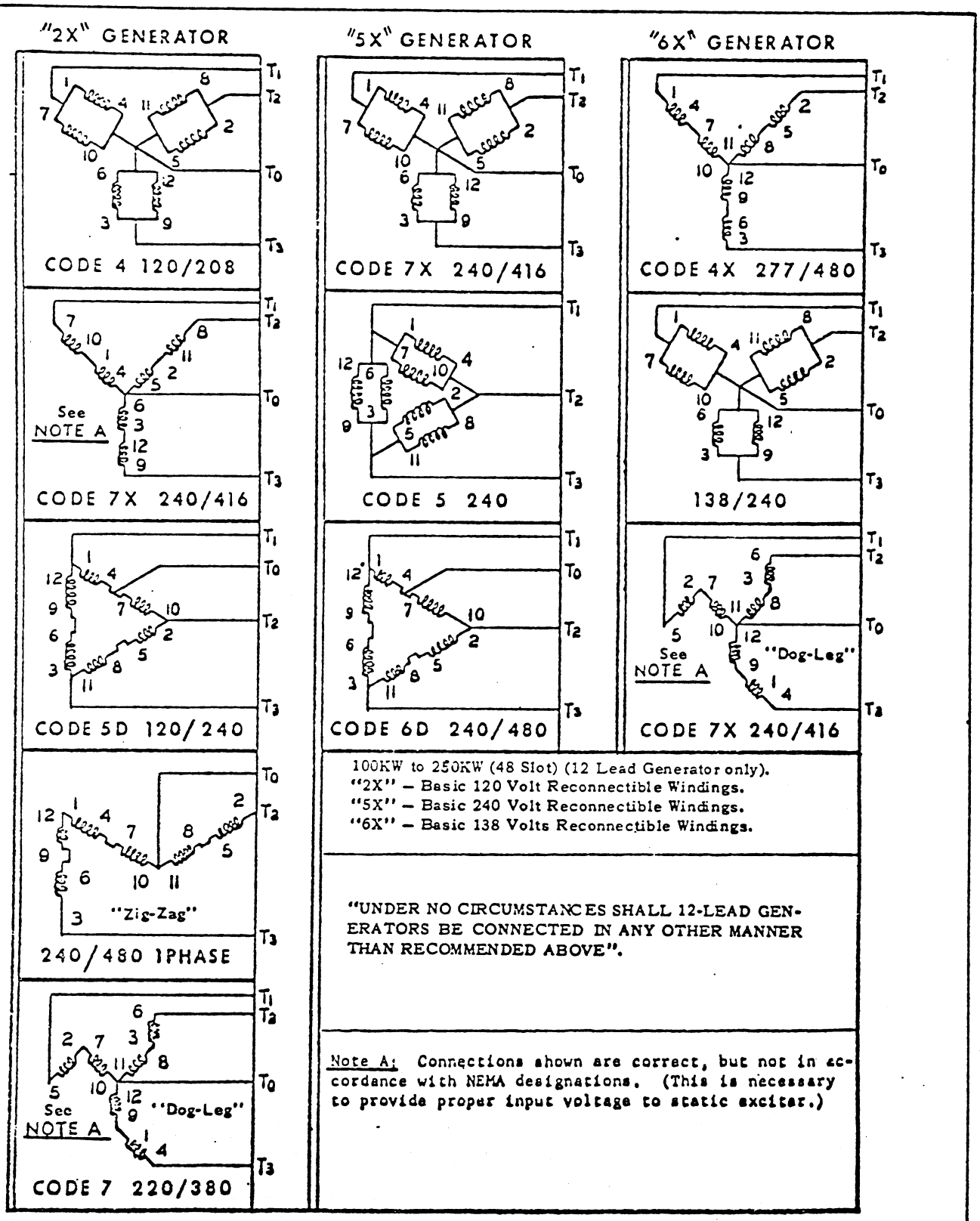
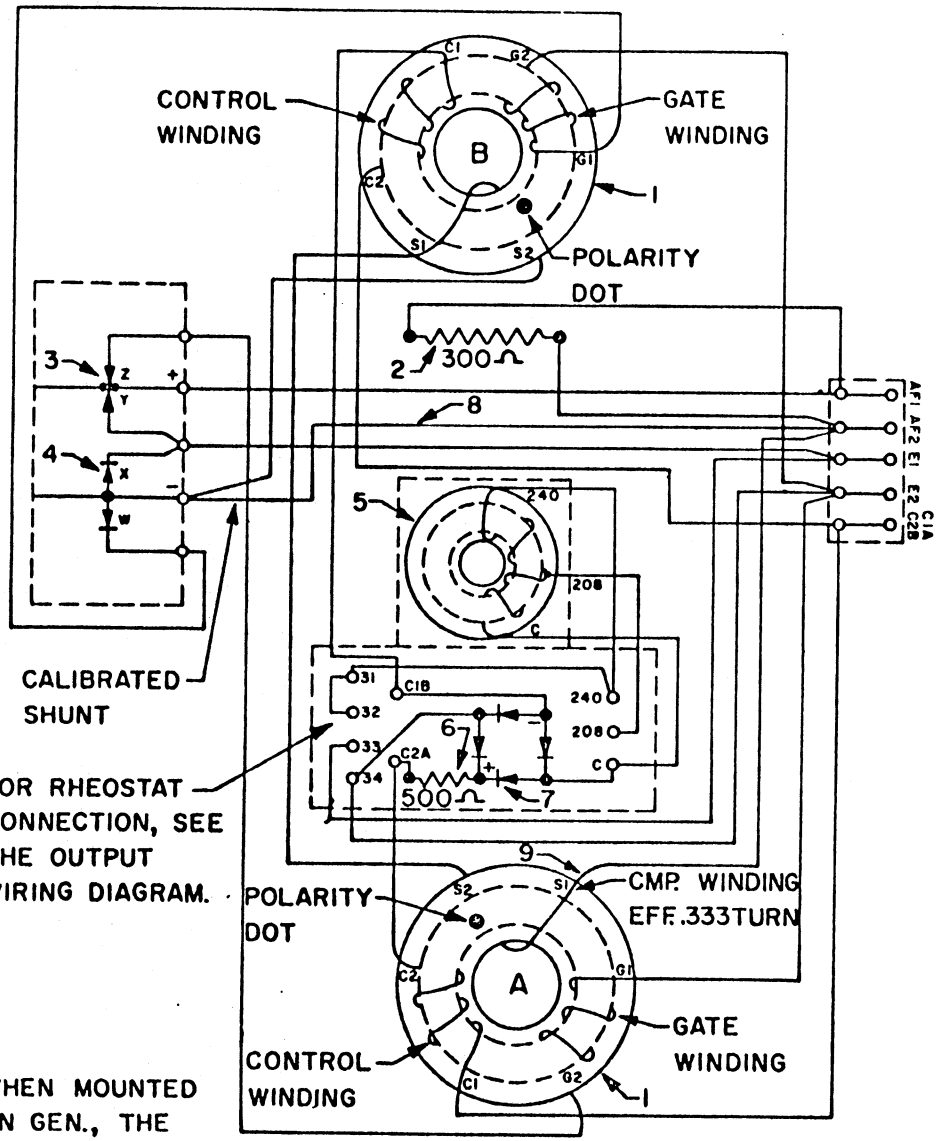


