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# OPERATORS MANUAL AND PARTS CATALOG

FOR

Onan®

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## ELECTRIC GENERATING PLANTS

# DFV

## 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
INTERNATIONAL DISTRICT OFFICE: EMPIRE STATE BLDG., 350-5TH AVE., RM. 2204, NEW YORK 10001

960—304 Price $1.00 4AB68 Printed in U.S.A.

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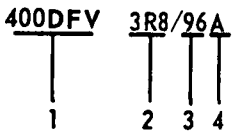
## INTRODUCTION

When the instructions in this manual refer to a specific model of electric plant, identify the model by referring to the *MODEL AND SPECIFICATION NO.* as shown on the ONAN nameplate. Electrical characteristics are are shown on the lower portion of the nameplate.

How to interpret MODEL and SPEC. NO.




1. Factory code for SERIES identification.
2. Combines with number 1 to identify model. Indicates model, output voltage, method of starting: E - ELECTRIC starting, R - REMOTE electric starting.
3. Factory code for designating optional equipment.
4. Specification letter. (Advances when factory makes production modifications.)

If it ever becomes necessary to contact a dealer or the factory regarding the plant, be sure to mention the complete Model, Spec. No , and 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.

Electric plants are given a complete running test under various load conditions and thoroughly checked before leaving the factory. Inspect the plant closely for loose or missing parts and any damage which may have occurred in shipment. Tighten loose parts, replace missing parts, and repair any damage before putting plant in operation.

## 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.

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**ONAN** FORM 27C104

# *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.

# SPECIFICATIONS

| | |
|---|---|
| Dimension (nominal) | |
| Height (inches) | 82 1/2 |
| Width (inches) | 55 3/4 |
| Length (inches) | 129 |
| Weight (approximate in pounds) | 12,000 |
| Number of cylinders | 12 |
| Displacement (cu. in) | 1710 |
| Bore (inches) | 5 1/2 |
| Stroke (inches) | 6 |
| BHP at 1,800-rpm (nominal) | 638 |
| Compression Ratio (Diesel) | 14.1:1 |
| Manufacturer (engine) | Cummins |
| Series | ~~VTA-1710~~ VT-1710 P700 |
| Governor Regulation % | 5 |
| Nominal Battery Voltage | 24 |
| Battery Size | |
| SAE Group 8D (12-volts) | Two |
| Amp/Hr. SAE 20-hr. Nominal | 200 |
| Solenoid Shift Starter | Yes |
| Engine Cooling Air (CFM at 1,800-rpm) | |
| City Water Cooling | 6750 |
| Radiator Cooling | 32,500 |
| Combustion Air (CFM at 1,800-rpm) | 1200 |
| Alternator Cooling Air (CFM at 1,800-rpm) | 3000 |
| Output Rated At Power Factor Load | 0.8 |
| Rating (Output in Watts) | |
| 50-cycle AC intermittent service | 330,000 |
| 50-cycle AC continuous service | 290,000 |
| 60-cycle AC intermittent service | 400,000 |
| 60-cycle AC continuous service | 350,000 |
| AC Voltage Regulation in ± % | 2 |
| AC Frequency Regulation in % | 5 |
| Revolving Field Alternator (4-pole) | Yes |
| Rotating Rectifier Exciter | Yes |
| Cooling System Capacity | |
| Radiator (gallons) | 37 1/2 |
| Heat Exchanger (gallons) | 35 |
| Engine Oil Capacity (gallons) | 13 |
| Exhaust Connections (inches pipe thread) | 3 1/2 |
| Air Cleaners (Dry type) | Yes |
| Closed Crankcase Breather System | No |
| RPM (60-cycle) | 1800 |
| RPM (50-cycle) | 1500 |
| Battery Charging Alternator | Yes |
| Turbocharger | Yes |

# DESCRIPTION

## GENERAL

An Onan electric generating plant of the DFV series is a complete unit consisting of a Diesel engine driving a self-excited AC generator, and such controls and accessories as specified by the purchaser.

## ENGINE

UT-1710P708

The engine is a Cummins basic model VTA1710 as described in the Cummins manual. The specific engine used may have variations due to some of the optional equipment available as specified by the plant purchaser.

## AC GENERATOR AND EXCITER

The complete generator consists of a brushless, 4-pole revolving field type alternator and a rotating rectifier exciter with a solid state transistorized voltage regulator. The alternating current output is generated in the stator winding of the generator, attached to the rear portion of the engine. The alternator's rotating field, attached directly to the engine flywheel, 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 rotating rectifier exciter provides for almost constant AC output voltage over a wide range of load conditions. It is used for providing excitation current (DC) to the rotating field of the generator. The improved design of this brushless unit simplifies servicing and maintenance. It does this by eliminating parts which are subject to normal wear, such as brushes, slip rings and commutator.

A solid-state transistorized voltage regulator system works in conjunction with the exciter. A voltage control rheostat is used to maintain a desired output voltage.

## STANDARD ENGINE CONTROLS AND EQUIPMENT

Engine controls and equipment, which are mounted on the control box, contain components for starting, controlling, and stopping the plant. Each of these controls is described below.

**Run-Stop-Remote Switch:** Starts and stops engine from either the plant or a remote location.

**Cranking Limiter:** Opens the starting circuit if engine does not start within approximately 45 seconds.

**Oil Pressure Gauge:** Indicates engine oil pressure. (Wired into a sending unit.)

**Water Temperature Gauge:** Indicates engine coolant temperature. (Wired into a sending unit.)

**Emergency Latch Relay:** Shuts engine off and protects from damage due to high water temperature, low oil pressure, and engine overspeed. Utilizes a safety indicator light and an alarm terminal. When cause of trouble has been corrected a button must be manually reset before engine can be started again.

**Automatic Overspeed Shutdown:** If plant speed exceeds 2100 rpm this switch automatically actuates the latching relay and shuts down the plant.

**High Water Temperature Cut-Out:** If engine coolant temperature exceeds 215°F the latching relay is energized, shutting down the plant.

**Low Oil Pressure Cut-Out:** Allows oil pressure build-up while starting and shuts down the plant through the latching relay if oil pressure drops below 14 psi.

**Battery Charging DC Alternator:** A 24-volt DC, 35 amp output charges the two 12-volt batteries necessary for starting. Also utilizes a mounted voltage regulator.

**Battery Charge Rate Ammeter:** Indicates the battery charging current.

## AC GENERATOR CONTROLS AND EQUIPMENT

The electrical instrument panel and equipment will vary according to the model and purchaser options. The following is a brief description of each of the controls and components which are standard items.

**AC Ammeter:** Indicates load current connected to the generator circuit.

**AC Voltmeter:** Indicates the voltage of the AC output.

**Voltage Adjusting Rheostat:** Provides for approximately 5% plus or minus adjustment of the output voltage.

**Phase Selector Switch:** Selects the phase of the gener-

ator output which is indicated by the AC ammeter and voltmeter.

**Frequency Meter:** Indicates the frequency of the output current in cycles per second. It can be used to check engine speed. (Each cycle per second equals 30-rpm engine speed.)

**Running Time Meter:** Registers the total number of hours to 1/10th, that the plant has run. Use it to keep a record of periodic servicing.

## OTHER OPTIONS

The generating plant is adaptable to AUTOMATIC LOAD TRANSFER equipment, manual/automatic paralleling switchboards, and other devices. Terminals can be provided for connecting optional warning equipment, etc.

SIGNAL LIGHTS may be included to warn of improper operation. Terminals for connecting such lights, horn or other warning devices are available. Refer to the engine wiring diagram if such equipment is to be connected.

Optional WATER JACKET (tank type) HEATERS are available to keep the engine coolant warm during periods of plant shutdown in low ambient temperatures. Connect the heater to a normally energized electric power source, making sure that the line voltage is correct for the rated voltage of the heater.

# INSTALLATION

## GENERAL

Installation points to consider include: adequate engine and generator cooling air, discharge of circulated air, adequate fresh induction air, discharge of exhaust gases, electrical connections, fuel connections, water connections, accessibility for operation and servicing and a sturdy, level floor.

Installations must be considered individually. Use these instructions as a general guide. Meet regulations of local building codes, fire ordinances, etc., which may affect installation details.

## LOCATION

Provide a location that is protected from the weather and is dry, clean, dust free and well-ventilated. If practical, install inside a building for protection from extremes in weather conditions, and preferably heated in cold weather.

## MOUNTING (Fig. 1 and 2)

Plants are mounted on a rigid skid base which provides proper support and adequate vibration damping. For convenience in draining crankcase oil and general servicing, plants can be mounted on raised pedestals (at least 6" high). Extra vibration isolators are available and may be installed under the plant base. If mounting in a trailer, or for other mobile applications, bolt securely in place. Extra support for the vehicle flooring may be necessary. Bolting down is optional for stationary installations.

**NOTE:** *Alignment of the generator to the engine is very important. Refer to instructions. (Fig. 1)*

## VENTILATION

Plants create considerable amounts of heat which must be removed by proper ventilation. Outdoor installations rely on natural air circulation but *mobile* and *indoor* installations need properly sized and positioned vents for the required air flow. See Specifications for the air required to operate with rated load under normal conditions at 1800-rpm.

Cooling air travels from the rear of the plant to the front end. Locate the room or compartment air inlet where most convenient, preferably to the rear of the plant. The inlet opening should be at least as large as the radiator area.

Engine heat is removed by a pusher fan which blows cooling air out through the front of the radiator. The cooling air outlet should be directly in front of the radiator and as close as is practical. The opening size should be at least as large as the radiator area. A duct of canvas or sheet metal should be used between the radiator and the air outlet opening. The duct will prevent recirculation of heated air.

A means of restricting the air flow in cold weather should be provided to keep the room or compartment temperature at a normal point.

On city water cooled plants the conventional radiator is not used and a constantly changing water flow cools the engine. Ventilation is seldom a problem, but sufficient air movement and fresh air must be available to properly cool the generator and support combustion in the engine. For small compartments, a duct of equal or larger area is recommended to remove the heated air from the generator air outlet to the outside atmosphere. Limit bends and use radius type elbows where needed. A larger well ventilated compartment or room does not require a hot air duct.

Installations made in a small room may require installation of an auxiliary fan (connected to operate only when the plant is running) of sufficient size to assure proper air circulation.

## CITY WATER COOLING

An optional method of engine cooling, in place of the conventional radiator and fan, uses a constant pressurized water supply. For piping connections, etc., refer to the separate outline drawing furnished. Variations of "city" water cooling are optional: the water may circulate directly through the engine cooling system or may be cooled through a heat exchanger. The cooling water may also be used to cool the exhaust manifolds. (Water cooled exhaust manifolds are recommended.) An electric solenoid valve is installed in the water supply line. connected to open the water flow only when the plant is operating. A rate-of-flow valve (either automatic or hand adjusted) is recommended for installation in the supply line to control the water flow. Use flexible hose to connect water supply and outlet flow pipes to the engine connection points. Pipe the outlet flow to a convenient drain. (continued page 10)

## INSTALLATION ALIGNMENT FOR DFV GENERATING PLANTS

When installing ONAN electric plants, the generator must be aligned to the engine to prevent premature generator bearing failure. Align the generator according to the following instructions:

1. Set the plant on its mounting foundation. (Either rigid foundation mounting or mounting plant on vibration isolators between skid base and foundation.) Remove the two mounting bolts which secure the generator support to the skid base (Fig. A). Remove shims between skid base and generator support. (Use mounting bolts as jackscrews to raise generator to remove shims. Remove tension from jackscrews and allow generator to hang free.)

