INSTRUCTION MANUAL AND PARTS CATALOG

FOR

Onan®

ELECTRIC GENERATING PLANTS

WF
WK
SERIES

NATURAL GAS- DRIVEN

ONAN 1400 73RD AVENUE N.E. • MINNEAPOLIS, MINNESOTA 55432
A DIVISION OF STUDEBAKER CORPORATION
IN CANADA: Guelph, Ontario • N.Y. INTERNATIONAL OFFICE: Empire State Bldg.

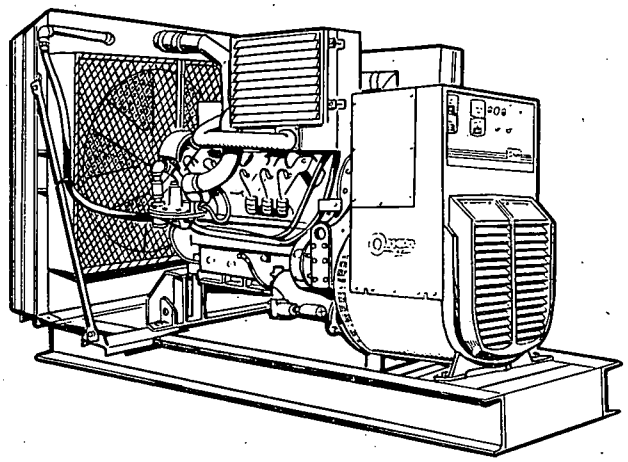
948- 304 2A70 Printed in U.S.A.

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 name-plate.

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

GENERAL INFORMATION



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INTRODUCTION

This manual includes instructions on the installation, operation, trouble-shooting and parts of the WF and WK series electric generating plants. Identify your model by referring to the *MODEL AND SPECIFICATION NO.* as shown on the ONAN nameplate. Electrical characteristics are shown on the lower portion of the nameplate.

How to interpret MODEL and SPEC NO.

400WK - 4XR/96A
1 2 3 4

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 is necessary to contact a dealer or the factory regarding the plant, 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 it's manufacturer.

Electric plants are given a complete running test under various load conditions and are thoroughly checked before leaving the factory. Inspect your plant closely for loose or missing parts and any damage which may have occured 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.

IMPORTANT...RETURN WARRANTY CARD ATTACHED TO UNIT

SPECIFICATIONS

	WF SERIES	WK SERIES
Dimensions (nominal)		
Height (inches)	94	94
Width (inches)	69	69
Length (inches)	143	143
Weight (approximate in pounds)	10,600	11,200
Number of cylinders	12	12
Displacement (cu. in.)	1616	1616
Bore (inches)	5-3/4	5-3/4
Stroke (inches)	5-3/16	5-3/16
BHP at 1,800 rpm (nominal)	700	700
Compression Ratio (natural gas)	10: 1	10: 1
Manufacturer (engine)	Waukesha	Waukesha
Series	L1616-GSIU	L1616-GSIU
Governor Regulation %	5	5
Nominal Battery Voltage	24	24
Battery Size		
SAE Group 8D (12 volts)	Two	Two
Amp/Hr. SAE 20 hour Nominal	225	225
Solenoid Shift Starter	Yes	Yes
Alternator Cooling Air (CFM at 1,800 rpm)	3000	3000
Output Rated At Power Factor Load	0.8	0.8
Rating (Output in Watts)		
50 cycle AC intermittent service	290,000	350,000
50 cycle AC continuous service	250,000	290,000
60 cycle AC intermittent service	350,000	400,000
60 cycle AC continuous service	300,000	330,000
AC Voltage Regulation in ±%	2	2
AC Frequency Regulation in %	5	5
Revolving Field Alternator (4 pole)	Yes	Yes
Rotating Rectifier Exciter	Yes	Yes
Cooling System Capacity including: Radiator (gallons)	51	51
Engine Oil Capacity (gallons)	25	25
Exhaust Connection (inches pipe thread)	8	8
Air Cleaners (Dry type)	Yes	Yes
Closed Crankcase Breather System	No	No
RPM (60 cycle)	1800	1800
RPM (50 cycle)	1500	1500
Battery Charging Alternator	Yes	Yes
Turbocharger	Yes	Yes

DESCRIPTION

GENERAL

A WF or WK Onan electric generating plant is a complete unit consisting of a natural gas engine driving a self-excited AC generator, and such controls and accessories as specified by the purchaser.

ENGINE

The engine is a Waukesha basic model L1616GSIU as described in the Waukesha manual. The specific engine used may have variations due to some of the optional equipment available as specified by the plant purchaser.

AC GENERATOR

The complete generator consists of a brushless, 4 pole revolving field 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.

EXCITER AND REGULATOR THEORY (FIGURE 1)

The exciter and solid-state voltage regulator operate together to control the alternator's output voltage. A portion of the AC output voltage that is generated in the stator is supplied to the power input of the voltage regulator. The voltage regulator compares this voltage with a built-in reference voltage. It then raises or lowers this voltage as necessary, and rectifies it to a DC voltage. This DC voltage is applied to the stationary field of the exciter which energizes the exciter's armature and produces three phase AC voltage. It is then supplied to a full wave bridge rectifier which converts it to DC. This DC voltage is then applied to the main alternator as field excitation current.

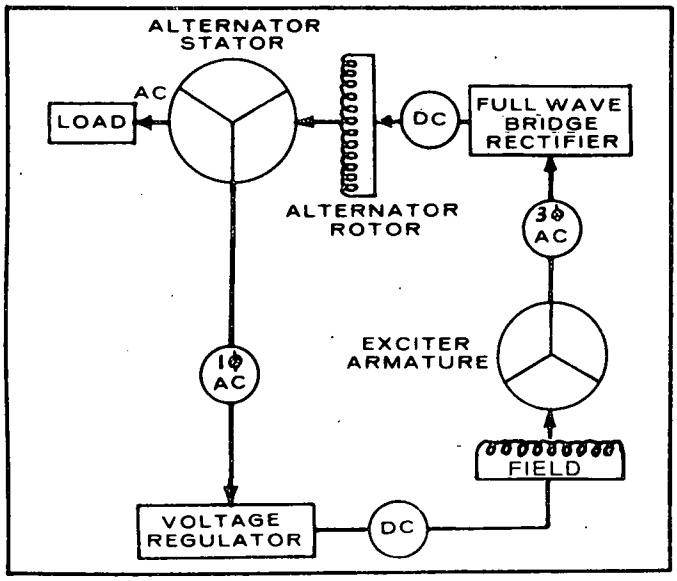


FIGURE 1. EXCITER AND REGULATOR SCHEMATIC

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 again be started.

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 emergency latch relay is energized, shutting down the plant.

Low Oil Pressure Cut-Out: Allows oil pressure buildup while starting and shuts down the plant through the emergency latch 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.

Voltmeter-Ammeter Selector Switch: Selects the phase of the generator 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 30rpm 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.

OPTIONAL EQUIPMENT

The WF or WK electric generating plant is adaptable to automatic load transfer equipment, manual/automatic paralleling equipment and switchboards. Signal lights and alarms can be connected to warn the operator of improper operation.

Cooling system options include city water cooling (heat exchanger or standpipe), remote mounting radiators, radiator air duct adapters and flexible coolant lines.

Fuel system options include regulators, filters, fuel solenoids flexible and rigid fuel lines, and fuel shut-off valves.

INSTALLATION

GENERAL

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.

Installation points to consider include:

1. Adequate engine cooling air.
2. Adequate generator cooling air.
3. Adequate fresh induction air.
4. Discharge of circulated air.
5. Discharge of exhaust gases.
6. Electrical connections.
7. Fuel connections.
8. Water connections.
9. Accessibility for operation.
10. Accessibility for servicing.
11. Level mounting surface.

LOCATION

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

MOUNTING

Plants are mounted on a rigid skid base which provides proper support. For convenience in draining crankcase oil and general servicing, mount plants 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 floor may be necessary. Bolting down is optional for stationary installations.

NOTE: *Alignment of the generator to the engine is very important. Refer to following instructions.*

CAUTION *The generator support must be aligned to the skid base to prevent premature generator bearing failure. Failure to do so could void the warranty. Align the generator support to the skid base according to the following instructions.*

1. Set the plant on its mounting foundation using vibration isolators between skid base and foundation (Figure 2). Secure the skid base to the mounting foundation. Remove the two mounting bolts and shims which secure the generator support to the skid base. Use the mounting bolts as jackscrews by moving the mounting bolts to the threaded holes.

