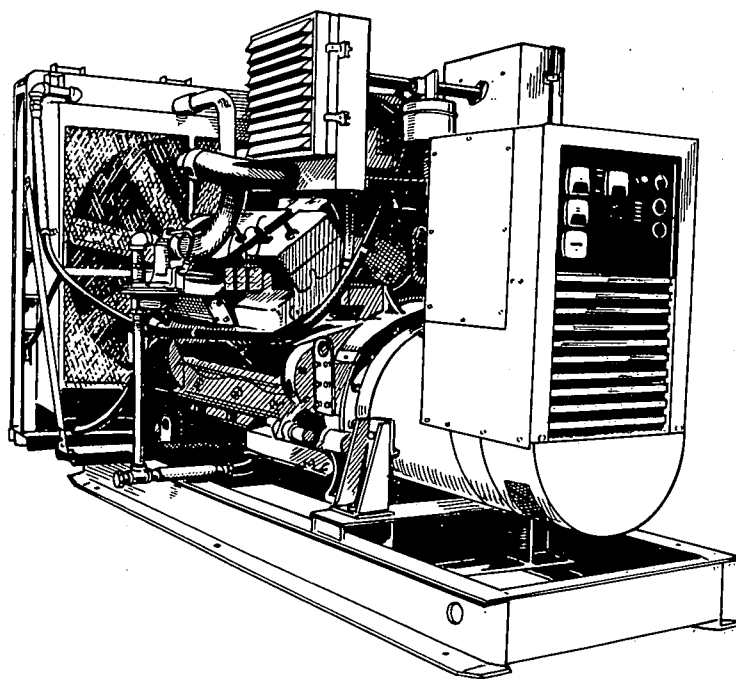


Service Dept Copy

# **OPERATORS MANUAL AND PARTS CATALOG**

FOR  
**WF**  
SERIES

## **ELECTRIC GENERATING SETS**



BEGIN SPEC. C

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# INTRODUCTION

## FOREWORD

This manual is applicable to the WF Series electric generating set, consisting of an Onan YB17 /1 350.0KW AC generator, driven by a Waukesha L1616-GSI natural gas engine. Information is provided on installation, operation troubleshooting and parts ordering for the WF set. The manual should be used in conjunction with the Waukesha engine manual, as your specific engine may have variations due to optional equipment available.

### CAUTION

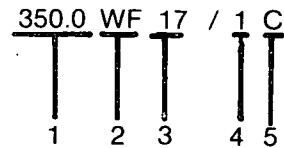
Onan uses this symbol throughout the text to warn of possible equipment damage.

### WARNING

This symbol is used to warn of any possible personal injury.

## MODEL IDENTIFICATION

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.



1. Indicates Kilowatt rating.
2. Factory code for SERIES identification.
3. Indicates voltage code:
4. Factory code for designating optional equipment.
5. Specification letter. (Advances when factory makes production modifications.)



## MANUFACTURER'S WARRANTY

Onan 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 Onan's instructions.

Onan will, under this warranty, repair or replace, as Onan may elect, any part which on examination shall disclose to Onan's satisfaction to have been defective in material and workmanship; provided that such part shall be returned to Onan's factory or one of its Authorized Service Stations, transportation charges prepaid, not later than one (1) year after the product is first placed in service. Such defective part will be repaired or replaced free of charge, including labor (in accordance with rates approved by Onan) during the stated one (1) year coverage under this warranty.

THIS WARRANTY AND ONAN'S OBLIGATION THEREUNDER IS IN LIEU OF ALL WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND ALL OTHER OBLIGATIONS OR LIABILITIES, INCLUDING LIABILITY FOR INCIDENTAL AND CONSEQUENTIAL DAMAGE.

No person is authorized to give any other warranty or to assume any other liability on Onan's behalf unless made or assumed in writing by an Officer of Onan, and no person is authorized to give any warranty or to assume any liabilities on the Seller's behalf unless made or assumed in writing by such Seller.