2. Secure the skid base to the mounting foundations.

3. Measure the clearance from the top surfaces of the skid base to both mounting surfaces of the generator support (Fig. B).

4. Add clearance of skid base - to - support (Fig. B) and weight correction figure (Table 1) to determine the total amount of generator alignment shims required. The clearances may be different for both sides of the skid base. Select shims (Table 2) required according to alignment figures.

5. Using mounting bolts as jackscrews, increase clearance between base and support to allow placing the shims between base and support (Fig. C). Lower generator and allow to rest on shims. Total generator clearance, base to support must equal the base-to-support clearance plus the weight correction figure.

6. Remove jackscrew bolts and install as mounting bolts through generator support, shims, and skid base. Secure and lock the mounting bolts in place (Fig. D).

**NOTE:** The laminated shim has .002" increment. Use these shims as thick as possible to eliminate having to separate the increments.

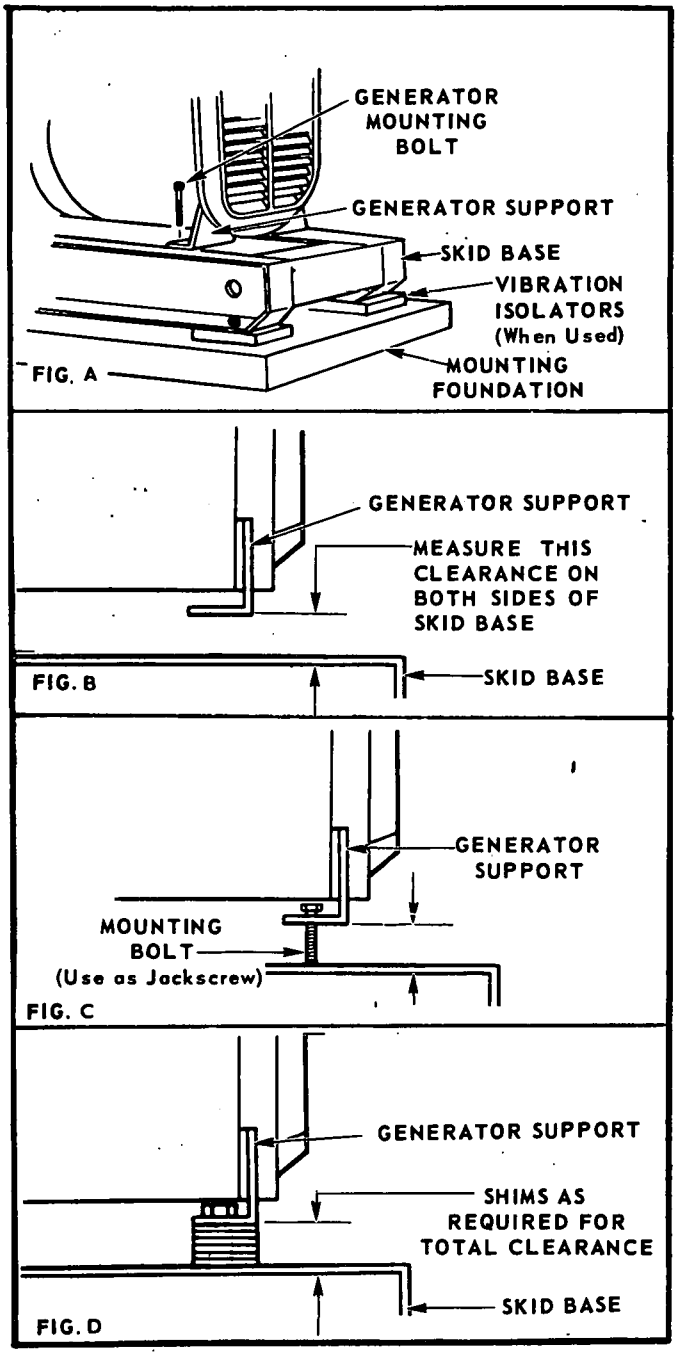



TABLE 1

| PLANT MOUNTING | WEIGHT CORRECTION FIGURE - INCH |
|---|---|
| Rigid Mounting | .020 |
| Vibration Isolator Mounts | .035 |

TABLE 2

| SHIM PART NUMBER | THICKNESS INCH | METAL GAUGE | SIZE |
|---|---|---|---|
| 232A1490 | .0359 | #20 | 3 x 3 |
| 232A1489 | .0598 | #16 | 3 x 3 |
| 232A1817 | .002 to .062 (Laminated Shim) (.002 Increments) | | 2 x 2-1/2 |

# TYPICAL INSTALLATION

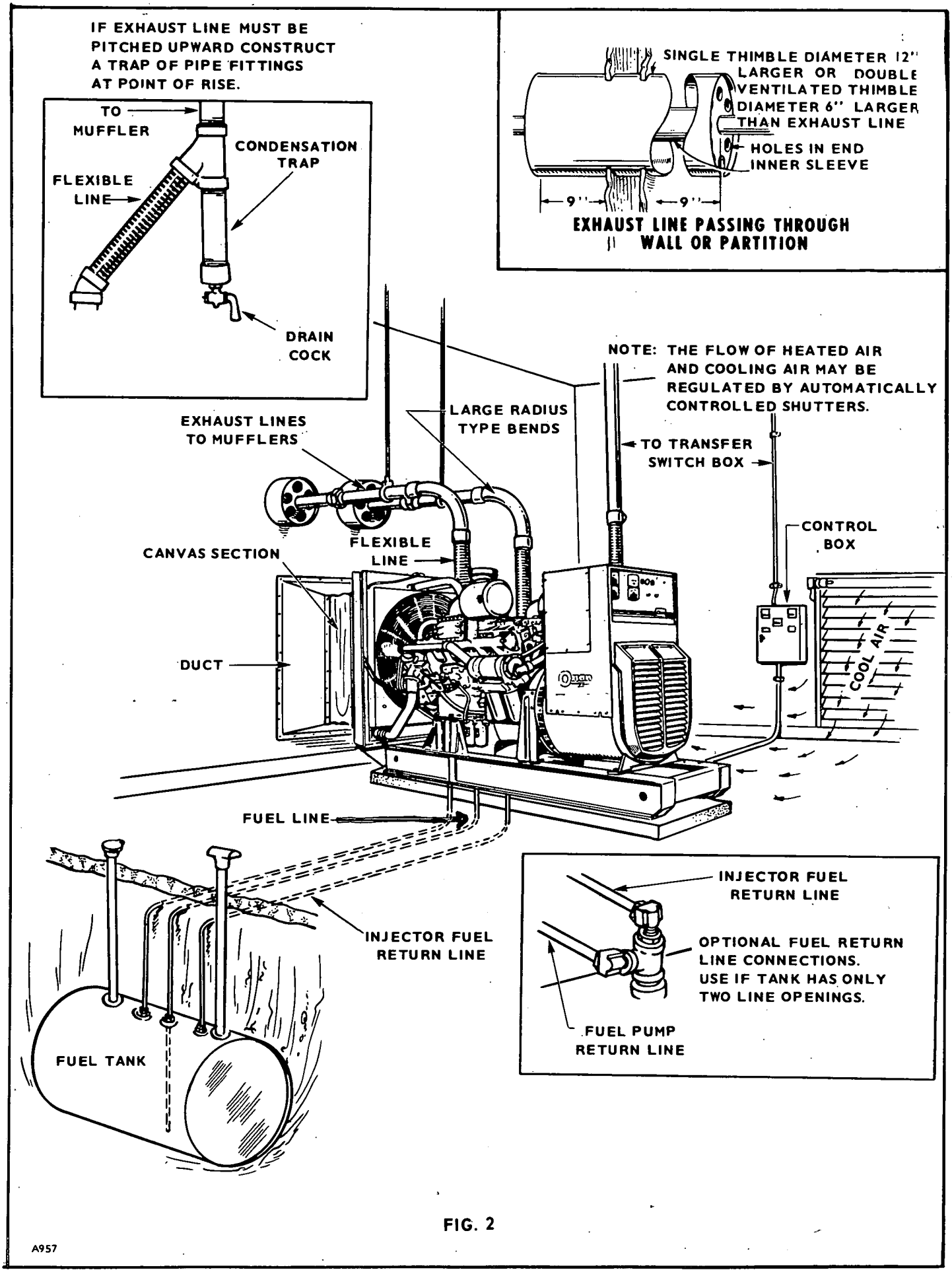
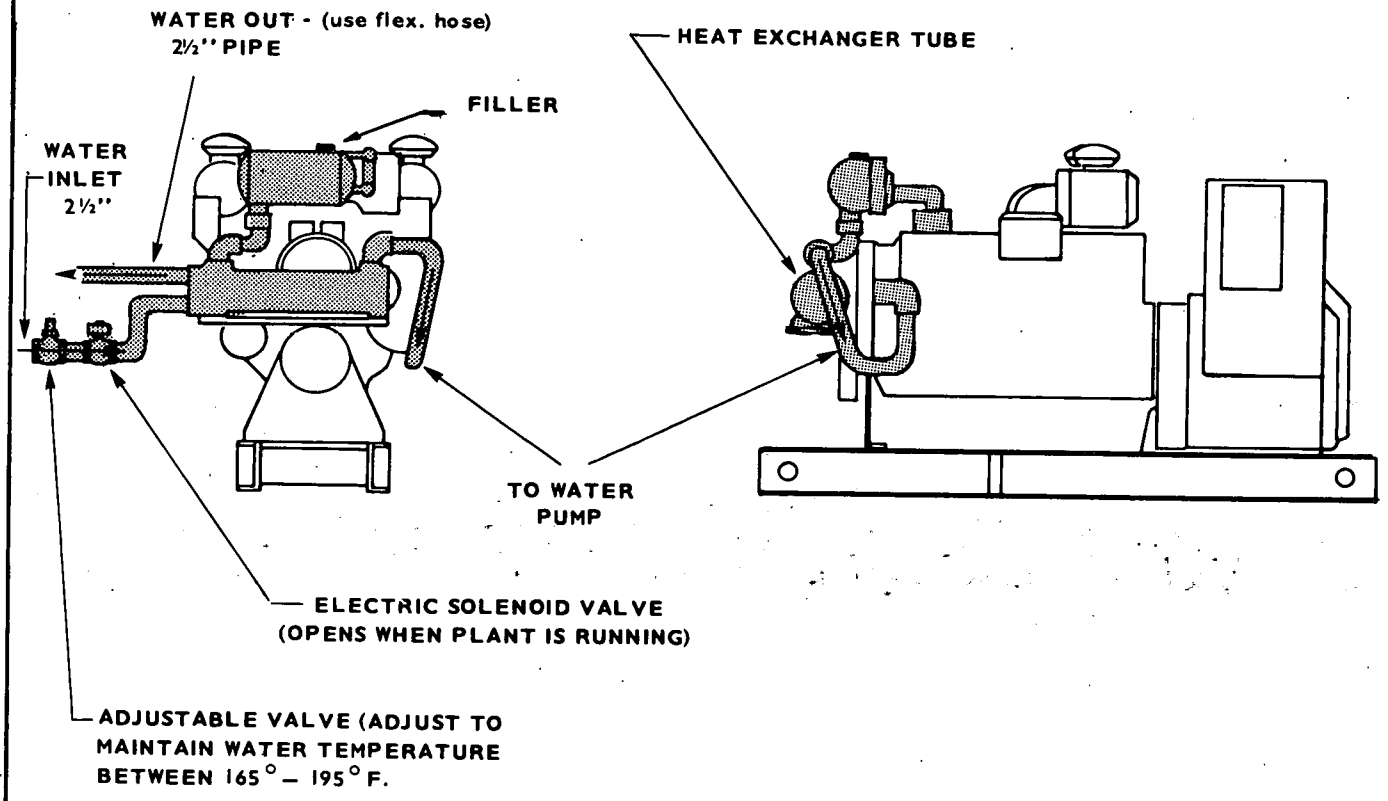