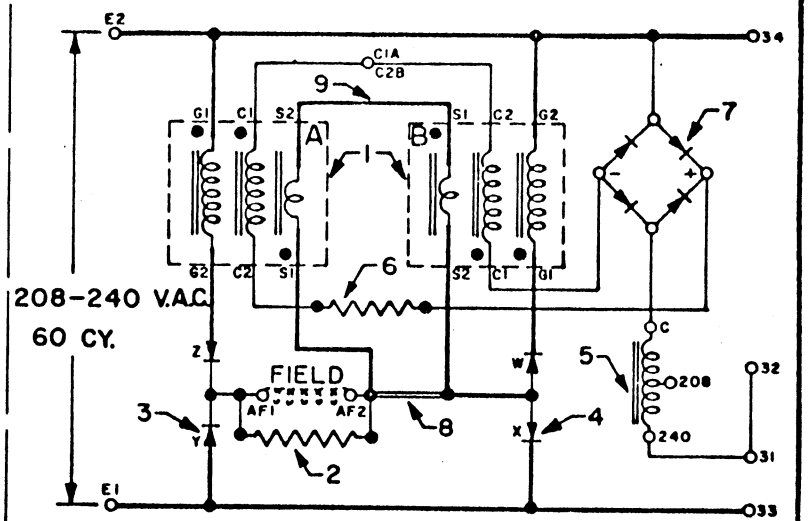
FIG. 1. 100 TO 250 KW RE-CONNECTION DIAGRAMS

625A279

PICTORIAL



SCHEMATIC



ITEM	QTY	DESCRIPTION
9	1	NO. 12 WIRE, 40" LG.
8	1	NO. 12 WIRE, 20" LG.
7	4	RECTIFIER–CONTROL
6	1	RESISTOR–STABILIZING
5	1	REACTOR–CONTROL
4	2	RECTIFIER–FIELD, NEG.
3	2	RECTIFIER–FIELD, POS.
2	1	RESISTOR–DAMPING
1	2	REACTOR–GATE

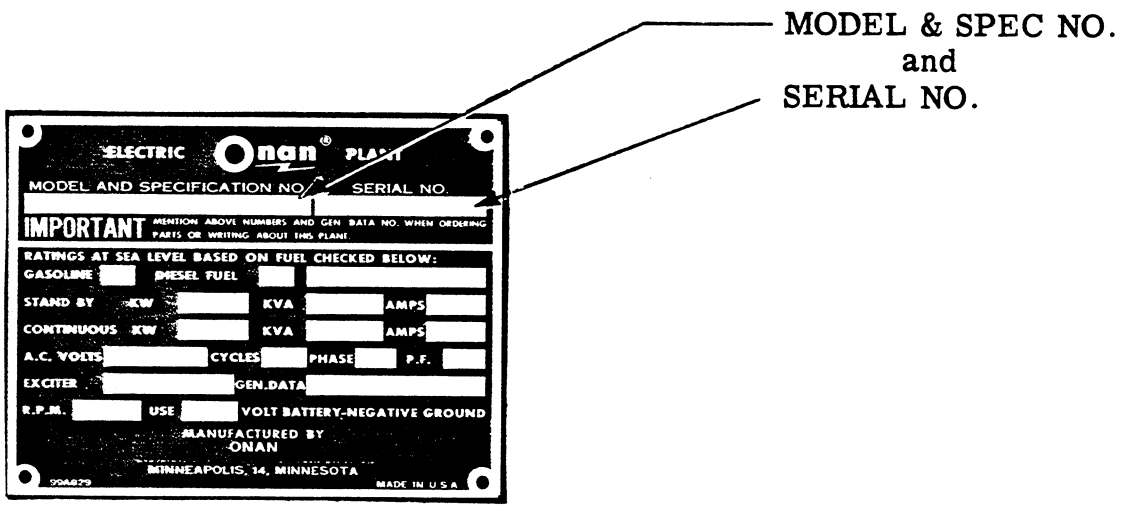
PARTS LIST

INSTRUCTIONS FOR ORDERING REPAIR PARTS

ONAN PARTS

ALL PARTS IN THIS LIST ARE ONAN PARTS. FOR ONAN PARTS OR SERVICE, CONTACT THE DEALER FROM WHOM YOU PURCHASED THIS EQUIPMENT OR REFER TO YOUR NEAREST AUTHORIZED SERVICE STATION.

TO AVOID ERRORS OR DELAY IN FILLING YOUR PARTS ORDER, PLEASE FURNISH ALL INFORMATION REQUESTED. REFER TO THE ONAN NAMEPLATE ON YOUR PLANT. ONAN NAMEPLATE IS LOCATED ON THE UPPER RIGHT SIDE OF THE FLYWHEEL HOUSING. ALWAYS GIVE THE COMPLETE:

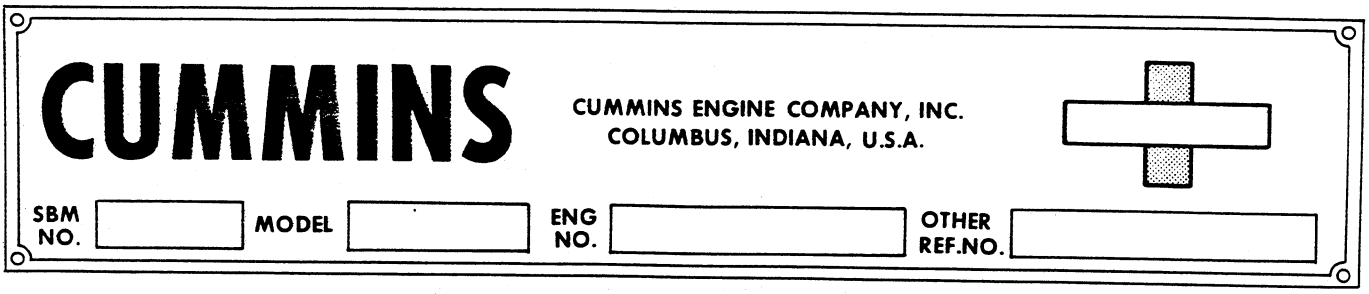


CUMMINS PARTS

ALL CUMMINS PARTS MUST BE ORDERED FROM THE CUMMINS ENGINE COMPANY, INC., COLUMBUS, INDIANA OR THEIR NEAREST AUTHORIZED CUMMINS DISTRIBUTOR OR DEALER.

REFER TO THE CUMMINS ENGINE NAMEPLATE LOCATED ON THE GEAR COVER ON THE RIGHT SIDE OF THF ENGINE AS VIEWED FACING THE RADIATOR END.

WHEN ORDERING PARTS OR REQUESTING SERVICE INFORMATION, SUPPLY CUMMINS WITH ALL INFORMATION STATED ON THE ENGINE NAMEPLATE.