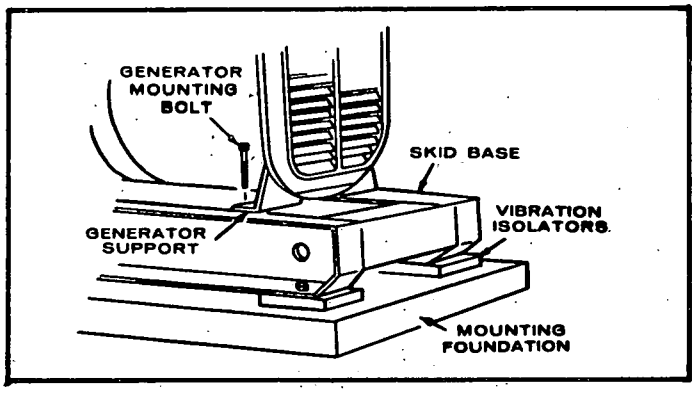


FIGURE 2.

2. Remove the tension from the jackscrews and allow generator to hang free. Using a feeler gauge or a dial indicator, measure the clearance from the top surface of the skid base to each generator support mounting surface (Figure 3). To this measured clearance, add .035 inches to each side of the skid base. This total clearance will determine the amount of shims required.

NOTE: *The clearance may be different for each side of the skid base. If there is a great difference, loosen the generator support and realign.*

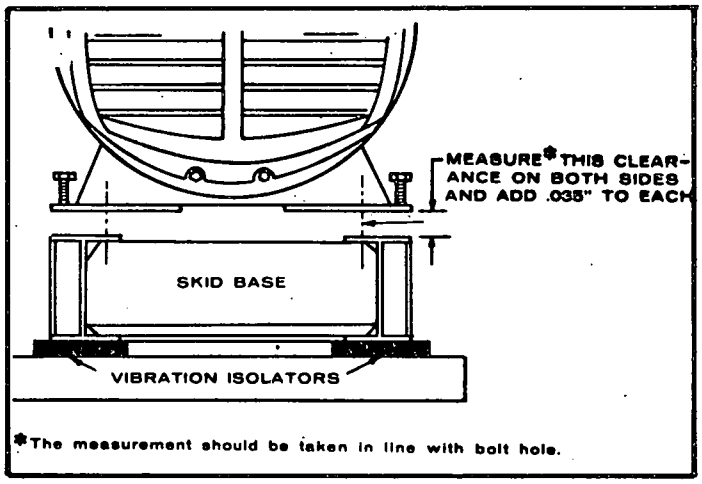


FIGURE 3.

3. After determining the proper clearance for each side of the skid base, turn jackscrews in the threaded holes to allow a clearance for placing the shims between skid base and generator support. (Figure 4).

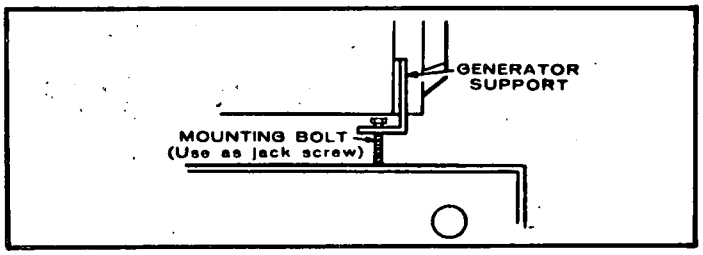


FIGURE 4.

Lower generator (using jackscrews) and allow to rest on shims. Recheck the total generator clearance, base to support; it must equal the base to support clearance plus the .035 in.

4. Remove the jackscrews and install as mounting bolts through generator support, shims and skid base. Secure and lock the mounting bolts in place (Figure 5).

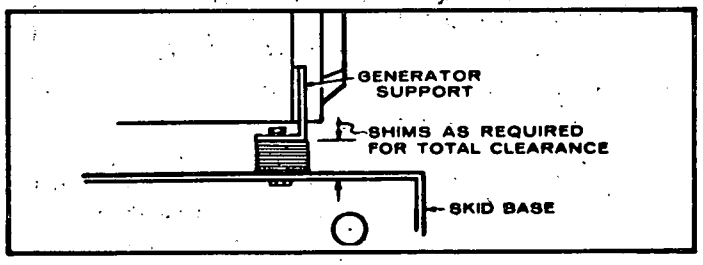


FIGURE 5.

NOTE: *Table 1 shows shim sizes.*

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 2-½

TABLE I

VENTILATION

Plants create considerable 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 (generator end) 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. Locate the cooling air outlet in front of the radiator and as close as is practical. The opening size should be at least as large as the radiator area. Use duct of canvas or sheet metal between the radiator and the air outlet opening. The duct prevents recirculation of heated air.

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

On city water cooled plants the conventional radiator is not used. 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, install a duct of equal or larger area to remove the heated air from the generator air outlet to the outside atmosphere. A larger, well ventilated compartment or room does not require a hot air duct.

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

CITY WATER COOLING

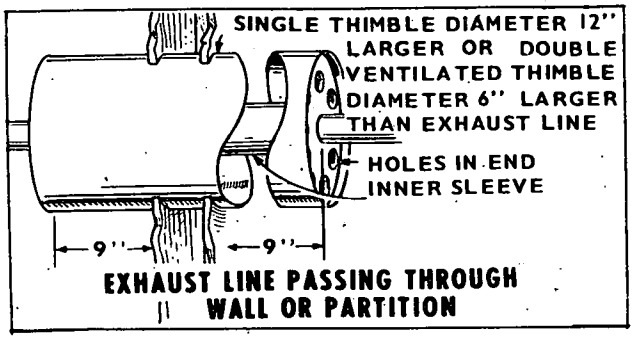
An optional method of engine cooling, in place of the conventional radiator and fan, uses a constant pressurized water supply. This we refer to as CITY WATER COOLING. There are two varieties of city water cooling: the HEAT EXCHANGER SYSTEM and the STANDPIPE SYSTEM.

The HEAT EXCHANGER provides for a "closed" engine cooling system. Engine coolant flows 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.

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 other impurities.

On both systems use flexible pipe for connecting water supply and outlet flow pipes to engine. Pipe the outlet flow to a convenient drain. Install an electric solenoid valve and a rate of flow valve in the water supply line. The electric solenoid valve opens and allows water flow through the system only when the plant operates. The rate of flow valve, either automatic or manual, provides for the proper flow rate to the engine. Adjust the flow to maintain water temperature between 165° and 195° while viewing the water temperature gauge.

Important: *Before filling cooling system check all hardware for security. This includes hose clamps, capscrews, fittings and connections. Use flexible coolant lines with heat exchanger, standpipe or remote mounting radiator.*