FIG. 2

A957

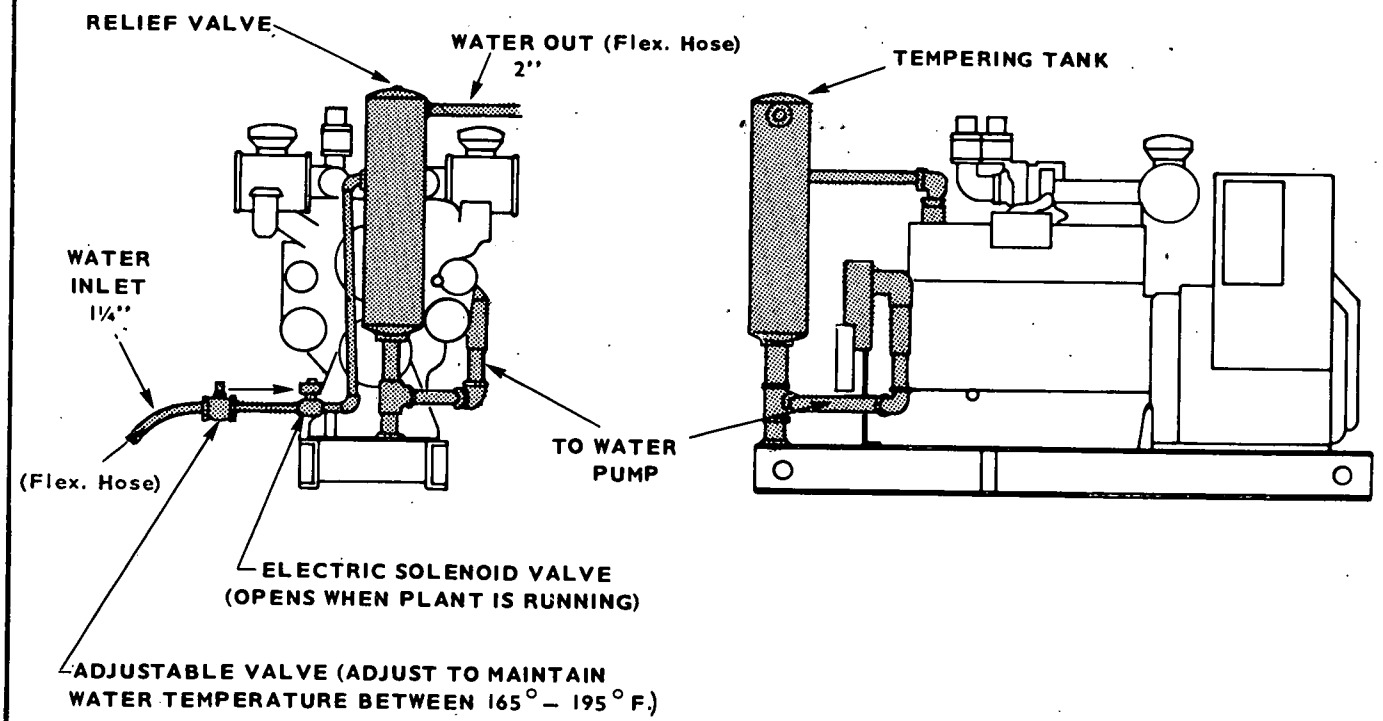
## TYPICAL CITY WATER HEAT EXCHANGER COOLING

FIG. 3




## TYPICAL CITY WATER STANDPIPE COOLING

FIG. 4



# 'DAY' TANK INSTALLATION

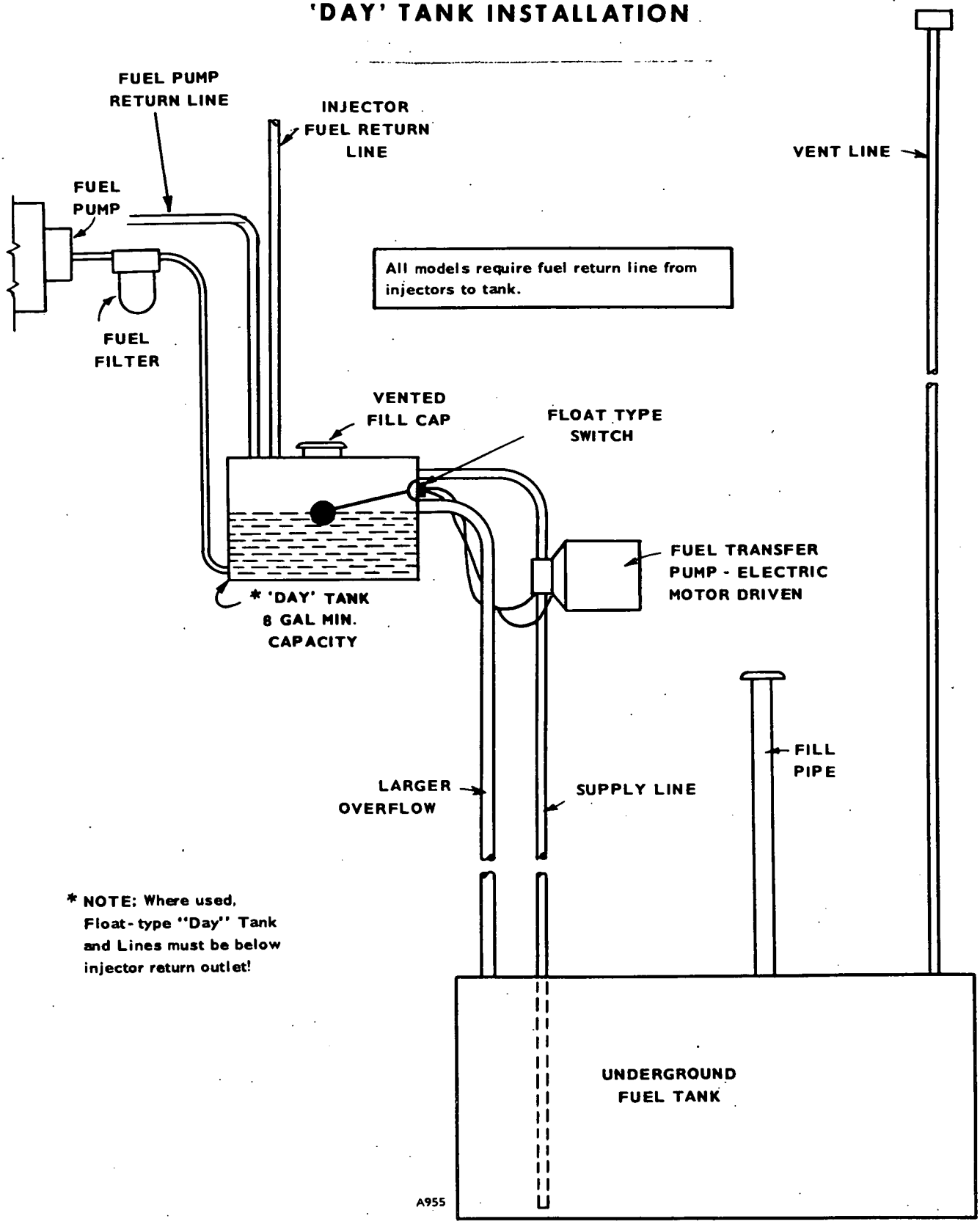



FIG.5

**Standpipe System (Fig. 4):** The standpipe system uses a mixing or tempering tank. Cooling water that circulates through the engine mixes with a source of cool "raw" water. The "raw" water supply must be free of scale-forming lime or similar impurities.

**Heat Exchanger System (Fig. 3):** The heat exchanger installation provides for a "closed" engine cooling system. Engine coolant circulates through a tubed chamber, keeping the coolant separate from the cool "raw" water supply. The coolant chamber must be filled for operation, as for a radiator cooled plant. An electric solenoid valve is installed in the water supply line, and is connected to open and allow water to flow only when the plant is operating. A rate of flow valve (either automatic or hand adjusted) is recommended for installation in the supply line to control the water flow. Use a flexible hose to connect water supply and outlet flow pipes to the engine connection points.

If the plant is equipped for "city" water cooling, see that the water supply to the engine is turned on. If the system is the "closed" (heat exchanger) type, see that the chamber portion is properly filled, similar to a radiator equipped unit. Make a preliminary adjustment of the water flow as indicated in Fig. 6 or 7. Make final adjustment after the plant warms up.

MINIMUM WATER FLOW, HEAT EXCHANGER COOLING

| ELECTRICAL LOAD | WATER TEMP. | MIN. FLOW GAL./MIN. |
|---|---|---|
| 400 KW | 60° | 80 |
| | 80° | 82 |

FIG. 6

MINIMUM WATER FLOW, TEMPERING TANK COOLING

| ELECTRICAL LOAD | WATER TEMP. | MIN. FLOW GAL./MIN. |
|---|---|---|
| 400 KW | 40° | 23.8 |
| | 60° | 28.2 |
| | 80° | 34.8 |

FIG. 7

## EXHAUST

Pipe exhaust gases outside any enclosure (Fig. 2). Use pipe at least as large as the $3\frac{1}{2}$" pipe size outlet of the engine. Increase the pipe diameter one pipe size for each additional 10' in length. Use a flexible connection at the engine exhaust manifold. Provide adequate support for the piping. Pipe fittings cause a resistance to the flow of exhaust gases and can result in a loss of engine power. Use sweeping elbows in preference to standard pipe elbows, and keep the number of necessary turns to a minimum. If the exhaust line runs upward at any point, install a vapor or condensation trap at the low point, with a provision for periodic draining. Shield or insulate the line if there is any danger of personnel contact. If the line passes close to a combustible wall or partition, allow at least 4" clearance. Install a suitable muffler.

## FUEL CONNECTIONS

Check local regulations governing the installation of a fuel supply tank.

**NOTE:** *In any Diesel engine installation fuel system cleanliness is of utmost importance. Make every effort to prevent entrance of any moisture or contamination matter of any kind. Do not use lines or fittings of galvanized material.*

The maximum fuel lift without any horizontal run should not exceed 8'. The horizontal run, if the supply tank is level with the fuel pump, should not exceed 12-1/2'. Use 5/8" tubing for the fuel supply line. The inlet fitting on the fuel filter is threaded for a 7/8" 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 3/4" SAE flared fitting. The The fuel pump return line is threaded for a 5/8" SAE flared fitting. Use 3/8" tubing for the fuel pump return line.