PARTS CATALOG
DFD SERIES

This parts catalog applies to the standard ONAN DFD Series electric generating plants. They are powered by a Cummins Model HRS-6 engine which is more completely described in the Cummins manual. Basically, the engine is a 6 cylinder, water cooled, super charged diesel (compression ignition) type. The cylinder bore is 5-1/8 inches, piston stroke is 6 inches, and displacement is 743 cubic inches.

Cummins Engine parts must be selected from the appropriate Cummins parts list and parts must be secured from the Cummins Engine Company or their authorized distributor or dealer.

"Right" and "Left" sides of the Generator and Controls are determined by FACING the Radiator (Front) End.

Parts in this catalog are illustrated in groups and have reference numbers which correspond to the like number in the list for that group. Parts illustrations are typical and should not be construed to represent a particular part number.

Compare your ONAN plant nameplate MODEL and SPEC with the Plant Data Table. The Plant Data Table contains all descriptive information pertinent to this list, such as voltage, phase, etc. which appears in the description of some parts that differ between basic models.

UNLESS OTHERWISE MENTIONED IN THE PARTS DESCRIPTION, PARTS ARE INTERCHANGEABLE BETWEEN ALL MODELS LISTED IN THE **DATA TABLE.**

PLANT DATA TABLE

MODEL & SPEC NO.†	ELECTRICAL DATA				
	WATTS *	VOLTS	CYCLES	PHASE	WIRE
140DFD-3R8/	140, 000	120/240	60	1	3
140DFD-4R8/	140, 000	120/208	60	3	4
140DFD-4XR8/	140, 000	277/480	60	3	4
140DFD-5DR8/▲	140, 000	120/240	60	3	4
140DFD-6R8/	140, 000	480	60	3	3
140DFD-7R8/	140, 000	220/380	60	3	4
140DFD-9R8/	140, 000	600	60	3	3

† - The NUMBER after the diagonal line (/) signifies standard or optional features (1 is standard). The LETTER ending the Model and Spec No. is the Spec Letter and will advance with manufacturing changes (A to B, B to C, etc.).

▲ - This is a delta-wound 240 volt model with one phase center-tapped. A limited amount of 1 phase 120/240 volt power can be utilized together with 3 phase power as long as no terminal current exceeds the rated nameplate current.

* - Maximum rating is shown. Continuous rating also appears on the nameplate.