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If it is necessary to contact a dealer or the factory regarding the set, always mention the complete Model, Spec No. and Serial No. as given on the ONAN nameplate. This nameplate information is necessary to properly identify your unit among the many types manufactured. Refer to the engine nameplate when requesting information from its manufacturer. The ONAN nameplate is located on the right side of the generator; the Waukesha nameplate is on the right side, above the crankcase.

Left side and right side are considered when viewed from the engine or front end of the generating set.

**IMPORTANT! RETURN WARRANTY CARD ATTACHED TO UNIT.**

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# SPECIFICATIONS

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## ENGINE DETAILS

Engine Manufacturer .....	Waukesha
Engine Series .....	L-1616-GSI
Number of Cylinders .....	12
Displacement .....	1616 cubic inches
BHP @ 1800 RPM .....	700
Compression Ratio .....	10.0 : 1
Bore .....	5.75 inches
Stroke .....	5.187 inches
Fuel .....	Natural Gas
Battery Voltage .....	24
Battery Group (Two 12-Volt, 225 A.H.) .....	8D - over 25° F Operating Temp.
Starting Method .....	Solenoid Shift
Governor Regulation .....	3% Maximum

## GENERATOR DETAILS

Type .....	YB 17 /1, Brushless
Rating (Watts)	
60 Hertz Continuous Standby .....	350,000
50 Hertz Continuous Standby .....	290,000
AC Voltage Regulation .....	2%
60 Hertz RPM .....	1800
50 Hertz RPM .....	1500
Output Rating .....	0.8 PF
A.C. Frequency Regulation .....	1.8 Hz No Load - Full Load
Battery Charging Current .....	35 Amps

## CAPACITIES AND REQUIREMENTS

Cooling System (Including Radiator and Intercooler) .....	60 gallons
Engine .....	32 gallons
Engine and Radiator .....	52 gallons
Heat Exchanger System (Including Surge Tank, Lines and Engine) .....	54 gallons
Engine Oil Capacity (Filter, Lines, Crankcase) .....	21 gallons
Exhaust Connection (inches pipe thread) .....	8

## AIR REQUIREMENTS (1800 RPM)

Engine Combustion .....	800 CFM
Radiator Cooled Engine .....	32,000 CFM
Total for Radiator Cooled Model .....	34,000 CFM
Alternator Cooling Air (1800 RPM) .....	1200 CFM
(1500 RPM) .....	1000 CFM
Fuel Consumption at Rated Load (1000 BTU Gas) .....	3850 cu. ft/hr.

## GENERAL

Height .....	94 inches
Width .....	69 inches
Length .....	146 inches
Weight (Approx.) .....	12,300 lbs.

**TABLE 1. GENERATOR VOLTAGE OPTIONS**

<b>VOLTAGE</b>	<b>PHASE</b>	<b>FREQUENCY</b>	<b>MAXIMUM CURRENT</b>	<b>PARALLEL WYE</b>	<b>SERIES WYE</b>	<b>CONNECT WIRE W12</b>
(YB17)						
120/208	3	60 Hz	1215 AMPS	x		H3
127/220	3	60 Hz	1148 AMPS	x		H4
139/240	3	60 Hz	1049 AMPS	x		H5
240/416	3	60 Hz	607 AMPS		x	H3
254/440	3	60 Hz	574 AMPS		x	H4
277/480	3	60 Hz	526 AMPS		x	H5
(YB517)						
110/190	3	50 Hz	1102 AMPS	x		H3
115/200	3	50 Hz	1048 AMPS	x		H4
120/208	3	50 Hz	1007 AMPS	x		H4
127/220	3	50 Hz	954 AMPS	x		H5
220/380	3	50 Hz	551 AMPS		x	H3
230/400	3	50 Hz	524 AMPS		x	H4
240/416	3	50 Hz	503 AMPS		x	H4
254/440	3	50 Hz	476 AMPS		x	H5