## DAY TANK (Fig. 5)

Engines may be equipped with an optional day tank. A float operated switch controls the electric fuel pump (not included with day tank) to maintain the correct fuel level to assure a constant source of fuel. Do not mount the tank on the plant. Mount the tank on a vibration free support below the engine fuel return line. The tank overflow line to supply tank is optional, consult local regulations. Refer to the installation instructions included with the tank.

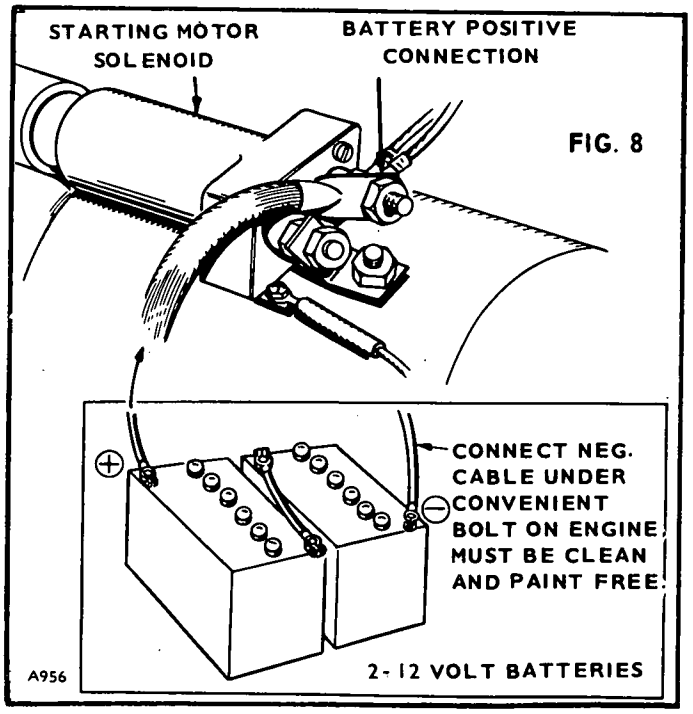



FIG. 8

## BATTERY (Fig. 8)

24-volt battery current is required for starting purposes. Use two 12-volt type 8 D batteries for a normal installation. Connect the batteries in series (negative post of first battery to positive post of second). Note a small wire connected to one of the two larger terminals on the starter 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 frame. Service the batteries as necessary.

Infrequent plant use (as in emergency standby service) may allow the batteries to self-discharge to the point where they cannot start the plant. If installing a load transfer switch that has no built-in charge circuit, a separate trickle charger should be connected. Onan load transfer controls include such a battery charging circuit.

## REMOTE CONTROL CONNECTIONS

Starting and stopping is through a 2-wire electrical system. To extend this control to one or several remote locations, a 3-place terminal block is provided in the plant control box. The terminal block is marked REMOTE, B+, and GND. If a load transfer or an automatic control is used, follow the instructions supplied with the control. If a SPST manual switch is used, connect the wires and mount the switch so the engine will run when the switch handle is up; the same as an ordinary light switch. The size wire to use is determined by the plant-to-control distance. Use #18 wire up to 900-ft. (Fig. 9). The GND terminal is for a customer-supplied alarm at a remote location to warn of low oil pressure, high water temperature and overspeed.

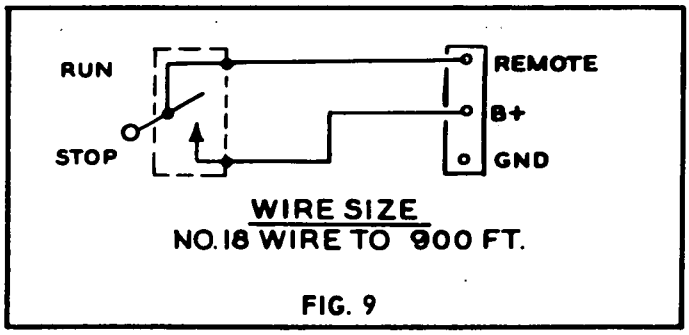



FIG. 9

## CONNECTING LOAD WIRES

Most local regulations require that wiring connections be made by a licensed electrician, and that the installation be inspected and approved before operation. All connections, wire size, etc., must conform to requirements of electrical codes in effect at the installation site.

If the installation is for standby service, a double throw transfer switch (Fig. 10) must always be used. This switch (either manual or automatic) must be connected so that it is impossible for the normal source and generator current to be connected to the load at the same time. Instructions for connecting an automatic load transfer control are included with such equipment. It is assumed that personnel connecting the generator, and any such auxiliary equipment, are fully qualified and understand the problems of balancing the circuits, grounding the plant, etc. Refer to the output control wiring diagram furnished. Each generator lead is marked according to the wiring diagram.

Make load wire connections to the generator according to the type of facilities provided. If large terminal posts are provided, make load wire connection directly to the posts. Some plants are "reconnectible" for different voltages and have extra leads. These are pre-connected according to the nameplate ratings.

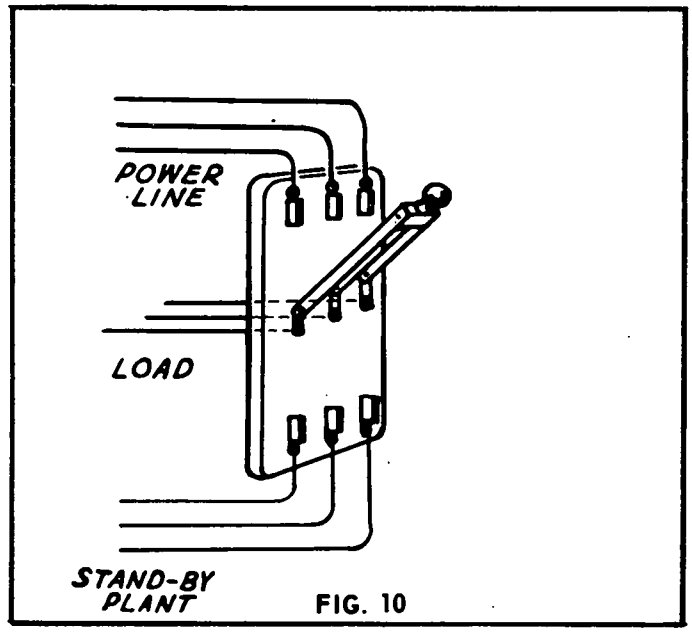



FIG. 10

**3-Phase, 3-Wire Plant (Fig. 11):** No terminal is grounded. For three-phase current, connect separate load wires to each plant terminal T1, T2, and T3.

If phase sequence is important, as with 3-phase motors, final connections may be postponed until a trial run is made, When the plant is installed for standby service, phase sequence of the normal line service and the generator output must be the same, for proper load operation.

Single-phase current is obtained from any two plant terminals. These single-phase circuits are thus available: T1-T2, T1-T3, and T2-T3. The load connected to any one single-phase circuit must not be greater than 1/3 the rated capacity of the plant.

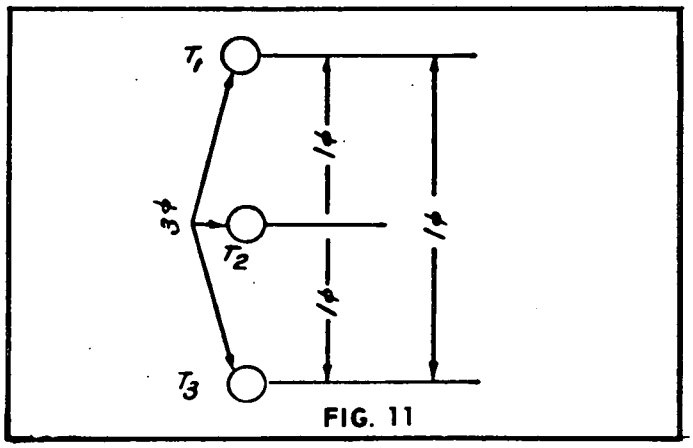



FIG. 11

If both single-phase and three-phase current is to be used at the same time, use care not to over-load 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 connected to any one single-phase circuit. For example, a 10,000-watt 3-phase load is connected to a 25,000 watt plant. This leaves 15,000 watts available for single phase use -- 5,000 watts on each circuit. Do not attempt to take all 15,000 watts in this example off one circuit, as over loading of the generator will result.

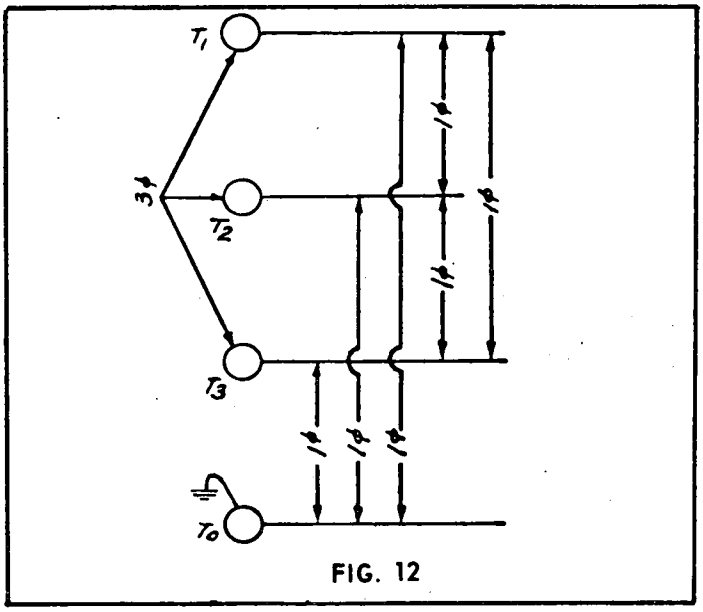


FIG. 12

**3-Phase, 4-Wire, Wye Connected Plant (Fig. 12):** The 3-phase 4-wire plant produces single-phase current of one voltage and three-phase current of a different voltage. The single-phase voltage is the lower voltage as noted on the plant nameplate, and the three-phase voltage is the higher nameplate voltage.

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, or T3. Three separate single-phase circuits are available, with not more than 1/3 the rated capacity of the plant from any one circuit.

For 3-phase current, connect separate load wires to each of the plant terminals T1, T2, and T3. If phase sequence is important, refer to the principles of connection as given for the 3-phase 3-wire plant. Single-phase current is obtained between any two 3-phase terminals.

If single-phase and 3-phase current is to be used at the same time, use care to properly balance the single-phase load.