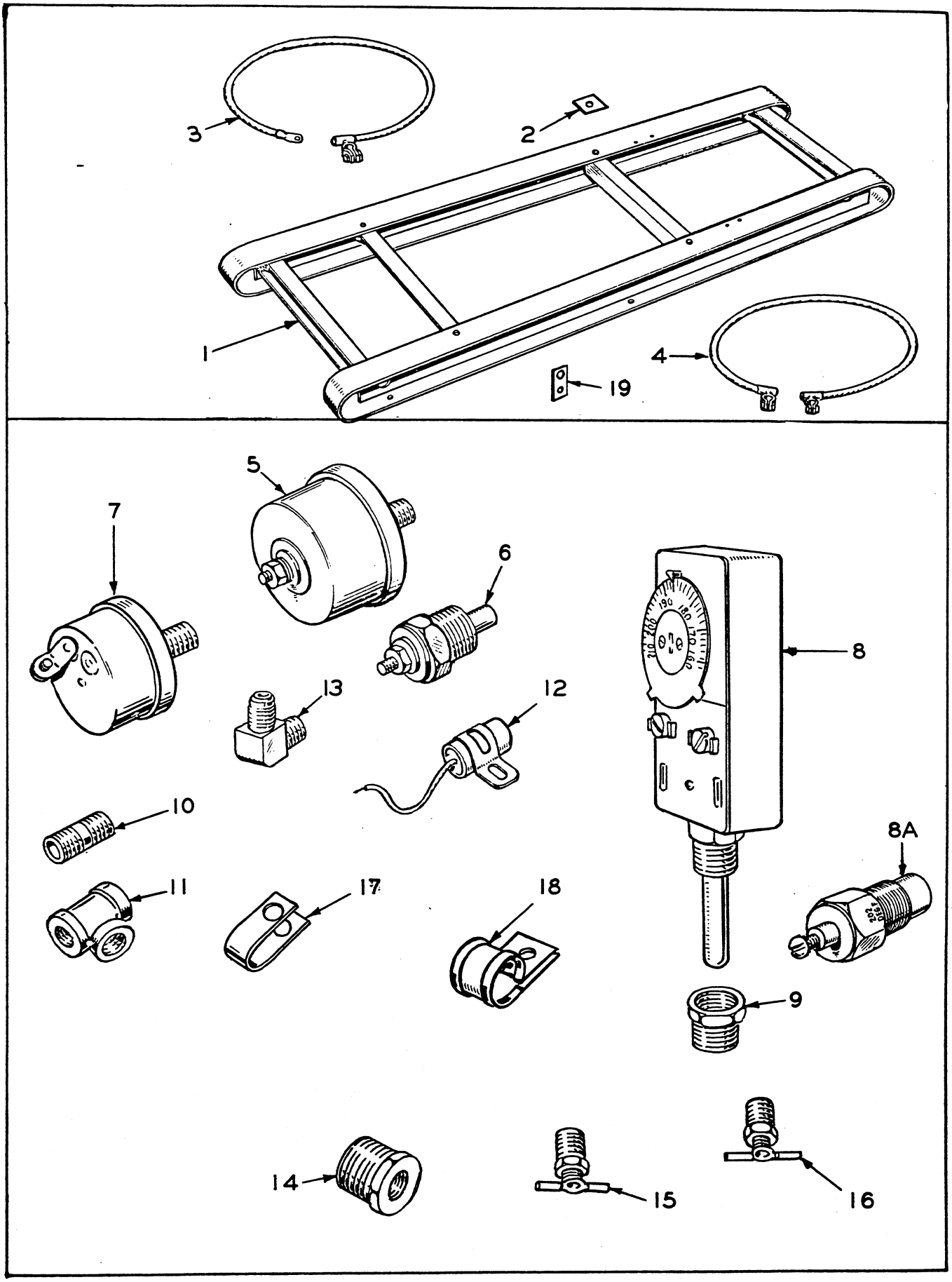


FIG. 1 - MOUNTING BASE, BATTERY CABLES & SENDER GROUP

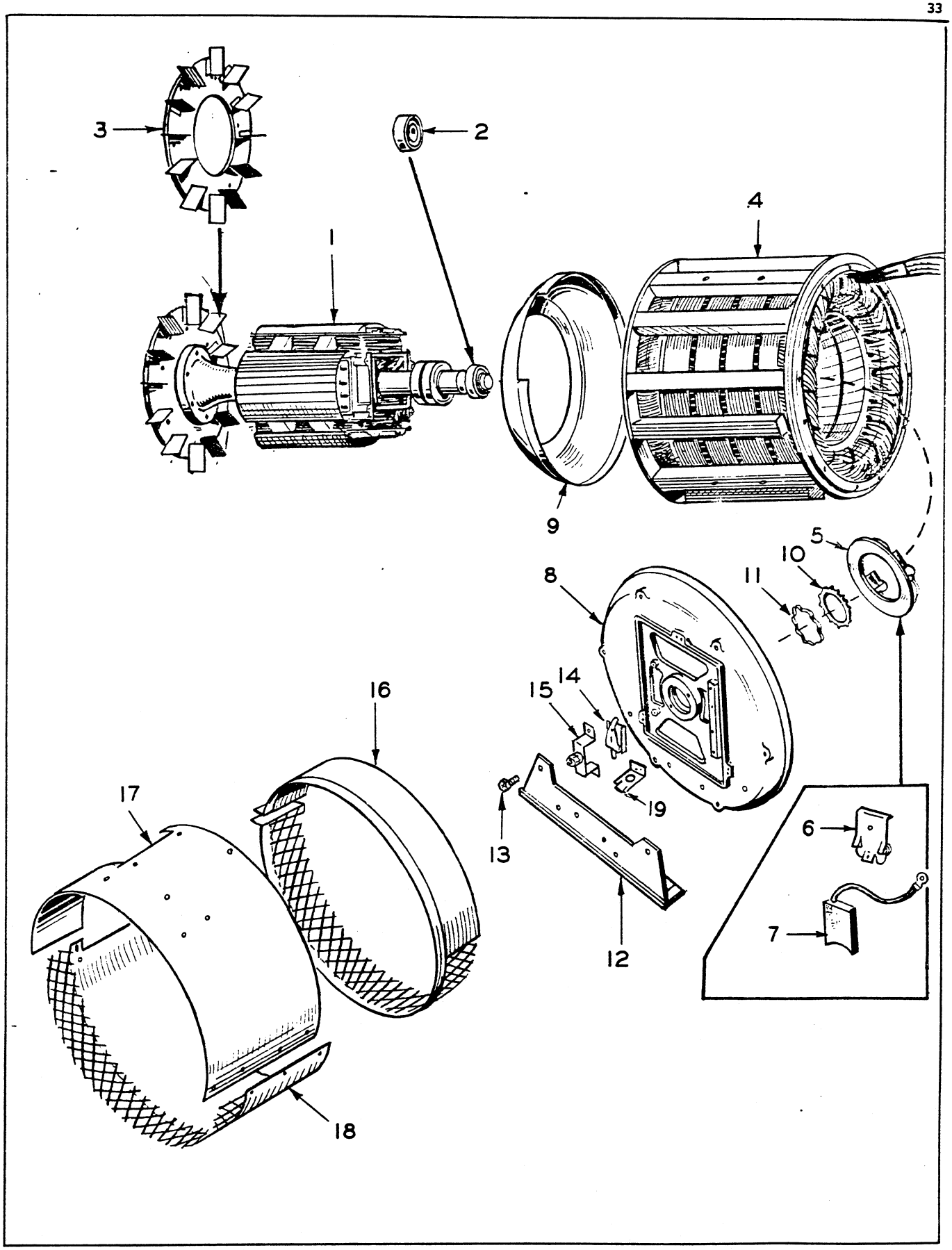


FIG. 2 - GENERATOR GROUP - Alternator Portion

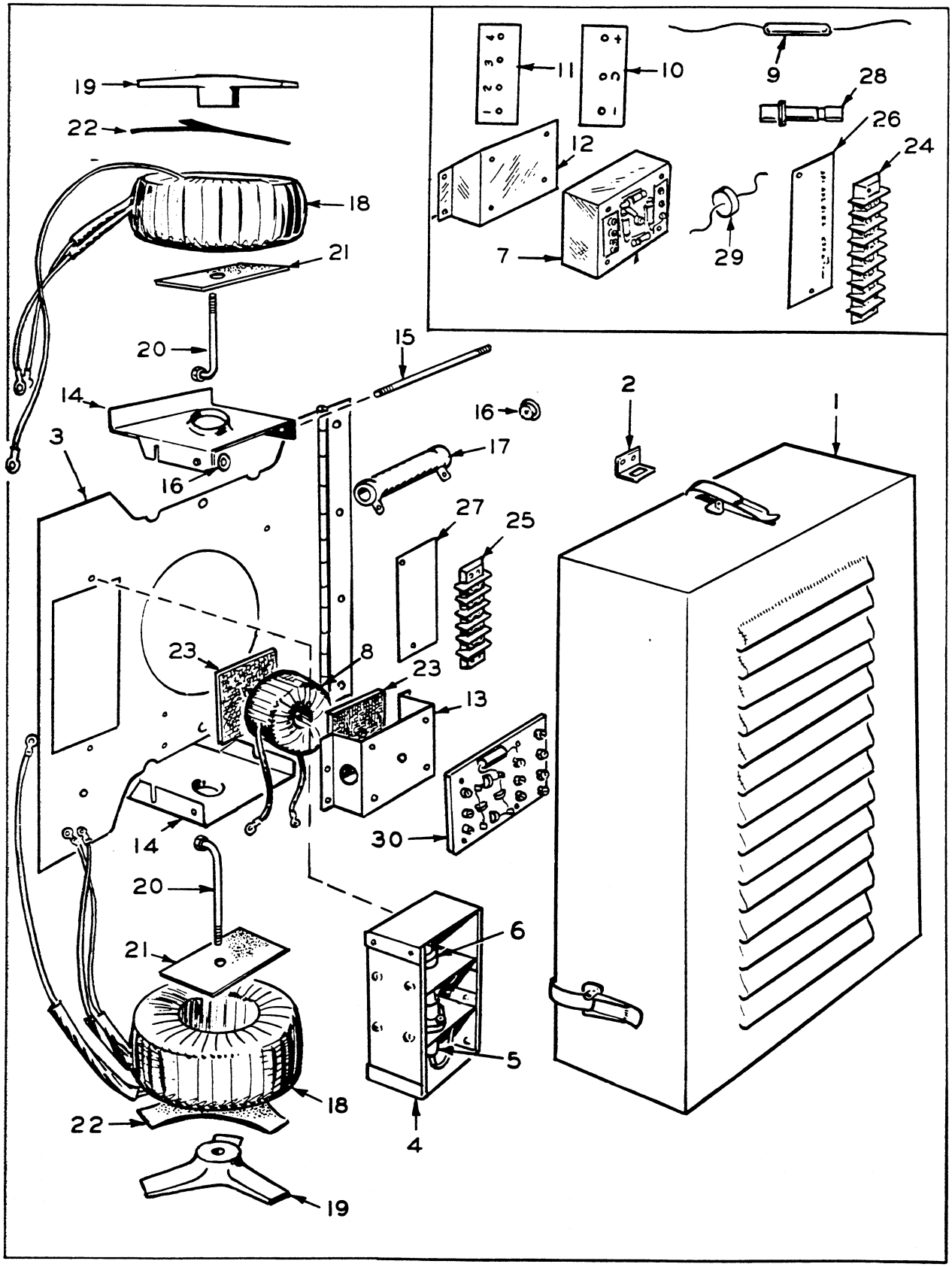


FIG. 3 - GENERATOR GROUP - Exciter Portion

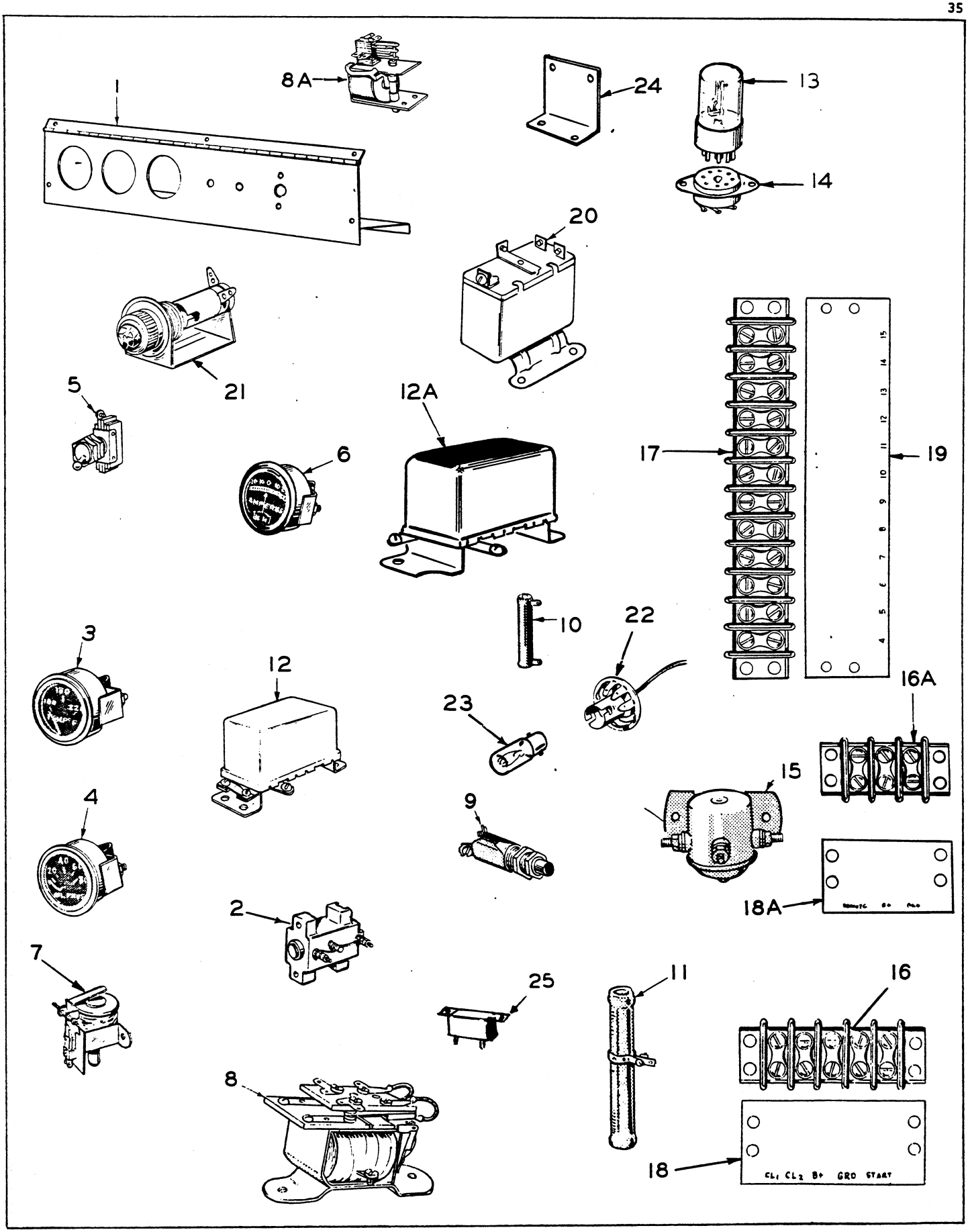


FIG. 4 - CONTROL GROUP - Engine Instruments

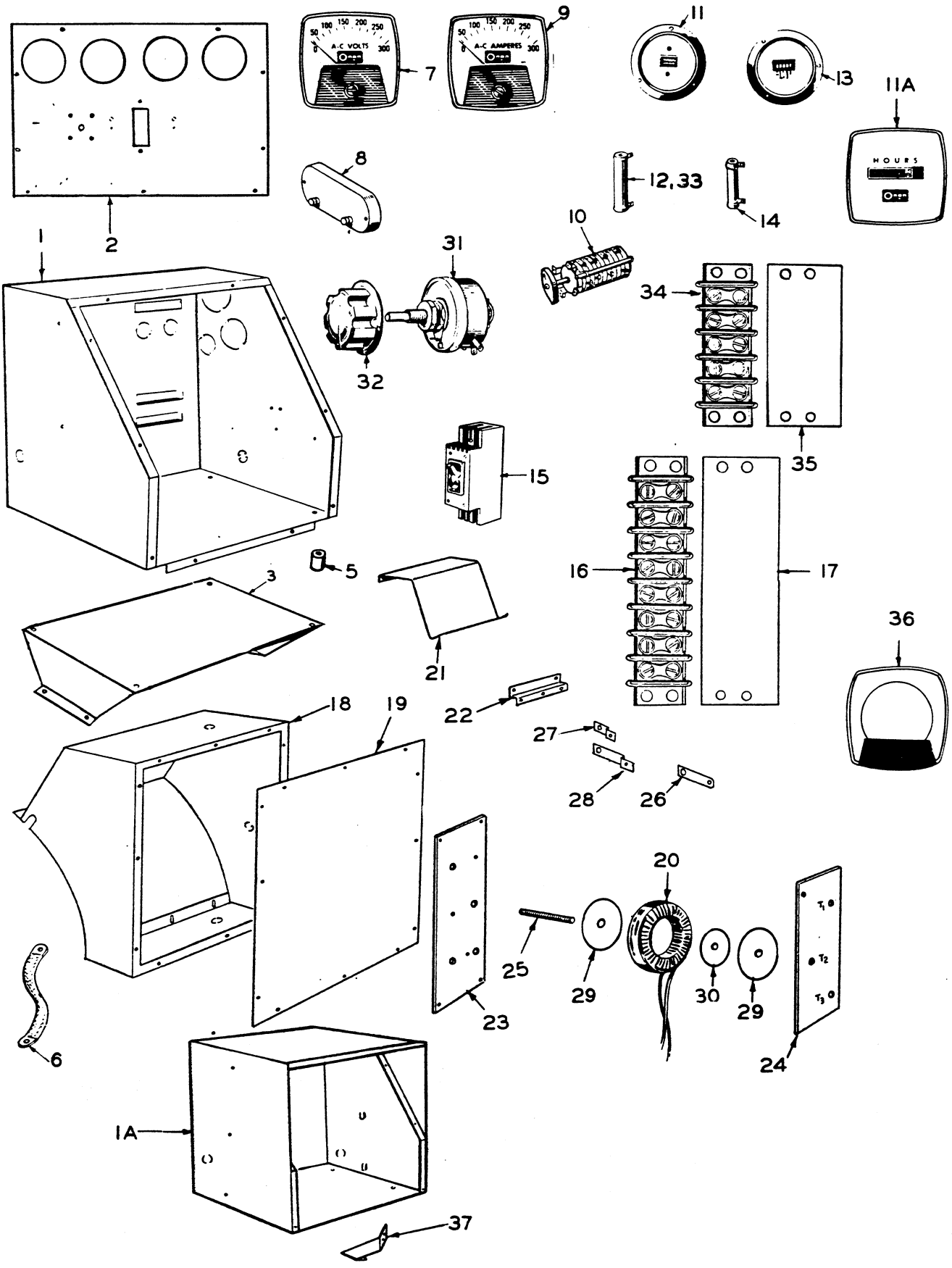


FIG. 5 - CONTROL GROUP - AC Output

REF. NO.	PART NO.	QUANT. USED	DESCRIPTION
			REPLACEMENT ENGINE
-	100P259	1	Engine, Replacement (Cummins Engine Company Model HRS-6) General description: Includes - Complete Cylinder Block; Fuel Pump; Air Cleaner; Fuel Filter; Oil Filter; Starter & Solenoid; Charge Generator & Voltage Regulator; Governor; Radiator; Water Pump; Fan Blades & Belt; Fan Guard; Exhaust Manifold; Flywheel Housing; Engine Supports; and Oil Cooler. Excludes - Throttle Control; Engine Wiring; Oil Pressure & Water Temperature Gauge Senders; and Mounting Base.
			FIG. 1 - MOUNTING BASE, BATTERY CABLES & SENDER GROUP
1	403C559	1	Base, Mounting.
2			Shim, Generator to Mounting Base.
	232A1489	2	No. 16 Gauge (.0598).
	232A1490	2	No. 20 Gauge (.0359).
3			Cable, Battery.
	416A444	1	Positive.
	416A445	1	Negative.
4	416A446	1	Cable, Battery Jumper.
5	193A98	1	Sender, Oil Pressure Gauge (Engine Sending unit only).
6	193A100	1	Sender, Water Temperature Gauge (Engine Sending unit only).
7	309B64	1	Switch, Oil Pressure.
8	309B1	1	Switch, High Water Temperature Cut-off - Adjustable - Use 309A146.
8A	309A146	1	Switch, High Water Temperature Cut-off - Non-Adjustable - Replaces 309B1.
9	505-19	2	Bushing, Pipe Reducer (1/2 x 3/8") High Water Temperature Switch (1), Water Temperature Gauge Sender (1).
10	505-98	1	Nipple, Close (1/8" x 3/4") Oil Pressure Tee to Block.
11	505-59	1	Tee, Pipe (1/8") Oil Pressure Switch and Oil Gauge Sender Mounting.
12	312A58	2	Condenser - .1 Mfd. (1) Charge Generator, (1) Charge Regulator - Replaces 312A15.
13	502-218	1	Elbow, Male (5/8" x 1/2") Brass - Fuel Inlet to Injection Pump.