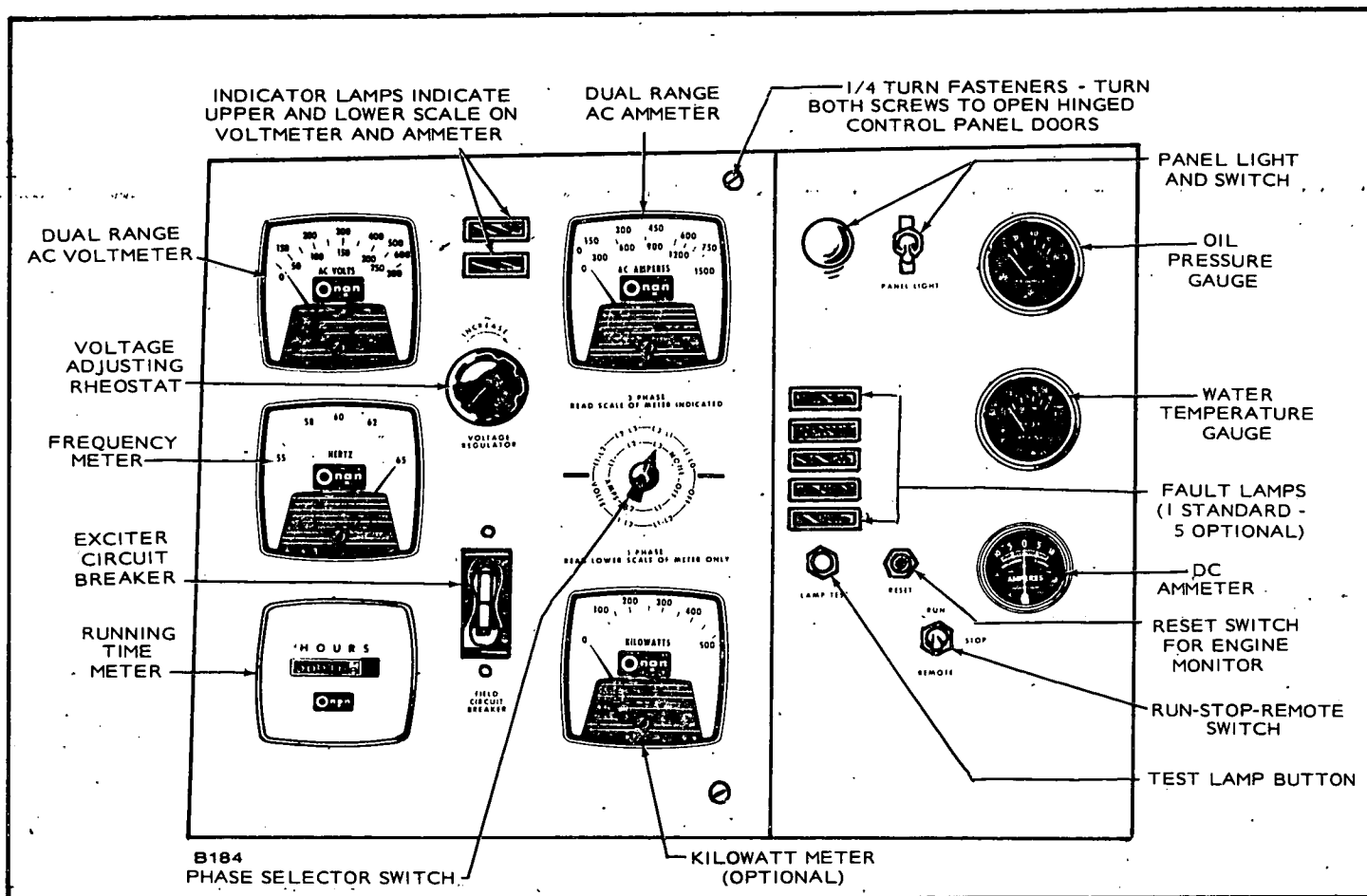


FIGURE 1. CONTROL PANEL

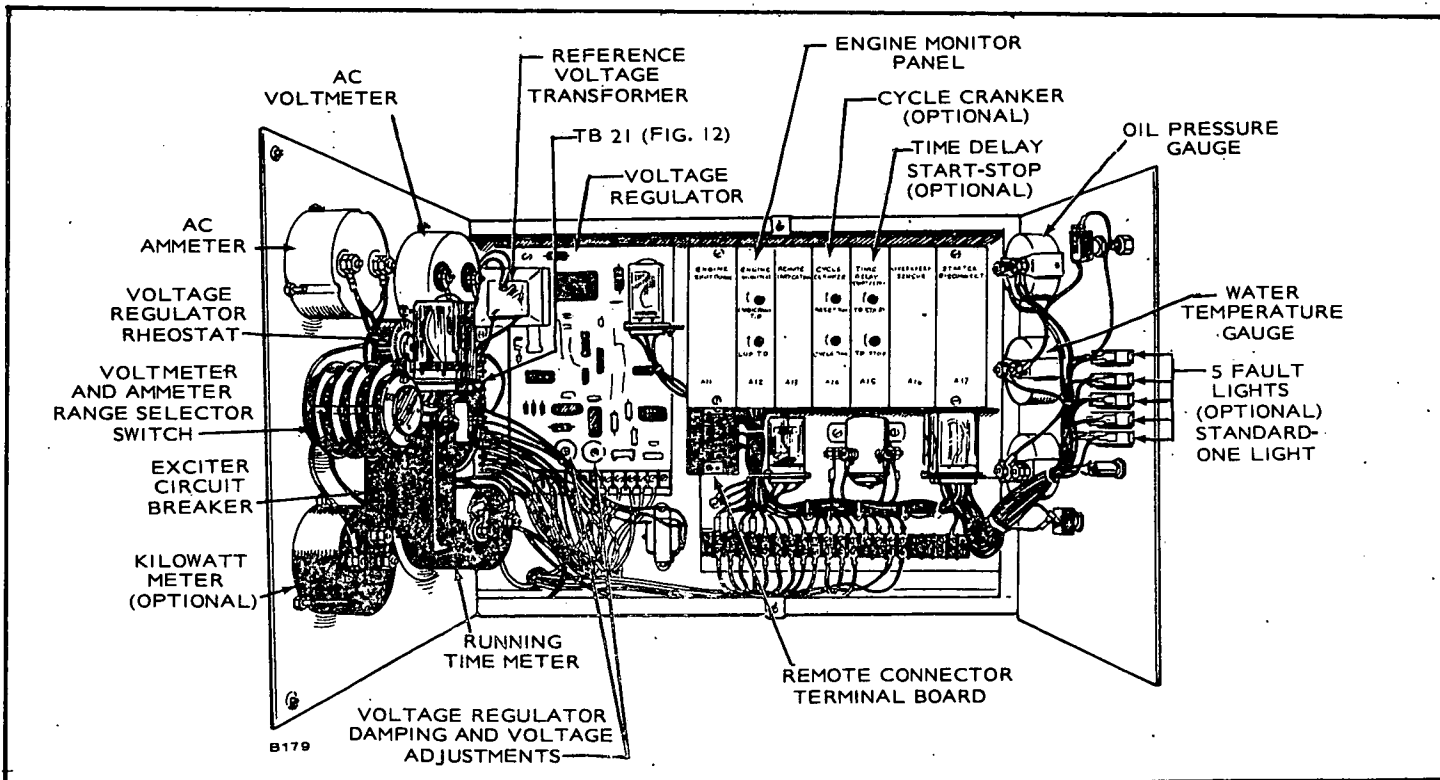


FIGURE 2. CONTROL PANEL INTERIOR

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# DESCRIPTION

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## GENERAL

An ONAN WF series electric generating set is a complete unit consisting of an engine driven AC generator, with controls and accessories as ordered.