**120/240-Volt, 3-Phase, 4-Wire Delta Connected Plant (Fig. 13):** The 3-phase Delta connected plant is designed to supply 120-volt single-phase current and 240 volt 3-phase current. For single-phase operation, con-

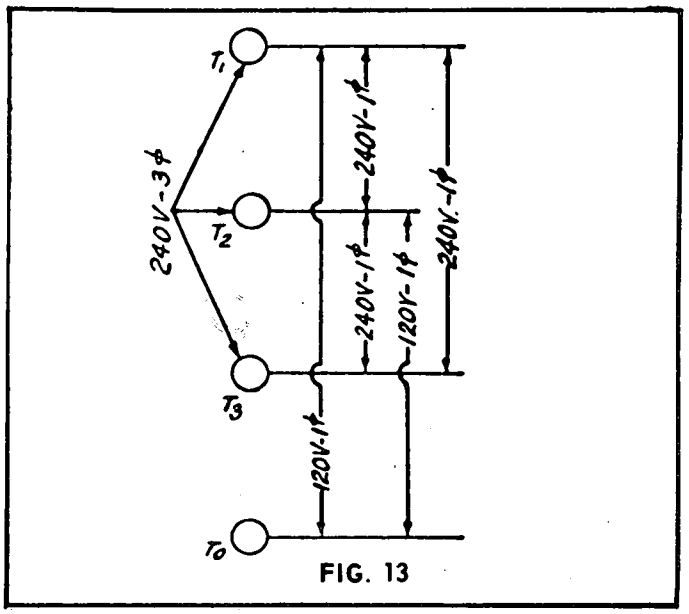


FIG. 13

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

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 required. For 120-volt service, connect the "hot" (black) load wire to either the T1 or T2 terminal. Connect the neutral (white) wire to the T0 terminal. Two 120-volt circuits are available. Any combination of single-phase and three-phase loading can be used at the same time as long as no terminal current exceeds the NAMEPLATE rating of the generator. If no 3-phase output is used, usable 1-phase output is 2/3 of 3-phase KVA.

**WARNING**
**ENGINE OIL and COOLANT DRAINED**

Rust inhibiting oil is applied to cylinders for shipping.

Before Operating: FILL cooling system. FILL with lubricating oil.

# OPERATION

## 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 meet these requirements. Check with the oil supplier.

The capacity of the oil pan is approximately 13 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 uses. Do not mix brands nor grades of lubricating oils.

## GOVERNOR OIL

Fill the sump of governor to level indicated on dipstick with engine lubricating oil of the viscosity recommended for engine lubrication at operating temperature.

## CRANKCASE BREATHER AIR CLEANER

Service the crankcase breather air cleaner as outlined in Cummins manual.

## COOLANT

For units which use either a radiator or heat exchanger (city water cooled), fill the cooling system with clean soft water. Use a good rust and scale inhibitor. If there is any possibility of a radiator cooled plant being exposed to freezing temperatures, use antifreeze with an ethylene glycol base. 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. Refer to Cummins manual for additional information.

**NOTE:** The electric solenoid valve, used with city water cooled plants, should be energized before initial starting of plant to allow coolant chambers to fill with coolant. This is accomplished by using a jumper from the 24-volt battery supply to the solenoid.

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.

## BEFORE INITIAL START

Refer to Pre-Start instructions (section 2) in the Cummins manual.

## STARTING

To start, press the RUN-STOP switch to its RUN position, holding in contact to crank the engine. The engine should start with a few seconds of cranking. Investigate any failure to start -- do not crank for more than 30 seconds at one time. If engine fails to crank, check that the cranking limiter switch is closed.

**OPERATORS NOTE:** Always use all instruments provided with the unit to obtain the most satisfactory service from it.

## CHECKING OPERATION

As soon as the engine starts, always check the oil pressure. Normal oil pressure is approximately (40-lb) at operating temperature. 92-93

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

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

**BREAK-IN NOTE:** Run plant at 50% rated load for the first 1/2 hour after reaching operating temperature.

**WATER FLOW** **(See typical installation on page 8 )**
If the plant is city water (pressure) cooled, but without the optional flow (Powers) 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 195°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 electrical load and allow the plant to run a few minutes at no load. This will allow the plant to cool off slightly, and may prevent an excessive temperature rise when the plant stops and ventilation ceases. Press the RUN-STOP switch to its STOP position to stop the plant.

## 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 the electrolyte is so diluted, but if the temperature is above 90°F, this should not be noticed. The lengthened battery life will be worth the effort.

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 distilled water, to normal 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.

## NO LOAD OPERATION

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

## EXERCISE PERIOD

If the plant is used infrequently, such as in standby service, start and operate for at least 30 minutes once a week. This exercise period keeps engine parts lubricated and insures easy emergency starts.

## OUT-OF-SERVICE PROTECTION

Protect a plant that is to be out-of-service for more than 30 days as follows:

1. Run plant until thoroughly warm.
2. Drain oil from oil base while still warm. Refill and attach a warning tag stating oil viscosity used.
3. Remove each injector. Pour 1 oz. (two tablespoons) of rust inhibitor (or SAE #50 oil) into each cylinder. Install injector.
4. Service air cleaner as outlined in Cummins manual.
5. Clean governor linkage and protect by wrapping with a clean cloth.
6. Plug exhaust outlets to prevent entrance of moisture, bugs, dirt, etc.
7. Wipe entire unit. Coat parts susceptible to rust with a light film of grease or oil.
8. Provide a suitable cover for the entire units.
9. If battery is used, disconnect and follow standard battery storage procedure.

## HIGH TEMPERATURES

1. See that nothing obstructs air flow to-and-from the plant.
2. Keep cooling system clean.
3. Use correct SAE No. oil for temperature conditions.

## LOW TEMPERATURES

1. Use correct SAE No. oil for temperature conditions. Change oil only when engine is warm.
2. Use fresh fuel. Protect against moisture condensation.
3. Keep fuel system clean, and batteries in a well charged condition.
4. Partially restrict cool air flow but use care to avoid overheating.
5. Refer to Cummins manual for additional information.

## DUST AND DIRT

1. Keep plant clean. Keep cooling system free of dirt, etc.
2. Service air cleaners as frequently as necessary.
3. Change crankcase oil every 100 operating hours.
4. Keep oil and fuel in dust-tight containers.
5. Keep injector pump linkage clean.

## HIGH ALTITUDE

Ratings are based at sea level and a 60°F ambient temperature. Refer to Cummins manual for specific information on high altitudes and deration.

# GENERAL MAINTENANCE

## GENERAL

Follow a definite schedule of inspection and servicing, based on operating hours. Use the running time meter to keep a record of operation and servicing. Service periods outlined below are for normal service and operating conditions. For continuous duty, extreme temperature, etc., service more frequently. For infrequent use, light duty, etc., service periods can be lengthened accordingly.

## ENGINE

Refer to the Cummins engine manual (section 4-2) for details and periodic maintenance.

## AC GENERATOR

In addition to the engine service operations scheduled under the "C" column in the Cummins manual, check the condition of the AC generator. Service and maintenance are outlined in the next chapter.

## 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 at the proper level above the plates by adding distilled water.

## CONNECTIONS (Fuel, exhaust, etc.)

Operator should periodically make a complete visual inspection of the plant while running at rated load. Some of the things to check for are as follows:

1. Check all fuel and oil lines for possible leakage.
2. Inspect exhaust lines and mufflers for possible leakage and cracks.
3. Periodically drain moisture from condensation traps.
4. Inspect water lines and connections for leaks and security.
5. Inspect electrical wires for security.

## ENGINE SPEED

Generator frequency is a direct ratio to the engine speed. Engine speed is controlled by the built-in governor of the fuel injection pump. The original factory governor setting should not be disturbed. However, in case of pump repair, the governor can easily be reset.

1. See that the injection pump is properly timed to the engine. Refer to the Cummins engine manual.
2. Refer to instructions in Cummins manual for governor adjustment. Adjust engine speed to 1800-rpm for 60-cycle operation and 1500-rpm for 50-cycle operation. Use an accurate tachometer for determining engine speed settings, or a frequency meter connected to AC generator output terminals. Multiply frequency by 30 to obtain engine speed.

EXAMPLE: 30 x 61 (cycles) equals 1830-rpm

Check generator voltage. It may be necessary to make a slight re-adjustment of the speed setting to obtain the the preferred voltage at average load. A range of 1830 to 1890-rpm (61 to 63 cycles) should give the desired voltage.

## BATTERY CHARGING DC ALTERNATOR

The information in this section is presented for field use only. If a major repair should become necessary, contact your local authorized dealer.

Brush Assembly Removal:

1. Remove the three No. 10-24 screws which fasten voltage regulator to DC alternator. Remove regulator to gain access to phenolic cover, disconnecting leads as required.
2. Remove the two No. 8-32 screws on phenolic cover and lift out cover and gasket.
3. Pull brush assembly straight up and lift out.
4. For reassembly reverse procedure.

**NOTE:** *For remote mounted voltage regulators use only steps 2 and 3.*

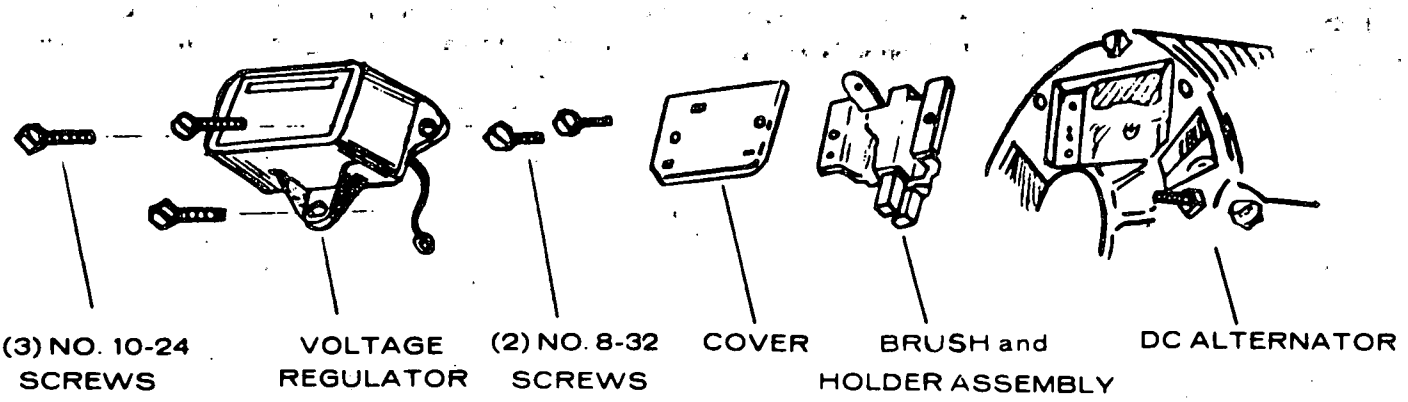



FIG. 14

## TROUBLE SHOOTING

| POSSIBLE CAUSE | REMEDY |
|---|---|
| **ALTERNATOR FAILS TO CHARGE OR PUTS OUT LOW OR UNSTEADY CHARGE RATE** | |
| Alternator belt loose. | Tighten belt. |
| Loose or dirty battery connections. | Clean and tighten. |
| Worn or defective brushes. | Replace brushes. |
| Faulty regulator. | Replace regulator. |
| **EXCESSIVE CHARGING RATE (Battery requires too frequent filling).** | |
| Loose connections on alternator and regulator. | Tighten connections. |
| Faulty regulator. | Replace regulator. |
| **NOISY ALTERNATOR** | |
| Defective or badly worn belt. | Replace belt. |
| Misaligned belt or pulley. | Align properly. |
| Loose pulley. | Tighten pulley. |
| Worn bearings. | Replace bearings. |

# AC GENERATOR AND EXCITER

**(Service and Maintenance)**

## GENERAL

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

## GENERATOR BEARING

The generator bearing is double sealed and lubricated for its life. It requires no servicing.