14	505-131	1	Bushing, Pipe Reducer (3/4" x 3/8") Radiator Outlet to Drain Valve.
15,16			Valve Drain
15	504-28	1	Radiator Drain.
16	504-3	1	Cylinder Water Jacket Drain.

PARTS LIST

REF. NO.	PART NO.	QUANT. USED	DESCRIPTION
			FIG. 1 - MOUNTING BASE, BATTERY CABLES & SENDER GROUP (Cont.)
17,18	-		Clip, Harness - Engine Control Connections.
17	416A96	3	"U" Shaped - All Metal.
18	332-49	2	"O" Shaped - Metal with rubber insulator.
19	191A214	1	Connector, Starter Terminal (1" x 2" Copper Strip).
			FIG. 2 - GENERATOR GROUP (Alternator Portion)
			NOTE: Output Terminal Box, Cover & Internal Parts are listed in the AC Output Control Group (Mounts on Side of Generator).
1	★	1	Rotor Assembly, Wound - Includes Bearing, Blower and Drive Assembly.
2	510P63	1	Bearing - To Spec E.
2	510P88	1	Bearing - Begin Spec E.
3	205C61	1	Blower.
4	★	1	Stator Assembly, Wound.
5	212C248	1	Rig Assembly, Brush - Includes Brushes & Springs.
6	212B1105	4	Spring, Brush.
7	214A56	4	Brush.
8	211D130	1	Bell, End - Alternator to Exciter - To Spec E.
8	211D153	1	Bell, End - Alternator to Exciter - Begin Spec E.
9	234D69	1	Baffle, Air.
10	232A1186	1	Holder, Bearing - Anti-Rotation - To Spec E.
10	232A1807	1	Holder, Bearing - Anti-Rotation - Begin Spec E.
11	232A1187	1	Spring, Bearing Holder - Anti-Rotation - To Spec E.
11	232A1808	1	Spring, Bearing Holder - Anti-Rotation - Begin Spec E.
12	232D1396	1	Support, Generator Mounting.
13	805-35	4	Bolt, Place - Generator Mounting Support to End Bell.
14	150A717	1	Switch Assembly, Overspeed.
15	150A713	1	Bracket, Overspeed Switch - Includes Contact Point.
16	234D70	1	Band, Generator - Front Portion (Narrow).
17			Band, Generator - Rear Portion - UPPER HALF (Wide).
	234D84	1	Single Phase Models - To Spec C.
	234C140	1	Single Phase Models - Begin Spec C.
	234D89	1	3 Phase Models - To Spec C.
	234C134	1	3 Phase Models - Begin Spec C.
18			Band, Generator - Rear Portion - LOWER HALF (Wide).
	234D86	1	Single Phase Models - To Spec C.