## ENGINE

The engine on the WF is a Waukesha L-1616GSI, as described in engine manual. Basic measurements and requirements will be found under Specifications. However, the engine used for your unit may have variations due to optional equipment available, therefore the Waukesha manual should be consulted.

## A.C. GENERATOR

The generator is an ONAN Type YB17 /1 12 lead, 4 pole revolving field, reconnectable bus-bar brushless unit. The alternating current is generated in the stator winding. The alternator rotor, attached directly to the engine flywheel turns at engine speed. Therefore, the speed at which the rotor turns, determines generator output frequency. The 60 hertz set operates at 1800 rpm and the 50 hertz at 1500 rpm. Excitation is achieved by feeding AC output to a voltage regulator, where it is compared with a reference voltage in the regulator, rectified and returned to the field of the exciter, then to the exciter armature, rectified and fed to the generator field.

## CONTROL PANEL

The following is a brief description of each of the standard controls and instruments located on the face of the panel. See Figure 1.

### DC PANEL

**Panel Light and Switch:** Illuminates control panel.

**Oil Pressure Gauge:** Indicates pressure of lubricating oil in engine (wired to a sensor unit located on the engine).

**Water Temperature Gauge:** Indicates temperature of circulating coolant in engine. (Wired to a sensor unit located on the engine.)

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

**Run-Stop-Remote Switch:** Starts and stops the unit locally or from a remote location.

**Reset Switch:** Manual reset for engine monitor after shut-down.

**Lamp Test:** Press to test warning lamp bulbs (when engine is running only).

**Warning Lights:** Indicates "Fault" in engine operation.

### AC PANEL

**AC Voltmeter:** Indicates AC generator output voltage.

Dual range instrument: measurement range in use shown on indicator light.

**AC Ammeter:** Indicates AC generator output current. Dual range instrument: measurement range in use shown on indicator lights.

**Voltmeter-Ammeter Phase Selector Switch:** Selects the phases of the generator output to be measured by the AC voltmeter and AC ammeter.

**Voltage Regulator:** Rheostat, provides approximately plus or minus 5% adjustment of the rated output voltage.

**Exciter Circuit Breaker:** Provides generator exciter and regulator protection from overheating in the event of certain failure modes of the generator, exciter and voltage regulator.

**Running Time Meter:** Registers the total number of hours, to 1/10th that the unit has run. Use it to keep a record for periodic servicing. Time is accumulative, meter cannot be reset.

**Frequency Meter:** Indicates the frequency of the generator output in hertz. It can be used to check engine speed. (Each hertz equals 30 rpm).

## OPTIONAL EQUIPMENT

### DC PANEL

**Warning Lights:** Eliminates the one "Fault" light and substitutes five indicator lights to give warning of -

- a. Overcrank (failed to start)
- b. Overspeed
- c. Low oil pressure
- d. High engine temperature
- e. Low engine temperature

Operation of these lights will be discussed in conjunction with engine monitor panel.

## AC PANEL

**Kilowatt Meter:** Indicates output of the AC generator in kilowatts. Connected into a transducer mounted in the control box housing.

## CONTROL PANEL INTERIOR

The only equipments discussed in this section will be those which the operator may have reason to adjust or inspect for service. Refer to Figure 2 for location of units mentioned.

**Terminal Board (TB) 21:** Connection of wandering lead (W12) to terminals H3, H4, H5 is made at this point, to change voltage regulator tap when reconnecting generator for different voltages. Refer to Figure 12.