## INSPECTION AND CLEANING

When inspecting the rotating rectifier assembly make sure diodes are kept free of dust, dirt, and grease. An excess amount of foreign matter on these diodes and heat sinks will cause the diodes to overheat which will result in diode failure. Blowing the assembly out with filtered, compressed air periodically is a good practice.

Also check to see that the diodes are securely mounted and the leadwires are tight and in good condition.

## TESTING ROTATING RECTIFIER ASSEMBLY

Faulty diodes (either shorted or open) will cause abnormal generator operation. Check these individual diodes as follows:

1. Remove access cover from exciter end of the generator.
2. Isolate each of the six diodes before proceeding.
3. To check, use an ohmeter to measure the resistance in the individual diode. Reverse the ohmeter leads and repeat resistance measurement. A good diode should have a high resistance value for one measurement and a low measurement when leads are reversed. If diode is not in good condition, replace with one known to be in good condition.
4. Check all diodes in accordance with step 3.

## REPLACEMENT OF DIODES

When replacing defective diodes, the following steps should be taken:

1. Unsolder leadwires from the diode terminal.
2. Use proper size wrenches to hold the body of the diode while removing nut attaching the diode to the heat sink (bracket).
3. Push the diode free of its mounting hole in the heat sink.
4. Be sure new diode is installed in the same position (or direction) as defective diode. These parts have directional arrows marked on them for this reason.
5. Insert new diode into its mounting hole in the heat sink or bracket. Using nut and washer provided, secure diode, being careful not to allow it to turn while tightening nut.
6. Connect leadwires to appropriate terminals.
7. Solder the leadwires removed from defective diode to terminal of the new diode. Excessive heat can damage a diode. Use a needle nose pliers on the terminal between the soldering iron and the diode to absorb destructive heat.
8. Replace access cover.

## EXCITER THEORY

The exciter and voltage regulator operate together to control the AC generator voltage output. AC voltage is tapped from one leg of the AC generator and supplied to to the AC Power Input of the voltage regulator. The AC voltage is rectified to a DC voltage in the regulator and is applied to the coils of the rotating field. The exciter field current is raised or lowered according to the AC generator output. An increase in exciter field current increases generator output. The exciter's three phase output is applied to a full wave bridge rectifier which converts each phase into DC current. This DC current is then applied to the AC generator's rotor as field excitation current.

## TROUBLE SHOOTING

If the main generator will not build up voltage:

1. Check for AC input into the voltage regulator from generator.
2. Check for AC input to regulator from potential transformer T1.
3. Check for DC output from voltage regulator to exciter field.
4. Check for DC output from each leg of the bridge rectifier assembly to the main generator rotor.

If main generator output is low:

1. Check adjustment of voltage adjusting rheostat R1.
2. Check governor adjustment for high engine speed.

2. Check load application for possible over-load.
3. Check DC output from each leg of the bridge rectifier.
4. Check governor adjustment for low engine speed.

If main generator output is high:

1. Check setting of voltage adjusting rheostat R1.
2. Check governor adjustment for high engine speed.
3. Check load connections to main generator for correct terminal connections.

## DISASSEMBLY

The rotating exciter and transistorized voltage regulator do not require complete disassembly. Individual components can be removed after disconnecting the attached lead wires. Refer to the Parts List for the exploded view and part numbers. Refer to the wiring diagrams for lead wire connections.

## RECONNECTIBLE POSSIBILITIES

The "reconnectible generator" is designed to provide multiple output leads for conversions to different voltage outputs than the original nameplate rating.

The reconnectible generator will be of the "Y" connected type, of which there are two versions. Each version can be reconnected to deliver the alternate voltages shown in the following table.

### CAUTION

Reconnection, for a different output voltage than that shown on the plant nameplate, may involve control panel changes, sometimes of an extensive nature. For specific information, contact the factory. Give the COMPLETE information shown on the Onan nameplate, and indicate the desired NEW voltage.

**GENERATORS RECONNECTIBLE ONLY AS SHOWN**

| | 3-PHASE 4-WIRE RECONNECTION |
|---|---|
| 400UV14N1A | 120/208 volts<br>240/416 volts |
| 400UV16N1A | 139/240 volts<br>277/480 volts |

## MISCELLANEOUS GENERATOR TORQUES

| | |
|---|---|
| Diode, Lock Nut | 30 in-lb. |
| Lock Nut, Exciter | 450-500 ft lb. |
| Lock Nut, End Bearing | 150-200 ft lb. |
| Endbell to Support Bracket | 195-200 ft lb. |
| Blower and Drive Disc to Flywheel | 120-125 ft lb. |
| Drive Disc to Hub | 275-280 ft lb. |

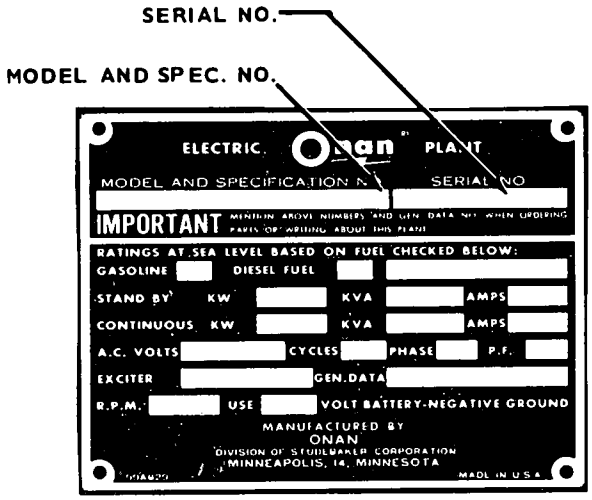
## PARALLEL OPERATION

If the plant is operated in parallel with another plant, special procedures are necessary to take. 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 equipped as such can usually be altered as necessary. Consult the factory for specific information.

# INSTRUCTIONS FOR ORDERING
# REPAIR PARTS

## ONAN PARTS

All parts in this list are *Onan* parts. For *Onan* parts or service, contact the dealer from who you purchased this equipment or your nearest authorized service station. To avoid errors or delay in filling your order, please refer to the *Onan nameplate* located on the upper right side of the flywheel housing and give the complete:

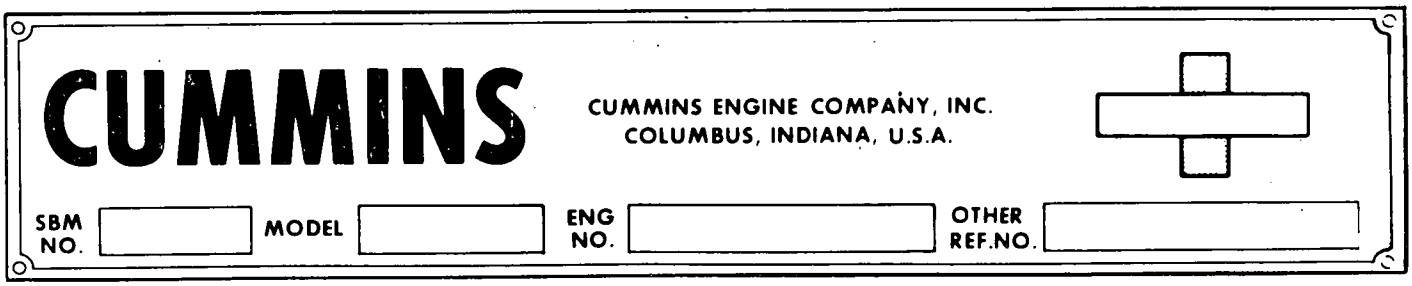



## CUMMINS PARTS

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 the 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

This catalog applies to the standard DFV plants as listed below. Powered by a Cummins VTA-1700-P700 engine (see Cummins Manual). Engine parts modified or added by *Onan* will be in this list and have *Onan* part numbers. These supersede similar parts listed in the Cummins manual. *Onan* parts are arranged in groups of related items and are identified by a reference. All parts illustrations are typical. Unless otherwise mentioned, parts are interchangeable. Right and left plant sides are determined by facing the front end of the engine.

### PLANT DATA TABLE

| MODEL AND SPEC NO. * | ELECTRICAL DATA | | | | |
|---|---|---|---|---|---|
| | WATTS*** | VOLTS | CYCLES | PHASE | WIRE |
| 400DFV-4R8/ | 400,000 | 120/208 | 60 | 3 | 4 |
| 400DFV-4XR8/ | 400,000 | 277/480 | 60 | 3 | 4 |
| 400DFV-7XR8/ | 400,000 | 240/416 | 60 | 3 | 4 |
| 400DFV-5DR8/ | 400,000 | 120/240 | 60 | 3 | 4 |
| 400DFV-6DR8/ | 400,000 | 240/480 | 60 | 3 | 4 |
| 400DFV-9XR8/ | 400,000 | 347/600 | 60 | 3 | 4 |
| 330DFV-57R8/ | 330,000 | 220/380 | 50 | 3 | 4 |

* - The Specification Letter advances (A to B, B to C, etc.) with manufacturing changes.
*** - Maximum rating is shown. Continuous rating also appears on nameplate.