	234C141	1	Single Phase Models - Begin Spec C.
	234D90	1	3 Phase Models - To Spec C.
	234C135	1	3 Phase Models - Begin Spec C.
19	234A107	1	Bracket, Conduit Connector - Begin Spec C.

★ - Order by description, giving Model, Spec & Serial Number (ONAN Nameplate).

REF. NO.	PART NO.	QUANT. USED	DESCRIPTION
			FIG. 3 - GENERATOR GROUP (Exciter Portion) Model 2SX
1 -			Cover, Exciter.
	234D73	1	Prior to Spec "C".
	234D116	1	Begin Spec "C".
2	232A1376	3	Bracket, Fastening - Exciter Cover to Alternator End Bell.
3	234D74	1	Panel Only, Exciter.
4			Rectifier Assembly, Power - Complete.
	305B206	1	Prior to Spec "C" (Includes four #305-205 Rectifiers plus wire and hardware).
	305B228	1	Begin Spec "C" (Includes #305P233 and two #305P234 Rectifiers plus wire and hardware).
5,6			Rectifier Only, Power (Field).
5	305-205	4	Prior to Spec "C" (Included in Rectifier Assembly #305B206).
			Begin Spec "C".
5	305P233	2	Lower two - Negative (Included in Rectifier Assembly #305B228).
6	305P234	2	Upper two - Positive (Included in Rectifier Assembly #305B228).
7,8			Reactor, Voltage Control.
7	315B53	1	Prior to Spec "C" (Includes #304-443 Resistor and four Rectifiers #305B203).
8	315A78	1	Begin Spec "C".
9			Resistor, Voltage Control Reactor.
	304-443	1	Prior to Spec "C" (Included in Reactor Assembly #315B53).
	304P476	1	Begin Spec "C" (Included in Rectifier & Resistor Assembly #305B227).
10,11			Strip, Marker - Voltage Control Reactor Connections - Prior to Spec "C".
10	332A644	1	Marked +, C, —.
11	332A645	1	Marked 1, 2, 3, 4.
12,13			Bracket, Mounting - Voltage Control Reactor.
12	232B1404	1	Prior to Spec "C".
13	234B115	1	Begin Spec "C".
14	234B75	2	Bracket, Gate Reactor Mounting.
15	520A190	1	Stud, Fixed Resistor Mounting.
16	304A15	2	Washer, Fixed Resistor Centering.
17	304-442	1	Resistor, Fixed - Mounts to Gate Reactor Bracket.
18	315A51	2	Reactor, Gate.
19	232A1389	2	Retainer, Gate Reactor.
20	232A1403	2	Stud, Gate Reactor Mounting.
21	232B1388	2	Gasket, Gate Reactor Mounting.