**Voltage Regulator:** Solid state unit controls AC output from generator at predetermined level regardless of load.

**Engine Monitor:** Printed circuit plug-in modules provide the following functions:

1. A 75 second cranking period.
2. Approximately a 12-1/2 second time delay for oil pressure buildup.
3. An external alarm contact to light a fault lamp and shut down the set for alarm conditions such as:
  - a. Overcrank (failed to start after cranking 75 seconds).
  - b. Overspeed (engine speed reaches approximately 2100 rpm).
  - c. Low oil pressure (approximately 14 psi).
  - d. High engine temperature (approximately 215° F).

On standard control panels, all four alarms are wired into one common fault lamp; on units with five fault lamps, four have shutdown alarms, the fifth (low engine temperature) lights a fault lamp only. Refer to Table 2.

**TABLE 2. FAULT LAMP OPTIONS**

SYSTEM	FAULT	FAULT LAMP	STOP ENGINE	EXTERNAL ALARM	PRE-ALARM
PENN STATE. SINGLE LIGHT	Overcrank	x	x	x	
	Overspeed	x	x	x	
	Low Oil Pressure	x		x	
	High Engine Temperature	x		x	
STANDARD SINGLE LIGHT	Overcrank	x	x	x	
	Overspeed	x	x	x	
	Low Oil Pressure	x	x	x	
	High Engine Temperature	x	x	x	
5 LIGHT	Overcrank	x	x	x	
	Overspeed	x	x	x	
	Low Oil Pressure	x	x	x	
	High Engine Temperature	x	x	x	
5 LIGHT PRE-ALARM	Low Engine Temperature	x			
	Overcrank	x	x	x	
	Overspeed	x	x	x	
	Low Oil Pressure	x	*	x	x
	High Engine Temperature	x	*	x	x
	Low Engine Temperature	x			

\* - With additional optional sensors.



**Standard Cranking Module:** Limits engine cranking time to 75 seconds. If engine fails to start after 75 seconds the engine monitor lights a fault lamp and opens the cranking circuit.

**Start-Disconnect and Overspeed:** Plug-in module. Operates at approximately 100 rpm above maximum cranking speed to prevent the starter from being energized while engine is running. Overspeed operates at 2000-2200 rpm.

## **OPTIONAL MODULES**

**Cycle Cranker:** Plug-in module replaces standard cranking circuit. Automatically provides a 15-second crank time and a 10-second rest time for three ON and two OFF cycles in 65 seconds. If engine fails to start, after 75-seconds the engine monitor lights a fault lamp and opens the cranking circuit.

**Time Delay Start/Stop:** Operative from remote location only. Provides 1-10 seconds time delay on starting and 30-seconds to 5-minutes delay on stopping. Delay period adjustable on engine monitor panel.

**Pre-Alarm:** Gives advance warning for low oil pressure or high engine temperature. Requires two sensors, each for engine temperature and oil pressure.