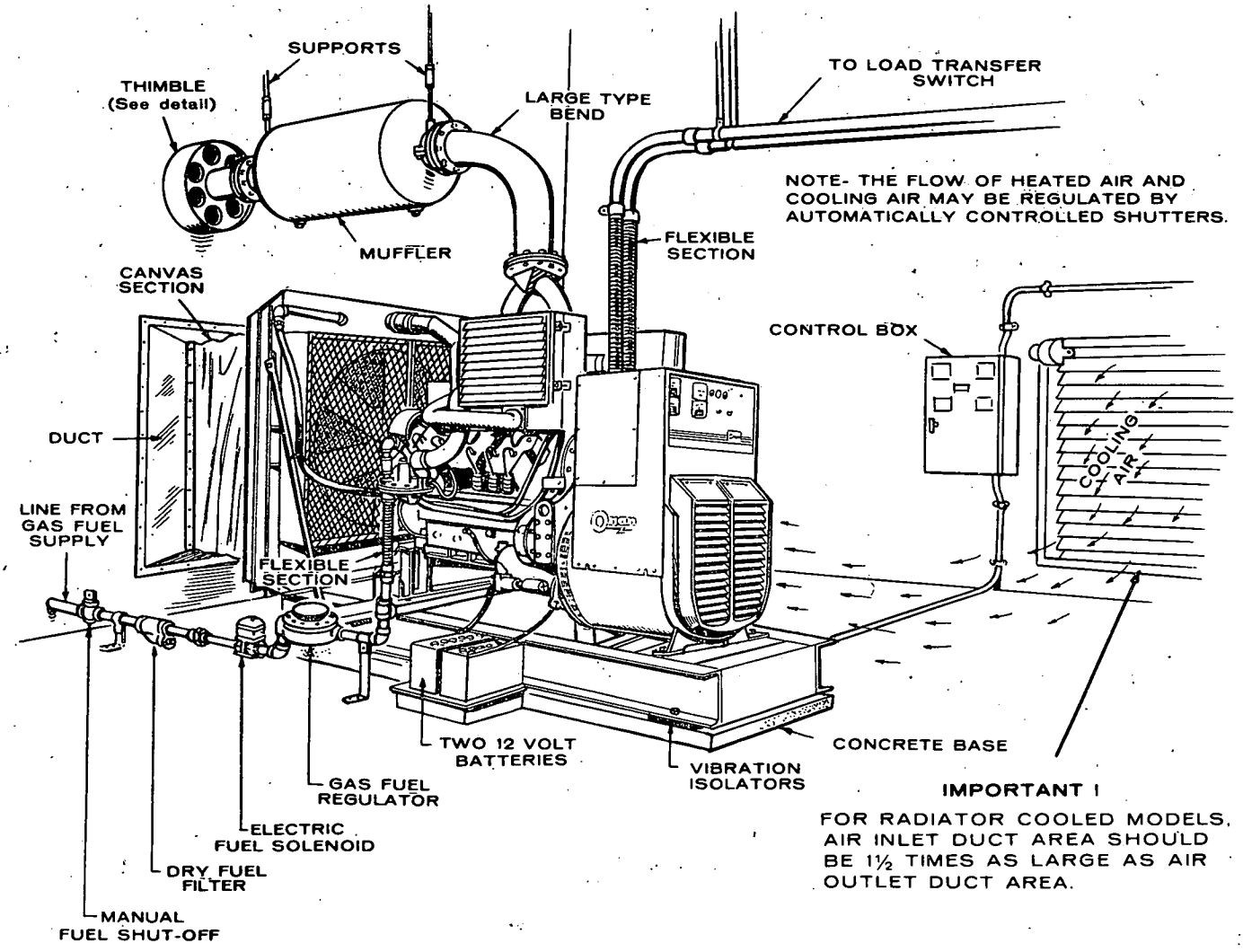


FIGURE 6. A TYPICAL INSTALLATION

EXHAUST

WARNING *Exhaust gases are deadly!*

Pipe exhaust gases outside any enclosure (Figure 6). Use pipe at least as large as the 8″ 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 (FIGURE 6)

Use 3 inch pipe for main fuel supply line. Install a shut-off valve and a dry fuel filter in main supply line. An electric fuel solenoid should be installed to open fuel supply when plant is energized. Install a line pressure regulator between solenoid and pressure reduction valves. Use flexible lines between "tee" and engine. DO NOT USE RUBBER HOSE. Provide proper support for entire installation. Refer to Waukesha manual for additional information.

BATTERY (FIGURE 7)

Starting the plant requires a 24 volt battery current. 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 the battery positive cable to the starter solenoid. 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, connect a separate trickle charger. 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 phase 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 an 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 No. 18 wire up to 900 feet (Figure 8).

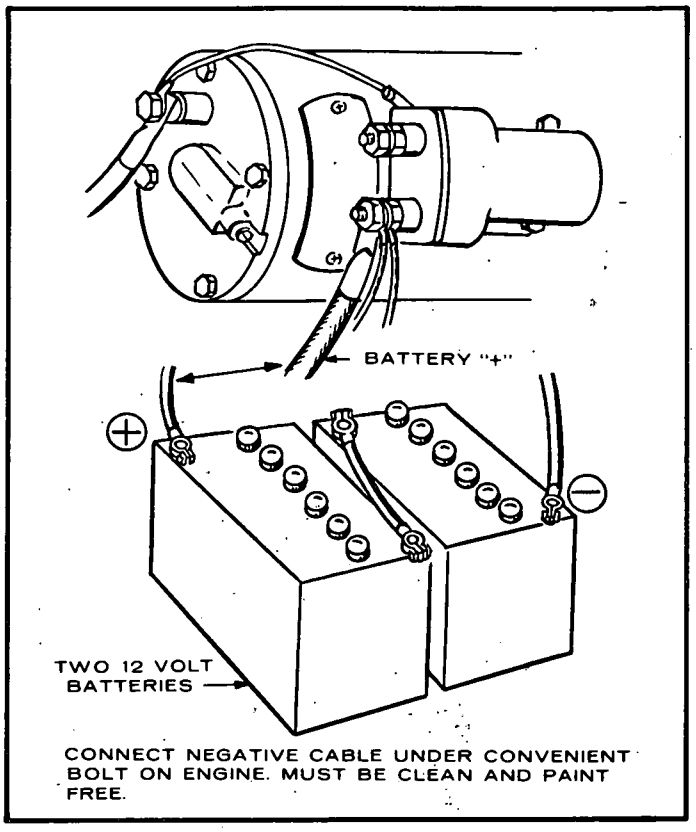


FIGURE 7. BATTERY CONNECTION

CONNECTING LOAD WIRES

Most local regulations require that a licensed electrician make the wiring connections 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, install a load transfer switch (Figure 9). The transfer control automatically starts the standby plant on interruption of normal power and transfers the load circuits when the plant reaches proper speed and voltage. When normal power is restored, the control automatically transfers the load back to the line and stops the plant.

Instructions for connecting an automatic load transfer

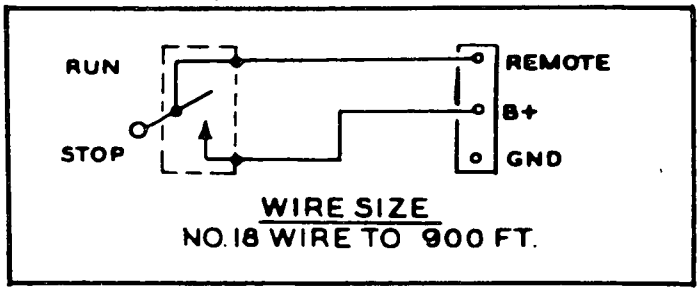


FIGURE 8. REMOTE STARTING

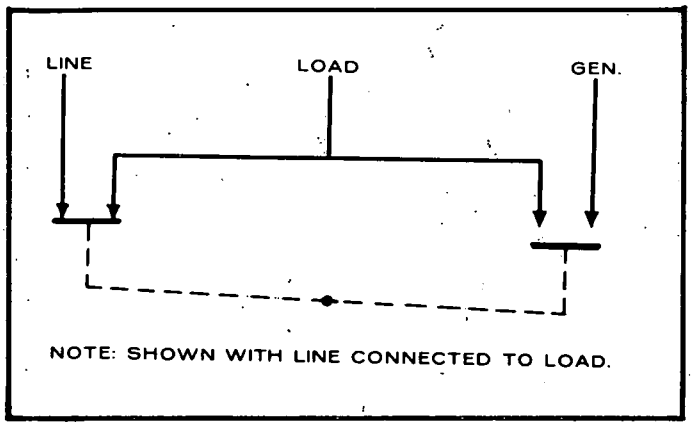


FIGURE 9. LOAD TRANSFER SWITCH

control are included with such equipment. Refer to the output control wiring diagram furnished. Each generator lead is marked according to the wiring diagram.

CAUTION *Personnel connecting the generator and any such auxiliary equipment must be fully qualified and understand the problems of balancing the circuits, grounding the plant, etc.*

Connect load wires directly to the large terminal bars provided (Figure 10). Some plants are "reconnectible" for different voltages and have extra leads. These are preconnected according to the nameplate ratings.

CAUTION *Reconnection, for a different output voltage then 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.*

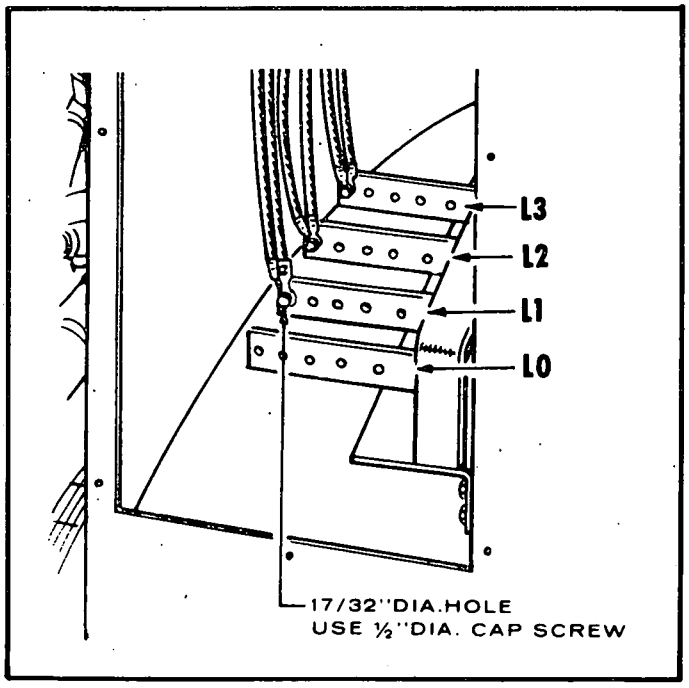


FIGURE 10. LOAD WIRE CONNECTIONS

3 Phase, 3 Wire Plant (Figure 11): No terminal is grounded. For three-phase current, connect separate load wires to each plant terminal L1, L2, and L3.