PARTS LIST

REF. NO.	PART NO.	QUANT. USED	DESCRIPTION
			FIG. 3 - GENERATOR GROUP (Exciter Portion) Model 2SX (Cont.)
22	232B1387	2	Gasket, Gate Reactor to Retainer.
23	232A1548	2	Gasket, Control Reactor Coil Mounting.
			Block, Terminal.
24	332A503	1	Prior to Spec "C" (8 Place).
25	332A532	1	Begin Spec "C" (5 Place).
			Strip, Terminal Block Marker.
26	332A643	1	Prior to Spec "C" - For 8 Place Block.
27	332A693	1	Begin Spec "C" - For 5 Place Block.
			Rectifier, Voltage Control Reactor.
28	305-203	4	Prior to Spec "C" (Included in Reactor Assembly #315B53).
29	305P218	4	Begin Spec "C" (Included in Rectifier & Resistor Assembly #305B227).
30	305B227	1	Resistor Assy., Rectifier & (Includes #304P476 Resistor and (4) Rectifiers #305P218) - Begin Spec "C".
			FIG. 4 - CONTROL GROUP (Engine Instruments Portion)
1			Panel Only, Lower Control -
	301C1672	1	Prior to Spec "D".
	301C2124	1	Begin Spec "D".
2	320A104	1	Limiter, Cranking.
3	193B112	1	Gauge, Water Temperature (Panel Unit Only).
4	193B111	1	Gauge, Oil Pressure (Panel Unit Only).
5			Switch, Toggle -
	308P2	1	Panel Lights - Begin Spec "D".
	308P2	1	RUN, STOP, AUTOMATIC - Prior to Spec "D".
	308P138	1	RUN, STOP, REMOTE - Begin Spec "D".
6	302A61	1	Ammeter, Charge (30-0-30).
7			Relay, Time Delay.
	307A388	1	Prior to Spec "F".
	307A899	1	Begin Spec "F".
8, 8A			Relay, Emergency Stop -
8	307B299	1	Prior to Spec "D".
8A	307A655	1	Begin Spec "D" - Latching.
9	308-91	1	Button, Emergency Stop Re-set - Prior to Spec "D".
10			Resistor, Fixed -
	304A446	2	(1) Water Temperature Gauge, (1) Oil Pressure Gauge (150 Ohm, 10 Watts) 5/16x1-3/4"
	304A262	3	(1) Start-Disconnect Relay (2) Emergency Stop Relay (50 Ohm, 10 Watt) 5/16 x 1-3/4" - Prior to Spec "D".
	304A262	1	Start-Disconnect Relay (50 Ohm, 10 Watt) 5/16 x 1-3/4" - Begin Spec "D".

PARTS LIST

REF. NO.	PART NO.	QUANT. USED	DESCRIPTION
	FIG. 4 - CONTROL GROUP (Engine Instruments Portion) Cont.		
10 (cont.)	304A248	1	Time Delay Relay (100 Ohm, 10 Watt) 5/16 x 1-3/4" - Prior to Spec "F".
	304A276	1	Between Fuel Solenoid Relay and Emergency Stop Relay (75 Ohm, 10 Watt) 5/16 x 1-3/4" - Begin Spec "D".
	304A62	1	Pilot Relay (25 Ohm, 25 Watt) 3/4 x 2" - Spec "D" through "E".
11			Resistor, Adjustable -
	304A66	1	Between Start-Disconnect Relay and Cranking Limiter - 3/4 x 4"
	304A194	1	Between Fuel Solenoid Relay and Start-Disconnect Relay - 9/16 x 2" - Prior to Spec "F".
12. 12A			Relay, Fuel Solenoid -
12	307B4	1	Prior to Spec "D".
12A	307B597	1	Begin Spec "D".
13			Relay, Cycle Cranking - Plug-in Type -
	307-509	1	Prior to Spec "D" - 15 Second Delay.
	307A697	1	Spec "D" through "E" - 10 Second Delay.
	307A753	1	Spec "D" through "E" - 5 Second Delay.
14	323-52	2	Socket, Cycle Cranking Relay - Prior to Spec "F" (Prior to Spec "D", 1 Only Used).
15	307-61	1	Relay, Pilot - Prior to Spec "F".
16, 16A, 17			Block, Terminal -
16	332A604	1	Remote Operation Connection (5 Place) - Prior to Spec "D".
16A	332A611	1	Remote Operation Connection (3 Place) - Begin Spec "D".
17	332A607	1	Engine Connection (12 Place).
18, 18A, 19			Strip, Block Marker
18	332A679	1	For Remote Operation Block (Marked CL1, CL2, B+, GND, START) Prior to Spec "D".
18A	332A762		For Remote Operation Block (Marked REMOTE, B+, GND) - Begin Spec "D".
19	332A608	1	For Engine Connection Block (Marked 4 through 15).
20	307B52	1	Relay, Start-Disconnect.
21	322P69	1	Receptacle, Pilot Light - Begin Spec "D".
22	322P72	2	Receptacle, Panel Light - Begin Spec "D".
23	322P17	3	Bulb, (1) Pilot Light (2) Panel Lights - Begin Spec "D".
24	301A1685	1	Bracket, Time Delay Relay Mounting
25	320P240	1	Breaker, Circuit - Starter Motor - Begin Spec "F".