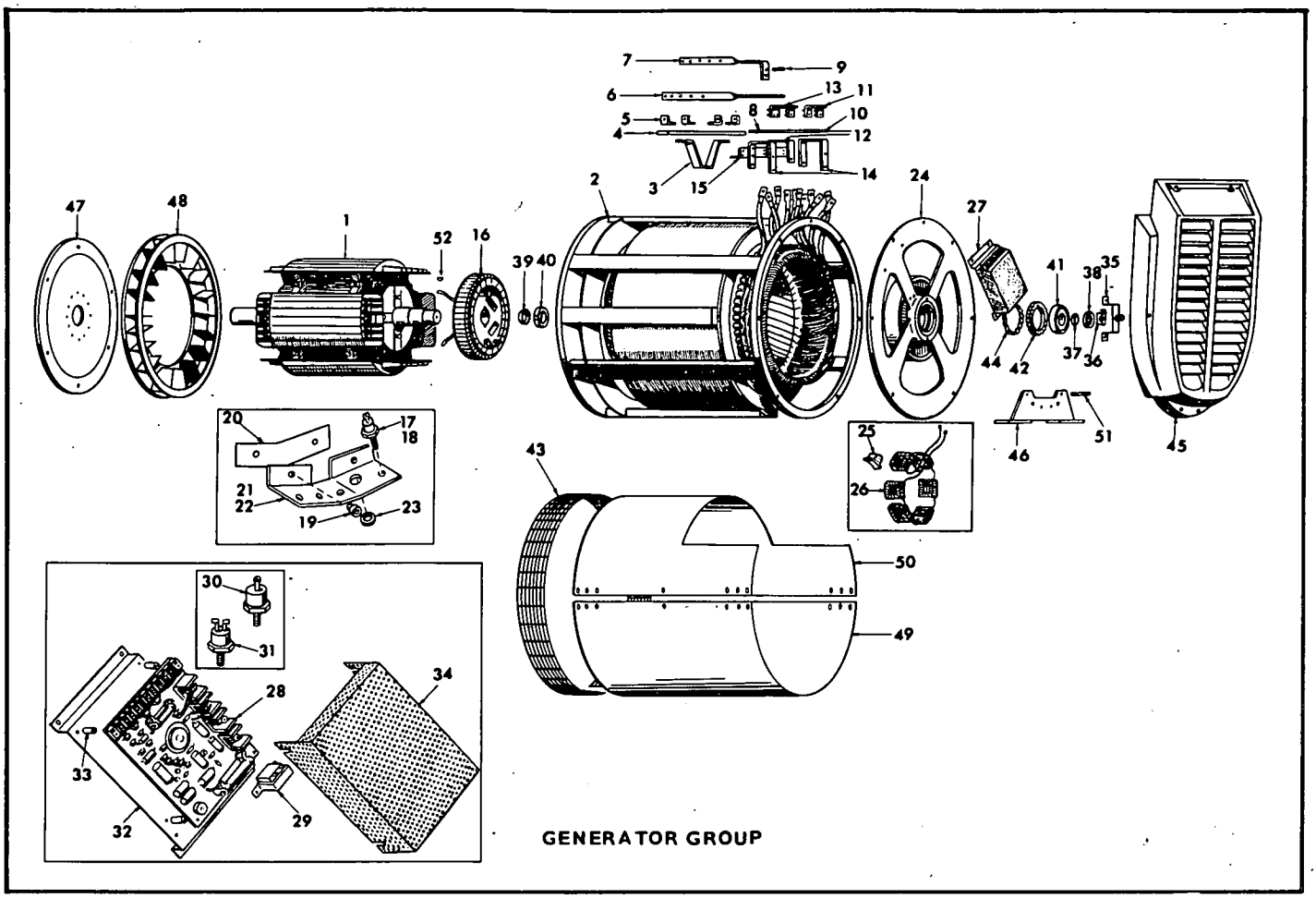
### REPLACEMENT ENGINE

| | | |
|---|---|---|
| 100P665 | 1 | Engine, Replacement (Cummins Engine Company Model V12-700IP) Spec A Only |
| 100P770 | 1 | Engine, Replacement (Cummins Engine Company Model VTA-1700-P700) Begin Spec B |

General Description:

Includes - Complete Cylinder Block, Fuel Pump (24-Volt); Air Cleaner; Fuel Filter; Oil Filter (Full Flow); Starter Motor (24-Volt); Governor (Woodward SG-5%); Fan Blades; Fan Belt; Fan Guard; Flywheel; Flywheel Housing; Water Pump; Engine Supports; Oil Pan; Oil Cooler; Exhaust Manifold; Alternator Belt tightner.

Excludes - Alternator; Alternator Mounting Brackets; Alternator Belt; Temperature Sender; Oil Pressure Sender.



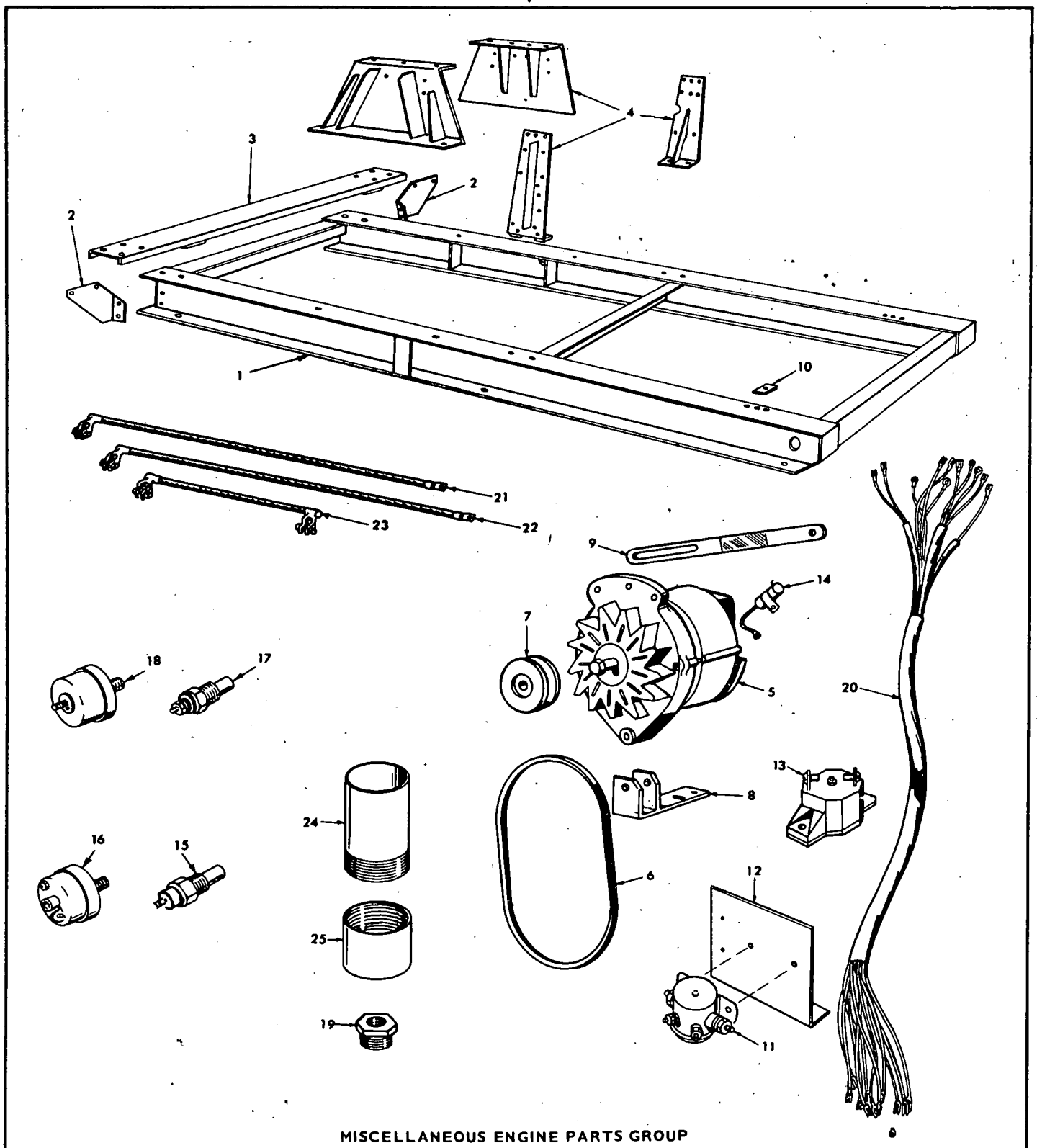

GENERATOR GROUP

| REF. NO. | PART NO. | QTY. USED | PARTS DESCRIPTION |
|---|---|---|---|
| 1 | * | 1 | Rotor Assy., Wound |
| 2 | * | 1 | Stator Assy., Wound |
| 3 | 232B1994 | 1 | Bracket, Bus Bar Support |
| 4 | 232B1997 | 1 | Board, Insulating-Bus Bar Support |
| 5 | 232A1992 | 4 | Bracket, Bus Bar |
| 6 | 232B1996 | 1 | Bar, Bus |
| 7 | 232B2001 | 3 | Bar, Bus |
| 8 | 232B1995 | 1 | Board, Insulating-Terminal |
| 9 | 520A693 | 16 | Stud, Terminal Board |
| 10 | 232B1998 | 1 | Board, Insulating- Terminal |
| 11 | 232A1990 | 3 | Bar, Bus |
| 12 | 232B2000 | 1 | Bracket, Terminal Board Mtg. |
| 13 | 232A1991 | 1 | Bar, Bus |
| 14 | 232B1999 | 2 | Bracket, Terminal Board Mounting |
| 15 | 315B302 | 1 | Shelf, Current Transformer |
| 16 | 201D1501 | 1 | Rotor Assy., Exciter (Wound) |
| 17 | 358C11 | 3 | Rectifier, Positive Stud |
| 18 | 358C12 | 3 | Rectifier, Negative Stud |
| 19 | 508A124 | 4 | Bushing, Shoulder - Heat Sink Mounting |
| 20 | 232A1985 | 2 | Insulator, Heat Sink Mounting |
| 21 | 363B25 | 1 | Sink, Heat - Rectifier (Positive) |
| 22 | 363B33 | 1 | Sink, Heat-Rectifier (Negative) |
| 23 | 508P93 | 2 | Grommet, Heat Sink |

| REF. NO. | PART NO. | QTY. USED | PARTS DESCRIPTION |
|---|---|---|---|
| 24 | * | 1 | Bell, End |
| 25 | 221B153 | 6 | Shoe, Pole - Exciter |
| 26 | 222B1693 | 1 | Coil Assy., Field (Set of 6 Coils) |
| 27 | 305C455 | 1 | Regulator, Voltage |
| 28 | 332D1160 | 1 | Board Assy., Printed Circuit |
| 29 | 315D301 | 1 | Inductor |
| 30 | RECTIFIER, VOLTAGE REGULATOR | | |
| | 358C15 | 1 | 300-Volt, 12-Ampere - Negative Base |
| | 358C16 | 1 | 300-Volt, 12-Ampere - Positive Base |
| 31 | 364-6 | 2 | Rectifier, Gate Controlled 300-Volt, 5.5 Ampere - Neg. Base |
| 32 | 305C454 | 1 | Chassis, Voltage Regulator |
| 33 | 305A458 | 4 | Spacer, Printed Circuit Board Mtg. |
| 34 | 305C456 | 1 | Cover, Voltage Regulator |
| 35 | 150A713 | 1 | Bracket, Overspeed Switch |
| 36 | * | 1 | Switch Assy., Overspeed |
| 37 | 510P93 | 1 | Lockwasher, Bearing |
| 38 | 510P91 | 1 | Locknut, Bearing |
| 39 | 510P94 | 1 | Lockwasher, Bearing |
| 40 | 510P92 | 1 | Locknut, Exciter |
| 41 | 510P90 | 1 | Bearing |
| 42 | 232B1923 | 1 | Ring, Bearing Holder |
| 43 | 234B272 | 1 | Cover, Fan |
| 44 | 232B1924 | 1 | Spring, Bearing Holder |
| 45 | 232E1973 | 1 | Grille, End Bell |

| REF. NO. | PART NO. | QTY. USED | PARTS DESCRIPTION |
|---|---|---|---|
| 46 | 232D1957 | 1 | Support, Generator End |
| 47 | 232C1880 | 1 | Disc, Rotor Drive |
| 48 | 205D76 | 1 | Fan, Generator |
| 49 | 234C279 | 1 | Band, Stator - Bottom |
| 50 | 234C289 | 1 | Band, Stator - Top |
| 51 | 520A692 | 2 | Stud, Generator Support |
| 52 | 515A162 | 1 | Key, Exciter Rotor |

* - Order by description, giving plant Model, Spec, and Serial Number from ONAN nameplate.