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: L1 - L2, L1 - L3, and L2 - L3. The load connected to any one single phase circuit must not be greater than 1/3 the rated capacity of the plant.

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 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 overloading of the generator will result.

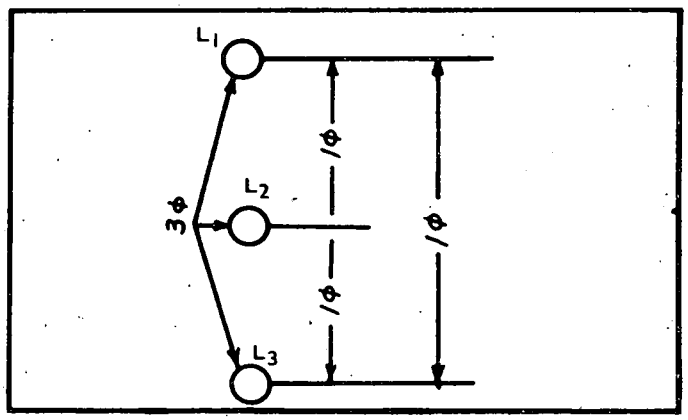


FIGURE 11. THREE PHASE, THREE WIRE

3 Phase, 4 Wire, Wye Connected Plant (Figure 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 L0 is grounded. For single phase current, connect the neutral (white) load wire to the L0 terminal. Connect the "hot" (black) load wire to any one of the other three terminals – L1, L2, or L3. 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 L1, L2, and L3. If phase

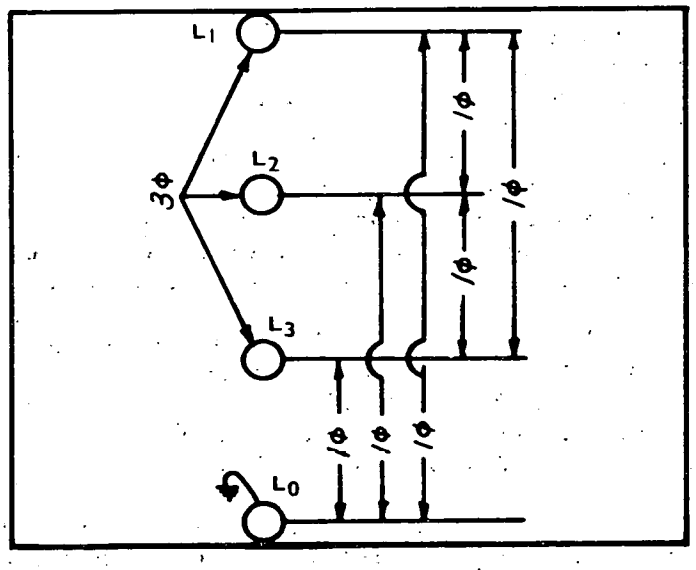


FIGURE 12. THREE PHASE, FOUR WIRE

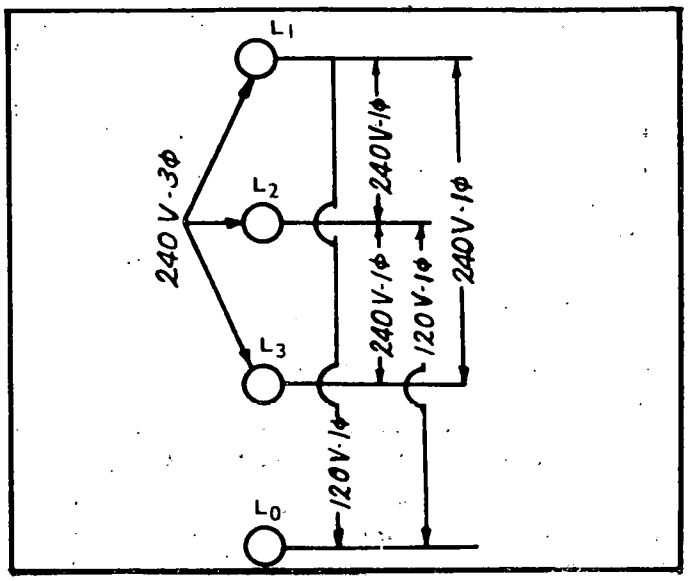


FIGURE 13. THREE PHASE, FOUR WIRE, DELTA CONNECTION

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 using single phase and three phase current at the same time, use care to properly balance the single phase load.

120/240 Volt, 3 Phase, 4 Wire Delta Connected Plant (Figure 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, connect the three load wires to the three plant terminals L1, L2, and L3 – one wire to each terminal. For 3 phase operation the L0 terminal is not used.

For 120/240 volt, 1 Phase, 3 wire operation, terminals L1 and L2 are the "hot" terminals. The L0 terminal is the neutral, which can be grounded if required. For 120 volt service, connect the "hot" (black) load wire to either the L1 or L2 terminal. Connect the neutral (white) wire to the L0 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.

OPERATION

CRANKCASE OIL

Refer to the Waukesha manual. Note that for average operating conditions, MIL-L-2104B 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 25 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.

CAUTION *Engine oil and coolant drained. Rust inhibiting oil is applied to cylinders for shipping. Before operating: Fill crankcase with oil. Fill cooling system with coolant.*

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 Waukesha manual for additional information.

CAUTION *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. Use a jumper from the 24 volt battery supply to the electric solenoid.*

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

FUEL

Refer to the Waukesha manual for fuel 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 in the Waukesha 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 40-50 psi at operating temperature.

The water temperature gauge indicates the coolant temperature during operation. Normal operating temperature is approximately 160-180°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 2 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

If the plant is city water (pressure) cooled, but without the optional flow (Powers or Marsh) 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 shutdown 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 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 skid 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 one 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. 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 will 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 spark plug. Pour one ounce (two tablespoons) of rust inhibitor (or SAE #50 oil) into each cylinder. Install spark plug.
4. Service air cleaners as outlined in Waukesha manual.
5. Clean throttle 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. If battery is used, disconnect and follow standard battery storage procedure.
9. Provide a suitable cover for the entire unit.

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 Waukesha manual for additional information.

DUST AND DIRT

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

HIGH ALTITUDE

Ratings apply to altitudes up to 1000 feet, standard cooling, normal ambients and with natural gas fuel. Consult factory or nearest authorized Onan distributor for operating characteristics under other conditions.

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 Waukesha manual for details and periodic maintenance.

AC GENERATOR
AC generator service and maintenance is 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.

BATTERY CHARGING DC ALTERNATOR
This information is presented for field use only. If a major repair is needed, 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.

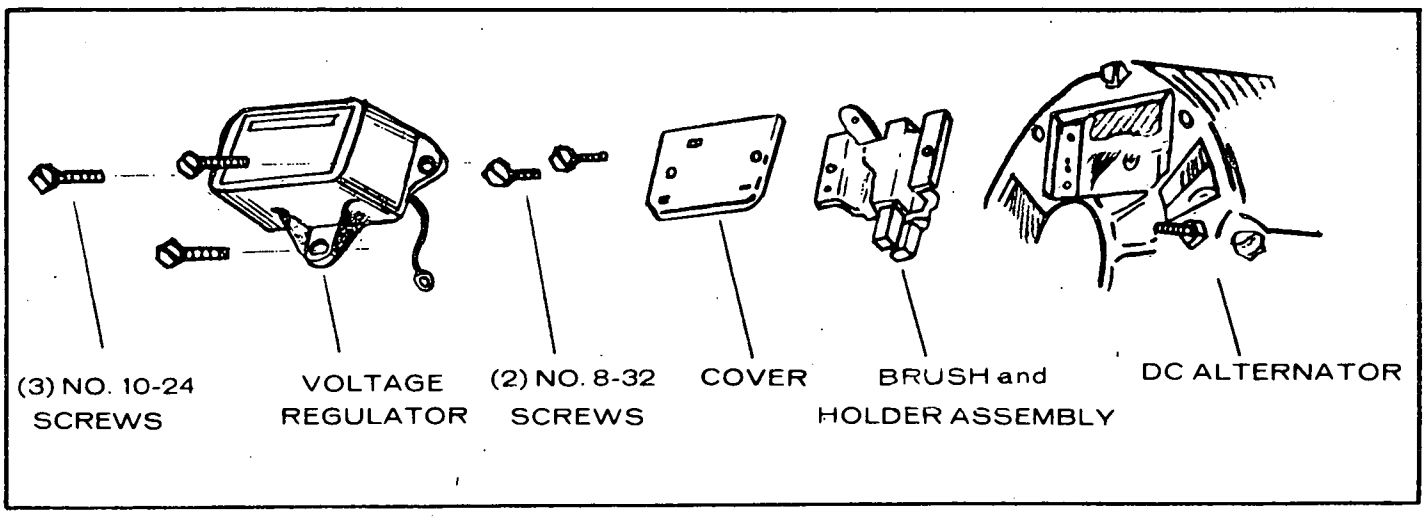
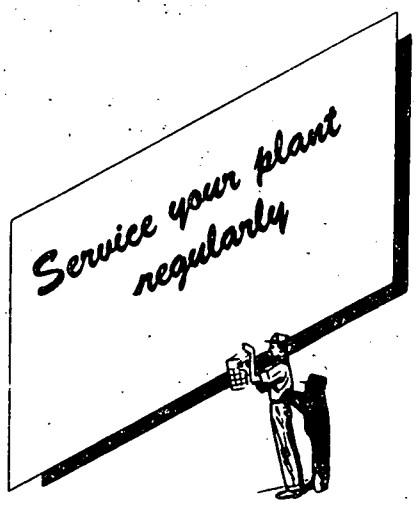


FIGURE 14. DC ALTERNATOR DISASSEMBLY


Service your plant
regularly

AC GENERATOR MAINTENANCE

GENERAL

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

ALTERNATOR BEARING

This bearing is double-sealed and lubricated for its life. It requires no servicing. The outside bearing retainer is electrically insulated from the end bell to prevent shaft currents.