PARTS LIST

REF. NO.	PART NO.	QUANT. USED	DESCRIPTION
			FIG. 5 - CONTROL GROUP (AC Output Portion)
1,1A			Box Only, Control -
1	301D1537	1	Prior to Spec "D".
1A	301D2115	1	Begin Spec "D".
2	★	1	Panel Only, Upper Control.
3	301C1830	1	Bracket, Control Box Mounting - Single Piece (Replaces two piece brackets).
5	402-78	4	Rubber, Mounting - Control Box to Mounting Bracket.
6	337A44	1	Strap, Ground.
7			Voltmeter, AC (Check VOLTMETER Scale - Select according to rating.) -
	302P421	1	Voltmeter Scale Reads 0-300 - Replaces 302-41.
	302P422	1	Voltmeter Scale Reads 0-600 - Replaces 302-42.
	302P423	1	Voltmeter Scale Reads 0-750.
8	302-157	1	Multiplier, Meter (Resistor) Voltmeter to Selector Switch (Use Only with 0-500 Scale Voltmeter) - Prior to Spec "D".
9			Ammeter, AC (Check AMMETER Scale - Select according to rating) -
	302P411	1	Ammeter Scale Reads 0-200.
	302P413	1	Ammeter Scale Reads 0-300 - Replaces 302-14.
	302P414	1	Ammeter Scale Reads 0-500 - Replaces 302-371.
	302P415	1	Ammeter Scale Reads 0-750 - Replaces 302-384.
10	308-22	1	Switch, Voltage and Current Selector.
11,11A			Meter, Running Time -
11			Prior to Spec "D" -
	302-212	1	60 Cycle Plants - (NOTE: When used to replace #302-387 Meter on early 480 volt & 277/480 volt plants also order #304A125 Resistor).
	302-102	1	50 Cycle Plants.
11A			Begin Spec "D" -
	302P465	1	For 120/208, 120/240, and 600 Volt, 3 Phase 60 Cycle Plants.
	302P466	1	For 220/380 Volt, 3 Phase, 60 Cycle Plants.
	302P467	1	For 277/480 Volt, 3 Phase, 60 Cycle Plants.
	302P469	1	For 220/380 Volt, 3 Phase, 50 Cycle Plants
12			Resistor, Running Time Meter -
	304A99	1	5, 000 Ohm, 10 Watt (Used only with #302-212 Meter on 120/240 volt, 3 phase plants prior to Spec "C").
	304A125	1	15, 000 Ohm, 25 Watt (Used only with #302-212 Meter on 480 and 277/480 volt plants prior to Spec "D").
	304A444	1	2, 500 Ohm, 10 Watt (Used only with #302-387 Meter on early 120/240 volt, 3 phase plants prior to Spec "C").

★ - Order by description, giving Model, Spec & Serial Number (ONAN Nameplate).

REF. NO.	PART NO.	QUANT. USED	DESCRIPTION
			FIG. 5 - CONTROL GROUP (AC Output Portion) Cont.
(cont.)			
12	304A445	1	6, 500 Ohm, 25 Watt (Used only with #302-387 Meter on early 480 volt and 277/480 volt plants).
	304A536	1	9, 000 Ohm, 50 Watt (Used only with #302P465 Meter on 600 volt plants - Begin Spec "D").
13			Meter, Frequency -
	302-213	1	60 Cycle Plants.
	302-234	1	50 Cycle Plants.
14			Resistor, Frequency Meter -
	304A305	1	45, 000 Ohm, 10 Watt (Used only on 480 volt and 277/480 volt, 3 phase plants.
	304A125	1	15, 000 Ohm, 25 Watt (Used only on 120/240 volt, 3 phase plants prior to Spec "C" and 220/380 volt, 3 phase plants begin Spec "D").
	304A402	1	60, 000 Ohm, 10 Watt (Used only on 600 volt, 3 phase plants).
15			Breaker, Circuit.
	320B18	1	Single Phase Plants.
	320B2	1	3 Phase Plants.
16	332A503	1	Block, Terminal (8 Place).
17	332A601	1	Strip, Block Marker (Marked 15 through 22).
18	301E1675	1	Box Only, Output Terminal - Mounts on Side of Generator.
19	301B1676	1	Cover, Output Terminal Box.
20			Transformer, Current (Mounts in Output Terminal Box) Check TRANSFORMER Nameplate - Select according to rating.
	302B106	3	Transformer Nameplate Reads "Ratio 200/5" (Use with 0-200 Scale AC Ammeter)
	302B107	3	Transformer Nameplate Reads "Ratio 300/5" (Use with 0-300 Scale AC Ammeter).
	302B372	3	Transformer Nameplate Reads "Ratio 500/5" (Use with 0-500 Scale AC Ammeter).
	302B385	3	Transformer Nameplate Reads "Ratio 750/5" (Use with 0-750 Scale AC Ammeter) NOTE: Single Phase Models use quantity of 2.
21,22			Bracket, Current Transformer Bottom Panel Mounting (Bolts to Generator Frame) - Prior to Spec "C".
21	232C1391	1	Upper (Large).
22	232C1390	1	Lower (Small).
23			Panel Only, Current Transformer Mounting - Bottom Panel (Mounts Output Terminal Studs) - Prior to Spec "C".
	232C1418	1	Single Phase Plants.
	232C1385	1	3 Phase Plants.

PARTS LIST

REF. NO.	PART NO.	QUANT. USED	DESCRIPTION
			FIG. 5 - CONTROL GROUP (AC Output Portion) Cont.
24			Panel Only, Current Transformer Retaining - Top Panel - Prior to Spec "C".
	232B1419	1	Single Phase Plants.
	232B1386	1	3 Phase Plants.
25			Stud, Output Terminal - Copper - Prior to Spec "C".
	232A1420	2	Single Phase Plants (7/8-14" x 6-1/2").
	232A1400	4	3 Phase Plants (5/8-18" x 6").
26			Strap, Output Terminal - Copper - Terminal Stud to Ground - Prior to Spec "C".
	337A58	1	Single Phase Plants (3-3/8" x 1-1/2").
	337A57	1	3 Phase Plants (3-1/4" x 1").
27			Strap, Output Terminal - Copper - GROUNDED Stud to Machine Screw - Prior to Spec "C".
	232A1416	1	Single Phase Plants (2-3/4" x 1-1/2").
	232A1397	1	3 Phase Plants (2-1/4" x 1").
28			Strap, Output Terminal - Copper - UNGROUNDED Studs to Machine Screw - Prior to Spec "C".
	232A1415	2	Single Phase Plants (4-1/4" x 1-1/2").
	232A1398	3	3 Phase Plants (3-3/8" x 1").
29			Washer, Neoprene Insulating - Current Transformer Mounting - Prior to Spec "C".
	508A81	4	Single Phase Plants (4-1/2" O.D.).
	508A79	6	3 Phase Plants (3" O.D.).
30			Washer, Fibre - Current Transformer Mounting - Prior to Spec "C".
	508A83	2	Single Phase Plants (2-1/4" O.D.).
	508A82	3	3 Phase Plants (1-1/2" O.D.).
31	303-111	1	Rheostat, Voltage Regulator - 175 Ohm, Model H - Begin Spec "C".
32	303-32	1	Knob, Rheostat - Begin Spec "C".
33	304A484	1	Resistor, Fixed - Rheostat (825 Ohm, 75 Watt) - Begin Spec "C".
34	332A604	1	Block, Terminal - Exciter Connections (5 Place) - Begin Spec "C".
35	332A690	1	Strip, Block Marker (5 Place) - Begin Spec "C".
36	302B448	As Req.	Plate, Meter Face - For appearance only - to give round meter a square appearance.
37	301A1914	1	Bracket, Panel Stop - Begin Spec "D".

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