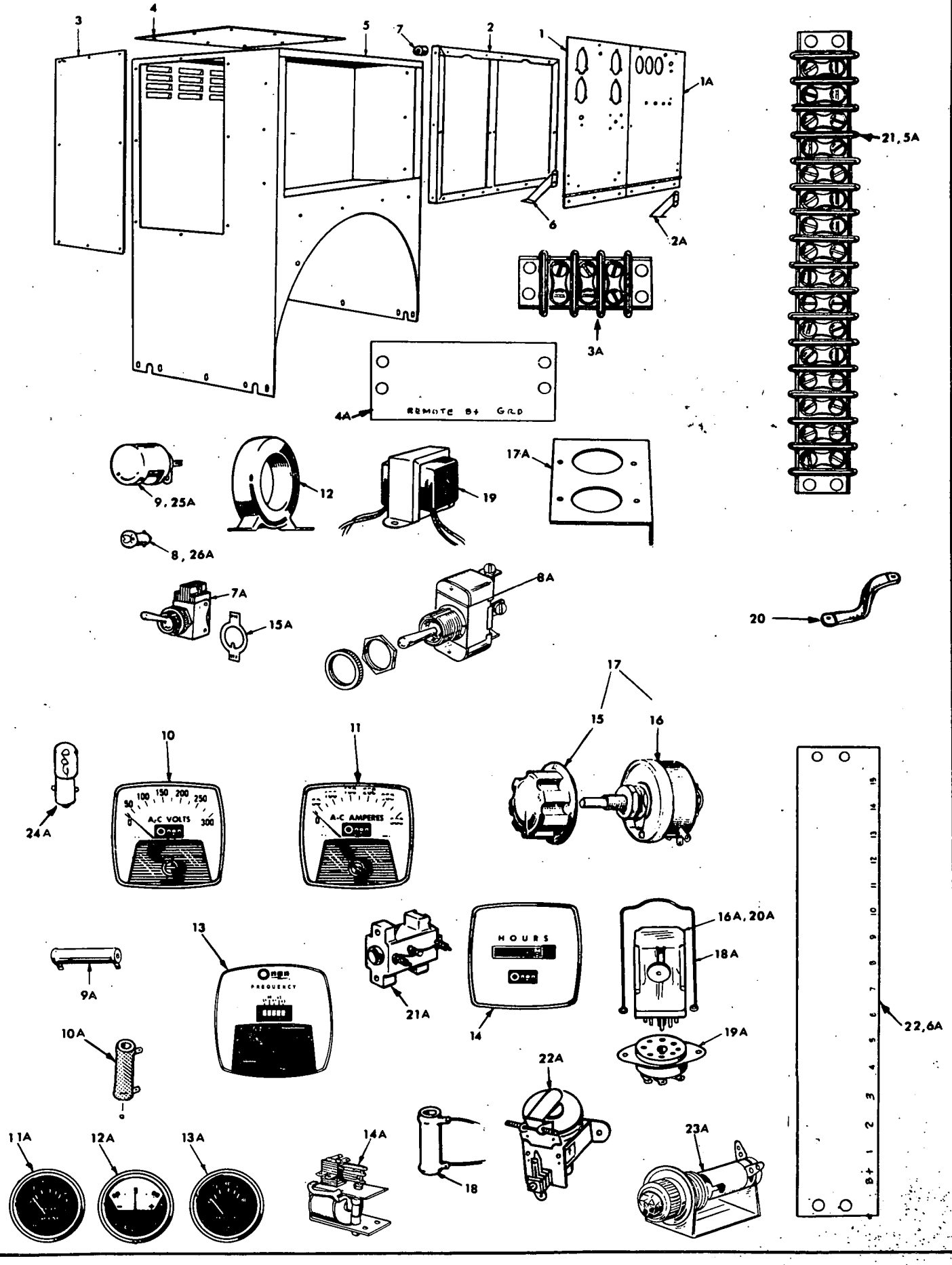

MISCELLANEOUS ENGINE PARTS GROUP

| REF. NO. | PART NO. | QTY. USED | PARTS DESCRIPTIONS |
|---|---|---|---|
| 1 | BASE, MOUNTING | | |
| | 403D803 | 1 | Spec A Only |
| | 403D867 | 1 | Begin Spec B |
| 2 | BRACE, RADIATOR MOUNTING | | |
| | 130C709 | 1 | Right Hand - Spec A Only |
| | 130C710 | 1 | Left Hand - Spec A Only |
| 3 | SUPPORT, RADIATOR | | |
| | 130D711 | 1 | Spec A Only |
| | 130D758 | 1 | Begin Spec B |
| 4 | BRACKET, ENGINE MOUNT | | |
| | 403C843 | 1 | Left Front - Spec A Only |
| | 403C844 | 1 | Right Front - Spec A Only |
| | 403C845 | 1 | Left Rear - Spec A Only |
| | 403C846 | 1 | Right Rear - Spec A Only |
| 5 | 191B688 | 1 | Alternator, Charge |
| 6 | 511-37 | 1 | Belt, Alternator Drive |
| 7 | 191C624 | 1 | Pulley, Alternator |
| 8 | 191B697 | 1 | Bracket, Alternator Mounting Mounting |
| 9 | 191A101 | 1 | Bracket, Alternator Adj. |
| 10 | SHIM, GENERATOR TO MOUNTING BASE | | |
| | 232A1817 | | .062" |
| | 232A1489 | AS | .0598" |
| | 232A1490 | REQ. | .0359" |

| REF. NO. | PART NO. | QTY. USED | PARTS DESCRIPTION |
|---|---|---|---|
| 11 | 307B61 | 1 | Solenoid, Starting |
| 12 | 306A220 | 1 | Bracket, Solenoid Mtg. |
| 13 | 320P240 | 1 | Breaker, Circuit - Starting Circuit |
| 14 | 312A58 | 1 | Condenser, Alternator |
| 15 | 309B178 | 1 | Switch, High-Temp. |
| 16 | 309B64 | 1 | Switch, Low - Oil Pressure |
| 17 | 193B100 | 1 | Sender, Water Temp. |
| 18 | 193A98 | 1 | Sender, Oil Pressure |
| 19 | BUSHING, REDUCER | | |
| | 505-21 | 1 | 3/4 to 1/2" |
| | 505-131 | 1 | 3/4 to 3/8" |
| 20 | 338C459 | 1 | Harness, Engine |
| 21 | 416A444 | 1 | Cable, Battery - Positive |
| 22 | 416A445 | 1 | Cable, Battery - Negative |
| 23 | 416A446 | 1 | Cable, Jumper |
| 24 | 505-456 | 1 | Nipple, Exhaust |
| 25 | 505P654 | 1 | Exhaust Coupling |

CONTROL GROUP (ENGINE INSTRUMENTS PORTION)

CONTROL GROUP (AC OUTPUT PORTION)



| REF. NO. | PART NO. | QTY. USED | PARTS DESCRIPTION |
|---|---|---|---|
| 1 | 301C2908 | 1 | Panel, Control |
| 2 | 301C2906 | 1 | Frame, Control Panel Mounting |
| 3 | 301A2905 | 2 | Plate, Control Box - Side |
| 4 | 301B2904 | 1 | Plate, Control Box - Top |
| 5 | 301D2903 | 1 | Box, Control |
| 6 | 301A1914 | 1 | Bracket, Panel Stop |
| 7 | 402A70 | 6 | Mount, Rubber - Control Box Frame |
| 8 | 322-81 | 1 | Lamp, Panel |
| 9 | 322-73 | 1 | Receptacle, Panel Lamp |
| 10 | VOLTMETER, AC (Check Voltmeter Scale - Select According to Rating) | | |
| | 302P421 | 1 | Scale Reads 0-300 |
| | 302P422 | 1 | Scale Reads 0-600 |
| 11 | AMMETER, AC (Check Ammeter Scale - Select According to Rating) | | |
| | 302P415 | 1 | Scale Reads 0-750 |
| | 302P641 | 1 | Scale Reads 0-1500 |
| 12 | TRANSFORMER, CURRENT (Check Transformer nameplate - Select According to Rating) | | |
| | 302B643 | 3 | Transformer Nameplate Reads 500/5 (Use with 0-500 Ammeter) |
| | 302B471 | 3 | Transformer Nameplate reads 750/5 (Use with 0-750 Ammeter) |
| | 302P644 | 3 | Transformer Nameplate reads 1500/5 (Use with 0-1500 Ammeter) |
| 13 | 302B213 | 1 | Meter Frequency |
| 14 | METER, RUNNING TIME | | |
| | 302P465 | 1 | 120/208 60-Cycle Plants |
| | 302P466 | 1 | 240/416-V, 60-Cycle Plants |
| | 302P467 | 1 | 277/480-V, 60-Cycle Plants |
| | 302P468 | 1 | 120/208-V, 50-Cycle Plants |
| | 302P469 | 1 | 240/416-V, 50-Cycle Plants |
| | 302P470 | 1 | 277/480-V, 50-Cycle Plants |
| 15 | 303-111 | 1 | Rheostat, Voltage Adjustment |
| 16 | 303P32 | 1 | Knob, Rheostat |
| 17 | 308B22 | 1 | Switch, Voltage & Current Selector |
| 18 | 304A305 | 1 | Resistor, Adjustable - 45,000-ohm, 10 - Watt (277/480 -V) |
| 19 | TRANSFORMER, POTENTIAL | | |
| | 315B32 | 1 | 120/208 - V Plants |
| | 315B36 | 1 | 277/480 - V Plants |
| | * | 1 | All except 120/208-V & 277/480-V |
| 20 | 337 - 44 | 1 | Strap, Ground |
| 21 | 332A795 | 1 | Block, Terminal (16 - Place) |
| 22 | 332A1134 | 1 | Strip, Terminal Block Marker (1 through 16) |
| 1A | 301C2907 | 1 | Panel, Control |
| 2A | 301A2951 | 1 | Bracket, Panel Stop |
| 3A | 332A611 | 1 | Block, Terminal |
| 4A | 332A762 | 1 | Strip, Term. Block Marker |
| 5A | 332A795 | 1 | Block, Terminal |
| 6A | 332A862 | 1 | Strip, Term. Block Marker |
| 7A | 308 - 2 | 1 | Switch, Panel Light |
| 8A | 308P138 | 1 | Switch, Run - Stop - Remote |
| 9A | 304A446 | 1 | Resistor, 150 - ohm, 10 - Watt |
| 10A | 304A66 | 1 | Resistor, 10 - ohm, 50 - Watt |
| 11A | 193B112 | 1 | Gage, Water Temp. |
| 12A | 302A61 | 1 | Ammeter, Charge |
| 13A | 193B111 | 1 | Gage, Oil Pressure |
| 14A | 307A655 | 1 | Relay, Shutdown |
| 15A | 308 - 3 | 1 | Plate, On - off Switch |
| 16A | 307P820 | 1 | Relay, Fuel Solenoid |
| 17A | 301A2393 | 1 | Bracket, Relay Mounting |
| 18A | 307P778 | 2 | Spring, Relay Holdown |
| 19A | 323 - 52 | 2 | Socket, Relay |
| 20A | 307P820 | 1 | Relay, Start Disconnect |
| 21A | 320B104 | 1 | Relay, Cranking |
| 22A | 307A899 | 1 | Relay, Oil Pressure |
| 23A | 322P69 | 1 | Receptacle, Emergency Lamp |
| 24A | 322 - 17 | 1 | Lamp, Emergency |
| 25A | 322P73 | 1 | Receptacle, Panel Lamp |
| 26A | 322 - 81 | 1 | Lamp, Panel |

* - Order by description, giving complete Model, Spec, and Serial number from ONAN nameplate.

# ONAN

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