INSPECTION AND CLEANING

When inspecting the rotating rectifier assembly, make sure diodes are kept free of dust, dirt and grease. Excessive foreign matter on these diodes and heat sinks will cause the diodes to overheat and will result in their failure. Blow the assembly out, periodically, with filtered, low pressure air. Also check to see that diodes and leadwires are properly torqued. The diodes should be torqued to 30 in. lb. or finger tight plus a quarter turn.

Inspect the voltage regulator assembly for loose parts and connections. Blow out dust, etc. with filtered, low pressure air.

TESTING ROTATING RECTIFIER ASSEMBLY

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

1. Remove access cover from exciter end of the generator.
2. Isolate each diode by disconnecting one end from its connection point.
3. To check, use an ohmmeter (Figure 15) to measure the resistance in the individual diode. Reverse the ohmmeter leads and repeat resistance measurement. A good diode should have a high resistance value for one measurement and a low value 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. Use proper size wrenches to hold the body of the diode while removing nut attaching the diode to the heat sink (bracket).
2. Push the diode free of its mounting hole in the heat sink.
3. 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.
4. Insert new diode into its mounting hole in the heat

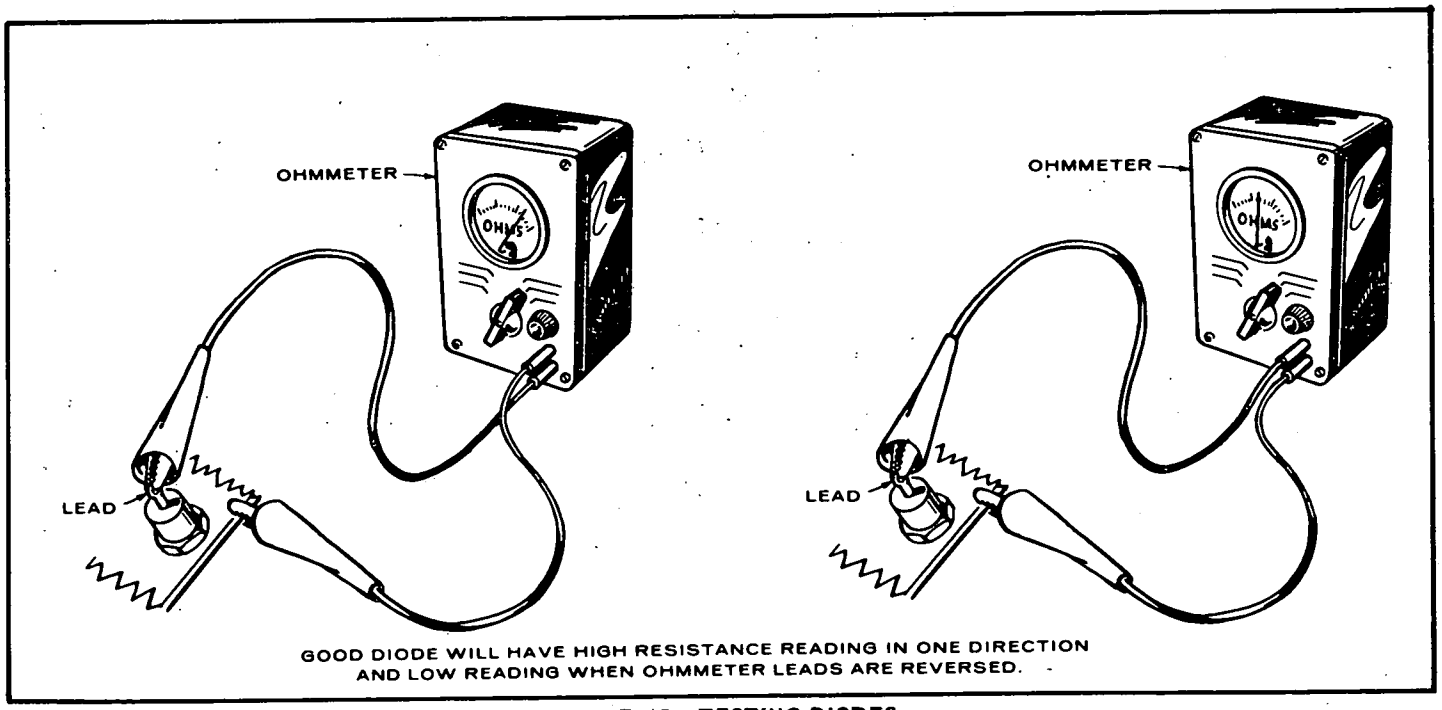


FIGURE 15. TESTING DIODES

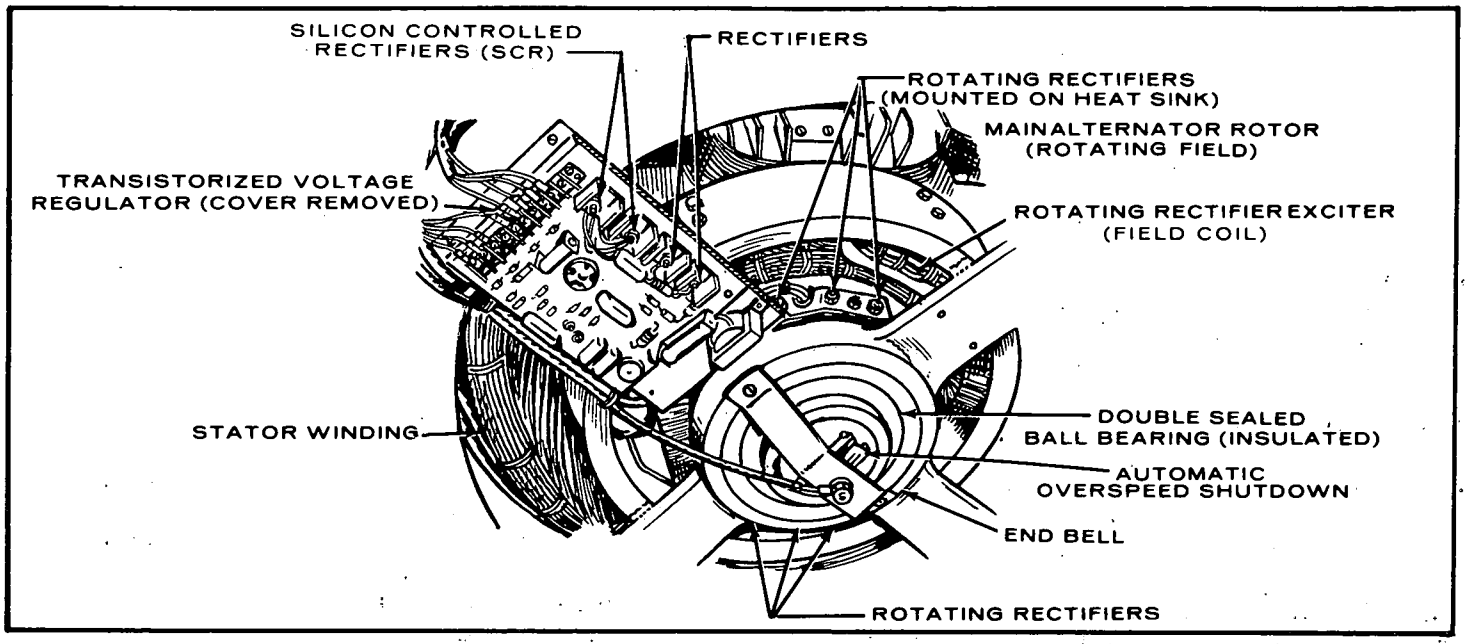


FIGURE 16. ALTERNATOR END VIEW

sink or bracket. Using nut and washer provided, secure diode, being careful not to allow it to turn while tightening nut. Do not over-torque.

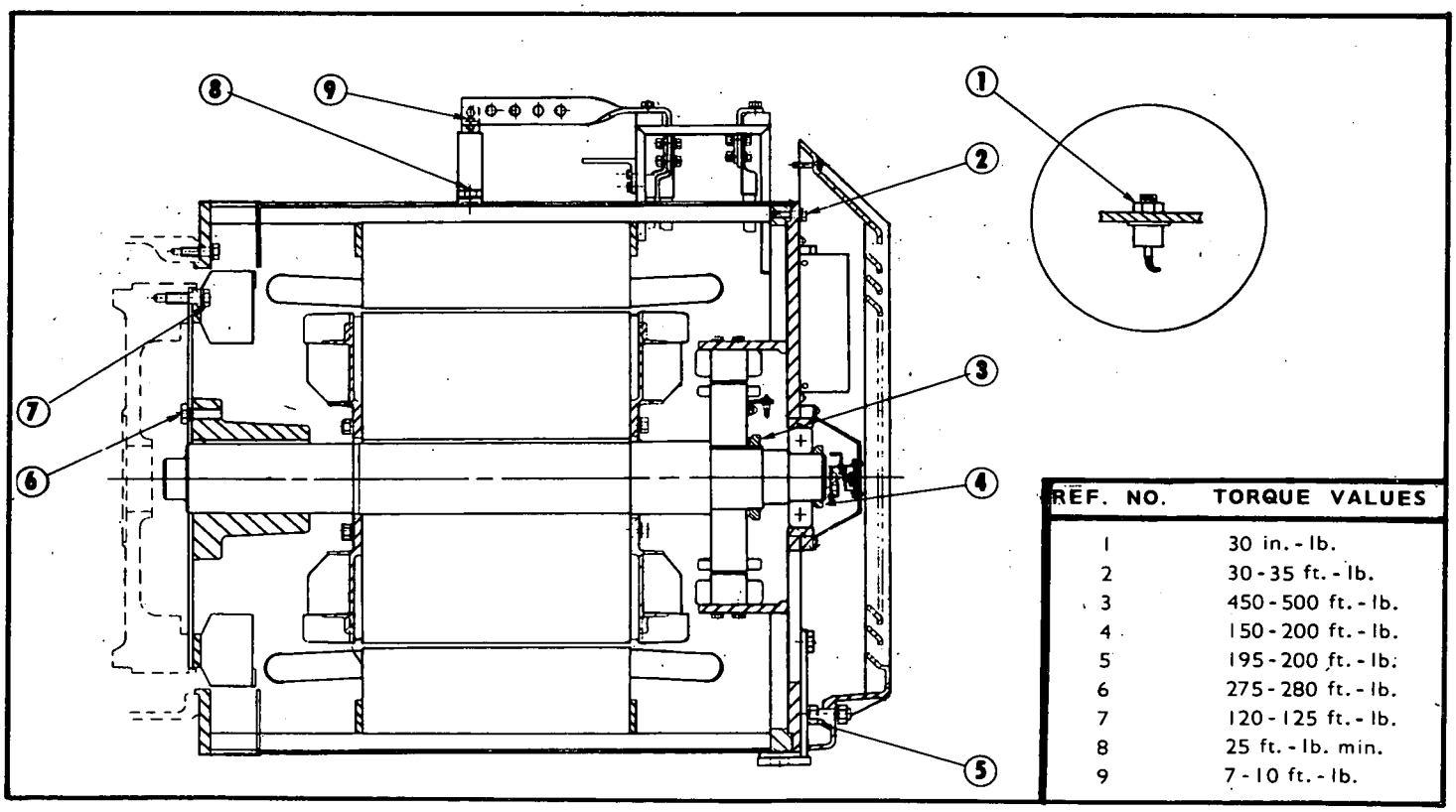
5. Connect leadwires to appropriate terminals.
6. Replace access cover.

DISASSEMBLY

Remove 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. Figure 16 shows alternator with end grille removed.

PARALLEL OPERATION

Parallel operation involves making many changes in the control system. Some of these changes are; special control panel with synchronizing lights, governor speed control, cross current compensating circuit, etc. Consult the factory for specific information.



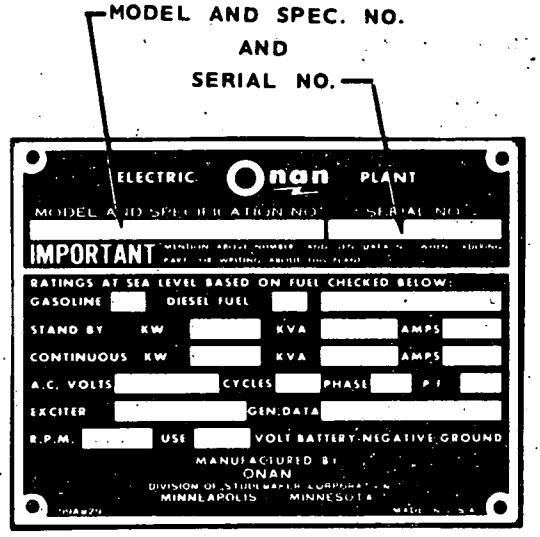
REF. NO.	TORQUE VALUES
1	30 in.-lb.
2	30-35 ft.-lb.
3	450-500 ft.-lb.
4	150-200 ft.-lb.
5	195-200 ft.-lb.
6	275-280 ft.-lb.
7	120-125 ft.-lb.
8	25 ft.-lb. min.
9	7-10 ft.-lb.

FIGURE 17. ALTERNATOR TORQUES

PARTS CATALOG

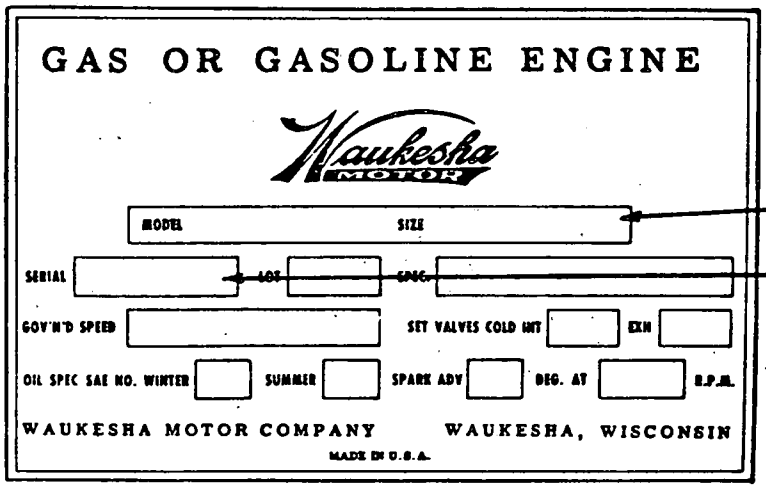
ONAN PARTS

All parts in this list are *Onan* parts. For *Onan* parts or service, contact the dealer from whom you purchased this equipment or 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:



WAUKESHA PARTS

All Waukesha parts must be ordered from the Waukesha Motor Company of Waukesha, Wisconsin, or their nearest authorized distributor. Refer to the Waukesha Engine flywheel housing. When ordering parts, always supply Waukesha with the following nameplate information:



MODEL, SIZE
AND
SERIAL NUMBER
shown on the engine nameplate.

This catalog applies to the standard WF and WK plants as listed below. Powered by a Waukesha L1616-GSIU engine (see Waukesha 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 Waukesha manual. Onan parts are arranged in groups of related items and are identified by a reference. All parts illustrations are typical. Using the Model and Spec No. from the Onan plant nameplate, select Parts Key No. (1, 2, etc., in the last column) that applies to your plant Model and Spec No. This Parts Key No. represents parts that differ between models. 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					PARTS KEY NO.
	WATTS	VOLTS	CYCLES	PHASE	WIRE	
290.0WF-54R/	290,000	120/208	50	3	4	1
290.0WF-54XR/	290,000	277/480	50	3	4	
290.0WF-55DR/	290,000	120/240	50	3	4	
290.0WF-57R/	290,000	220/380	50	3	4	
290.0WF-59XR/	290,000	347/600	50	3	4	
350.0WF-4R/	350,000	120/208	60	3	4	
350.0WF-4XR/	350,000	277/480	60	3	4	
350.0WF-5DR/	350,000	120/240	60	3	4	
350.0WF-9XR/	350,000	347/600	60	3	4	
330.0WK-54R/	330,000	120/208	50	3	4	2
330.0WK-54XR/	330,000	277/480	50	3	4	
330.0WK-55DR/	330,000	120/240	50	3	4	
330.0WK-57XR/	330,000	220/380	50	3	4	
330.0WK-59XR/	330,000	347/600	50	3	4	
400.0WK-4R/	400,000	120/208	60	3	4	
400.0WK-4XR/	400,000	277/480	60	3	4	
400.0WK-5DR/	400,000	120/240	60	3	4	
400.0WK-9XR/	400,000	347/600	60	3	4	

* - The Specification Letter advances (A to B, B to C, etc.) with manufacturing changes.

REPLACEMENT ENGINE

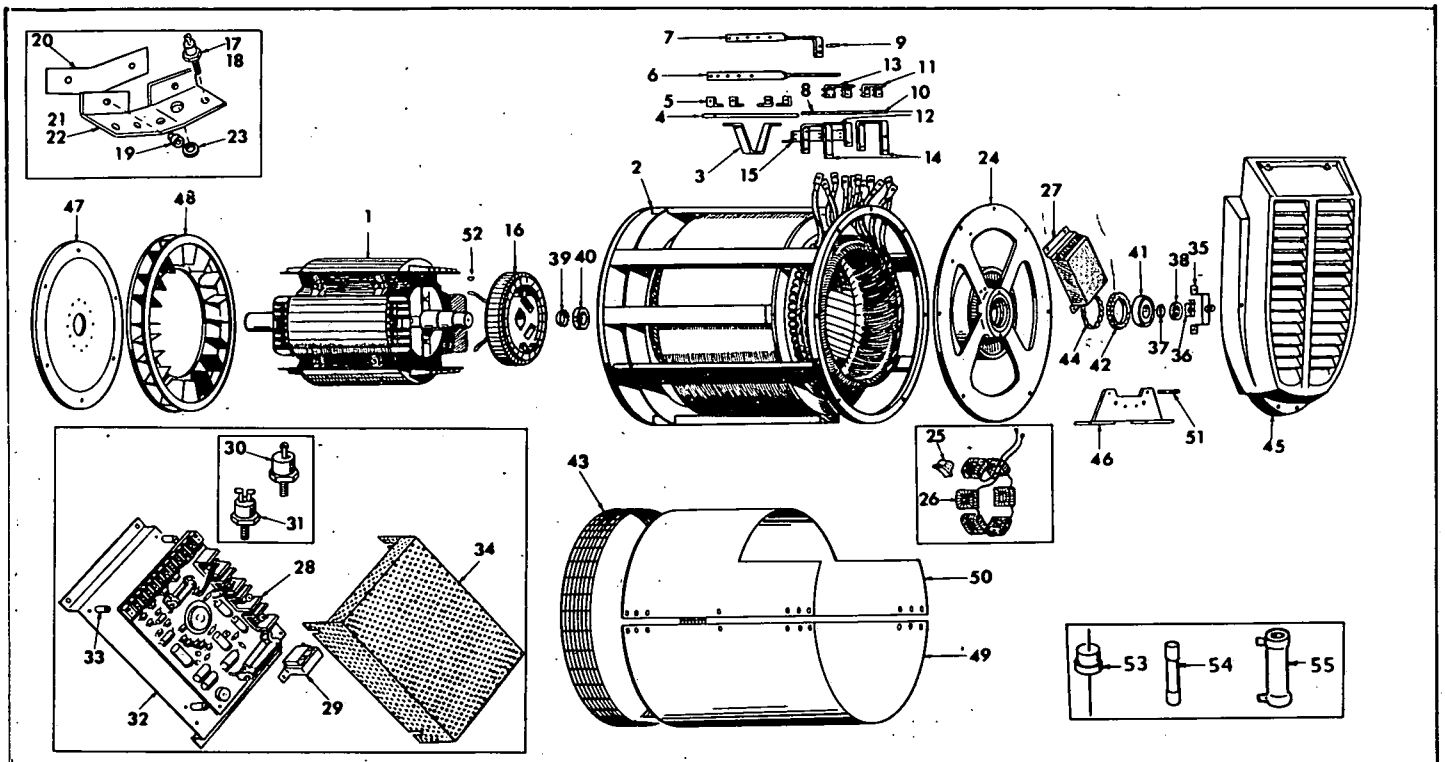
Engine, Replacement - Waukesha Motor Company Model L1616-GSIU.

100P815	1	WF (Key 1)
100P806	1	WK (Key 2)

General Description:

Includes - Complete Cylinder Block, Air Cleaner, Oil Filter, Starter Motor (24 Volt), Governor, Fan Blade, Fan Guard, Flywheel Housing, Water Pump, Engine Supports, Oil Pan, Oil Cooler, Exhaust Manifold, Alternator Belt Tightener, Alternator Drive Belt, Spark Plugs, Alternator Mounting Bracket, Viscous Damper, Barring Device, Regulator, Turbo Charger, Intercooler, Radiator, Pump and Surge Tank, Breather System, Exhaust Y, and Intercooling Plumbing.

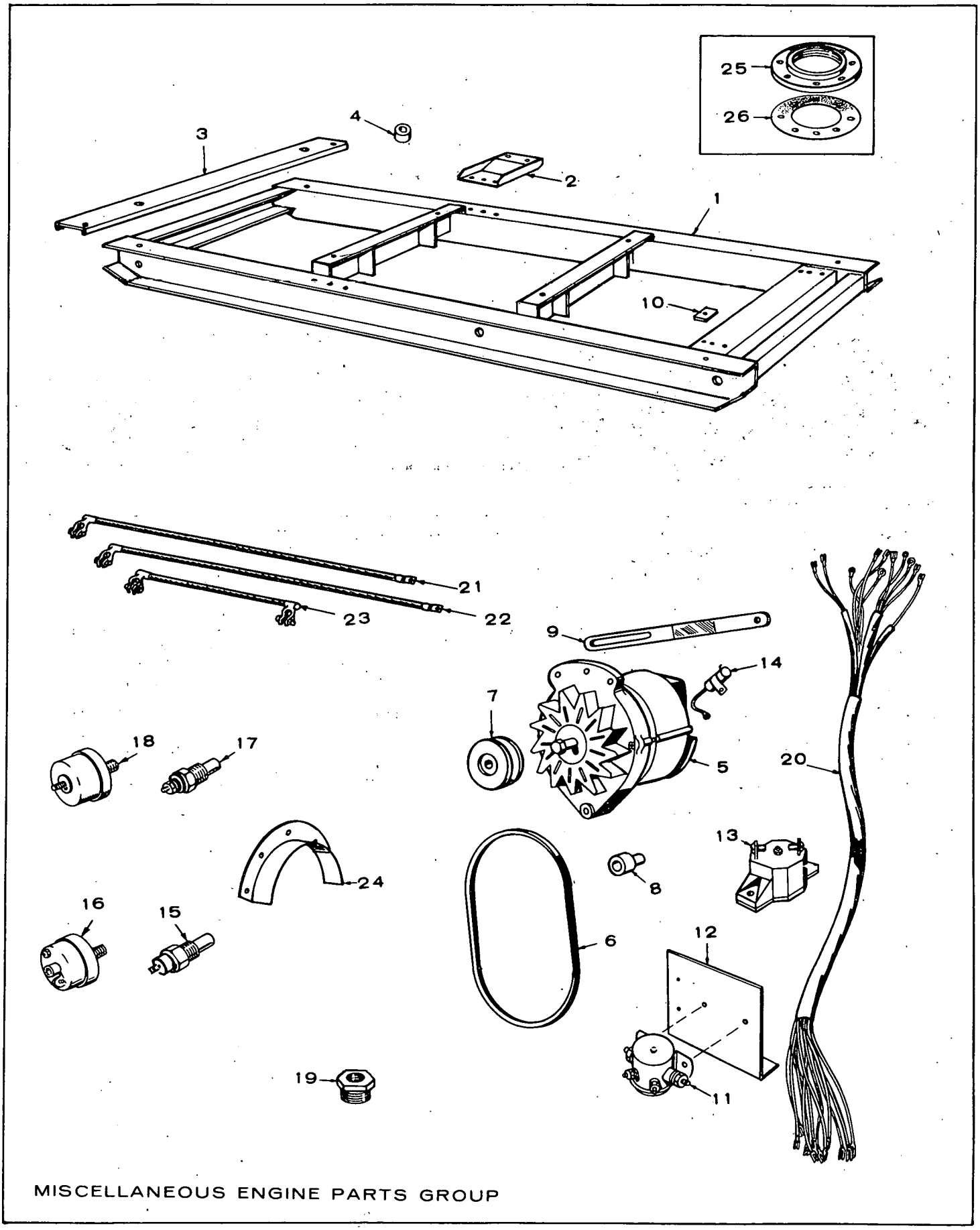
Excludes - Alternator, Temperature Sender, Oil Pressure Sender, and Gauges.



GENERATOR GROUP

REF. NO.	PART NO.	QTY. USED	PART 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 Mtg.
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	4	Insulator, Heat Sink Mtg.
21	363B25	1	Sink, Heat - Rectifier (Positive)
22	363B33	1	Sink, Heat - Rectifier (Negative)
23	508P93	1	Grommet, Heat Sink
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	364-9	2	Rectifier, Gate Controlled 300 Volt, 5.5 Ampere - Negative Base
32	305C454	1	Chassis, Voltage Regulator
33	305A458	4	Spacer, Printed Circuit Board Mounting
34	305C456	1	Cover, Voltage Regulator
35	*	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
46	232D1957	1	Support, Generator End
47	232C1880	1	Disc, Rotor Drive
48	205D76	1	Fan, Generator
49	BAND, STATOR - BOTTOM		
	234C287	1	Key 1
	234C288	1	Key 2
50	BAND, STATOR - TOP		
	234C277	1	Key 1
	234C278	1	Key 2
51	520A692	2	Stud, Generator Support
52	515A162	1	Key, Exciter Rotor
53	357C9	1	Rectifier, Silicon
54	321-38	1	Fuse, 18 Amp. - 250 volt
55	RESISTOR, FIXED		
	353P26	1	12 watt, 1200-ohm
	353P27	1	8 watt, 2000-ohm

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

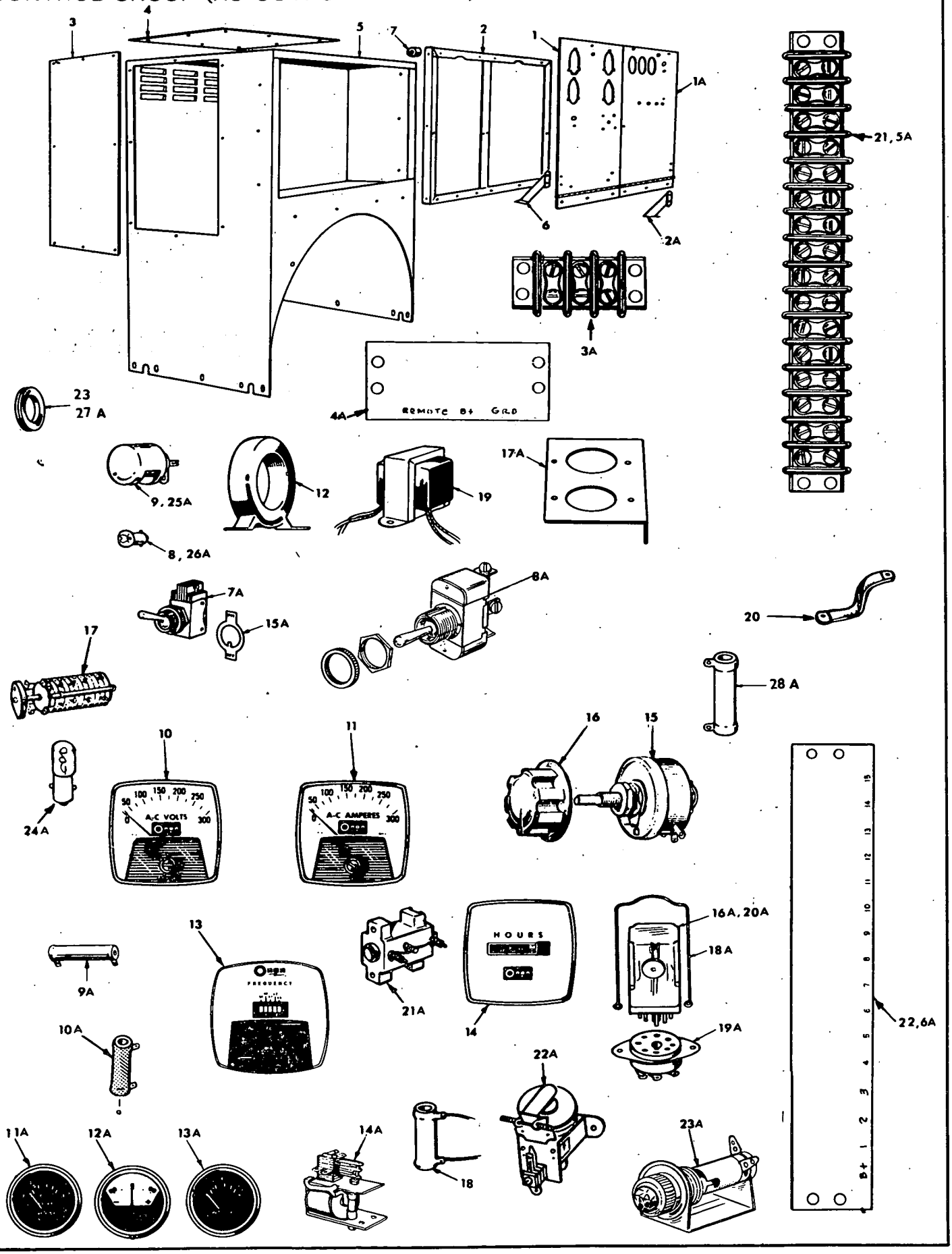


MISCELLANEOUS ENGINE PARTS GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	403D884	1	Base, Mounting
2	130D788	2	Brace, Radiator Mtg.
3	130D789	2	Support, Radiator
4	403A851	6	Spacer, Head
5	191B688	1	*Alternator Charge (Motorola Part Number 70D44039B04)
6	511-37	1	Belt, Alternator Drive
7	191C624	1	Pulley, Alternator
8	232A1813	1	Spacer, Alternator Mounting
9	191A101	1	Bracket, Alternator Adj.
10	SHIM, GENERATOR TO MOUNTING BASE		
	232A1817		.062"
	232A1489	AS	.0598"
	232A1490	REQ.	.0359"
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-Temperature
16	309B64	1	Switch, Low - Oil Pressure
17	193B100	1	Sender, Water Temperature
18	193A195	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	191B725	1	Guard, Alternator Belt
25	155P673	1	Flange, Exhaust
26	155P677	1	Gasket, Exhaust Flange

* - For components contact your nearest Motorola dealer or Motorola Automotive Products Inc., 9401 W. Grand Ave., Franklin Park, Illinois, 60131.

CONTROL GROUP (ENGINE INSTRUMENTS PORTION)
CONTROL GROUP (AC OUTPUT PORTION)



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	301C2908	1	Panel, Control
2	301C2906	1	Frame, Control Panel Mtg.
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)		
	302P414	1	Scale Reads 0-500
	302P415	1	Scale Reads 0-750
	302P416	1	Scale Reads 0-1000
	302P640	1	Scale Reads 0-1200
	302P641	1	Scale Reads 0-1500
12	TRANSFORMER, CURRENT (Check Transformer Nameplate - Select According to Rating)		
	302B547	3	Transformer Nameplate Reads 500/5 (Use with 0-500 Ammeter)
	302B625	3	Transformer Nameplate Reads 750/5 (Use with 0-750 Ammeter)
	302P589	3	Transformer Nameplate Reads 1000/5 (Use with 0-1000 Ammeter)
	302P643	3	Transformer Nameplate Reads 1200/5 (Use with 0-1200 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 V, 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)
23	GROMMET		
	508P1	1	For 1-1/16" Hole
	508P93	1	For 1 1/16" Hole
1A	301C2907	1	Panel, Control
2A	301A2951	1	Bracket, Panel Stop
3A	332A611	1	Block, Terminal
4A	332A1009	1	Strip, Terminal Block Marker
5A	332A795	1	Block, Terminal
6A	332A862	1	Strip, Terminal Block Marker
7A	308-2	1	Switch, Panel Light
8A	308P138	1	Switch, Run-Stop-Remote
9A	304A446	2	Resistor, 150 ohm, 10 Watt
10A	304A66	1	Resistor, 10 ohm, 50 watt
11A	193B112	1	Gauge, Water Temperature
12A	302A61	1	Ammeter, Charge
13A	193B194	1	Gauge, Oil Pressure
14A	307A655	1	Relay, Shutdown
15A	308-3	1	Plate, On-Off Switch
16A	307P904	1	Relay, Stop
17A	301A2393	1	Bracket, Relay Mounting
18A	307P778	2	Spring, Relay Holddown
19A	SOCKET, RELAY		
	323P52	1	8 Contacts
	323P551	1	11 Contacts
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
27A	GROMMET		
	508P1	1	For 1-1/6" Hole
	508P60	1	For 1" Hole
28A	304A262	1	Resistor, 50-Ohm - 10 Watt

* - Order by description, giving complete Model, Spec, and Serial Number from Onan nameplate.

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