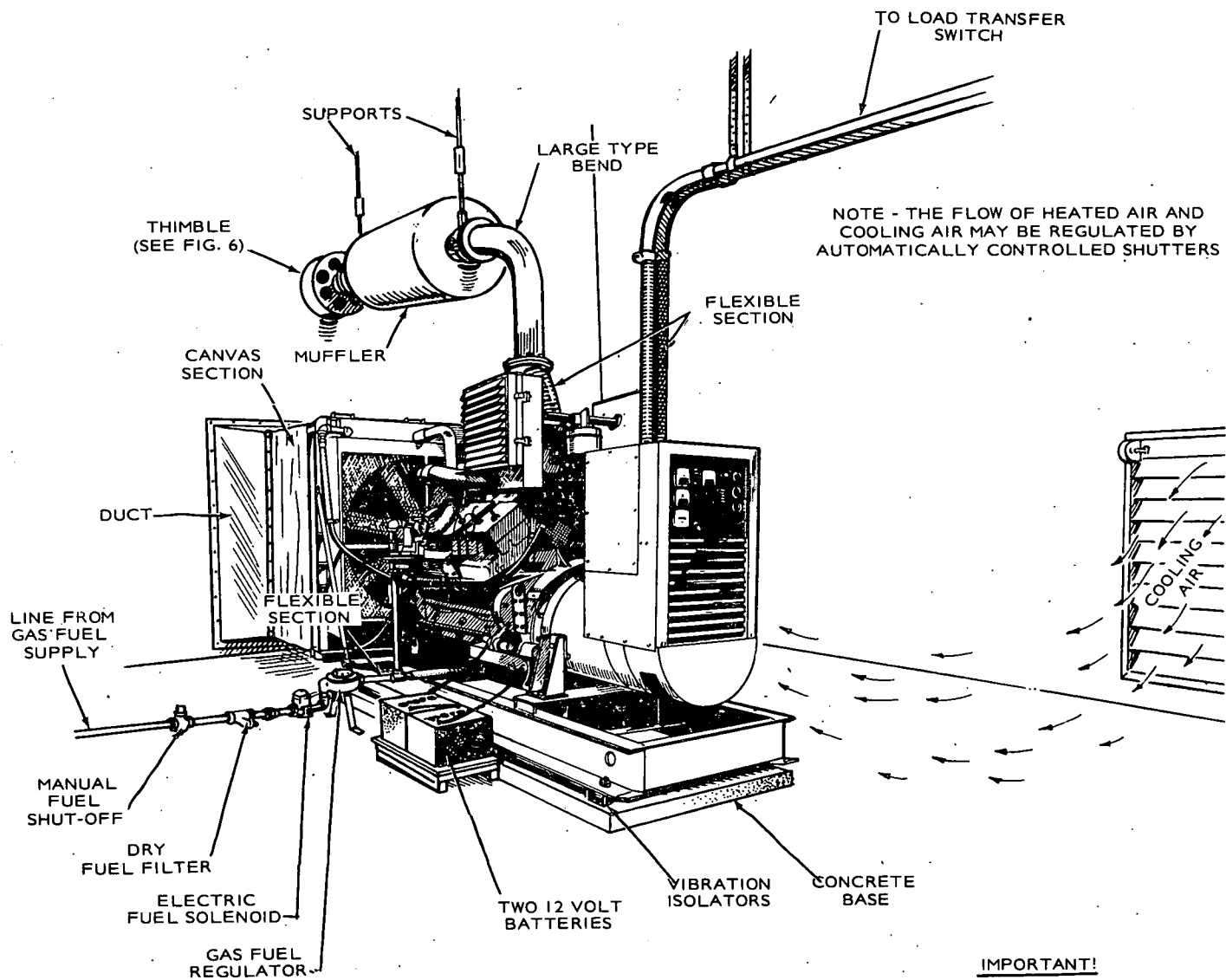


FIGURE 3. TYPICAL INSTALLATION

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# INSTALLATION

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## 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. See Figure 3.

Installation points to consider include:

1. Level mounting surface.
2. Adequate 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 and servicing.
10. Vibration isolation.
11. Noise levels.

## LOCATION

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

## MOUNTING

Generating sets are mounted on a rigid skid base which provides proper support. Install vibration isolators between skid base and foundation. For convenience in draining crankcase oil and general servicing, mount set on raised pedestals (at least 6" high). 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 recommended for stationary installations.

## VENTILATION

Generating sets 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.

## RADIATOR COOLING

Cooling air travels from the rear of the set to the front end. Locate the room or compartment air inlet where most convenient, preferably to the rear of the set. Make the inlet opening at least as large as the radiator area (preferably 1-1/2 times larger).

Engine heat is removed by a pusher fan which blows cooling air out through the front of the radiator. Locate the cooling air outlet directly in front of the radiator and as close as practical. The opening size should be at least as large as the radiator area. Length and shape of the air outlet duct should offer minimum restriction to air flow. Use a 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.

## CITY WATER COOLING

On city water cooled sets 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, 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.

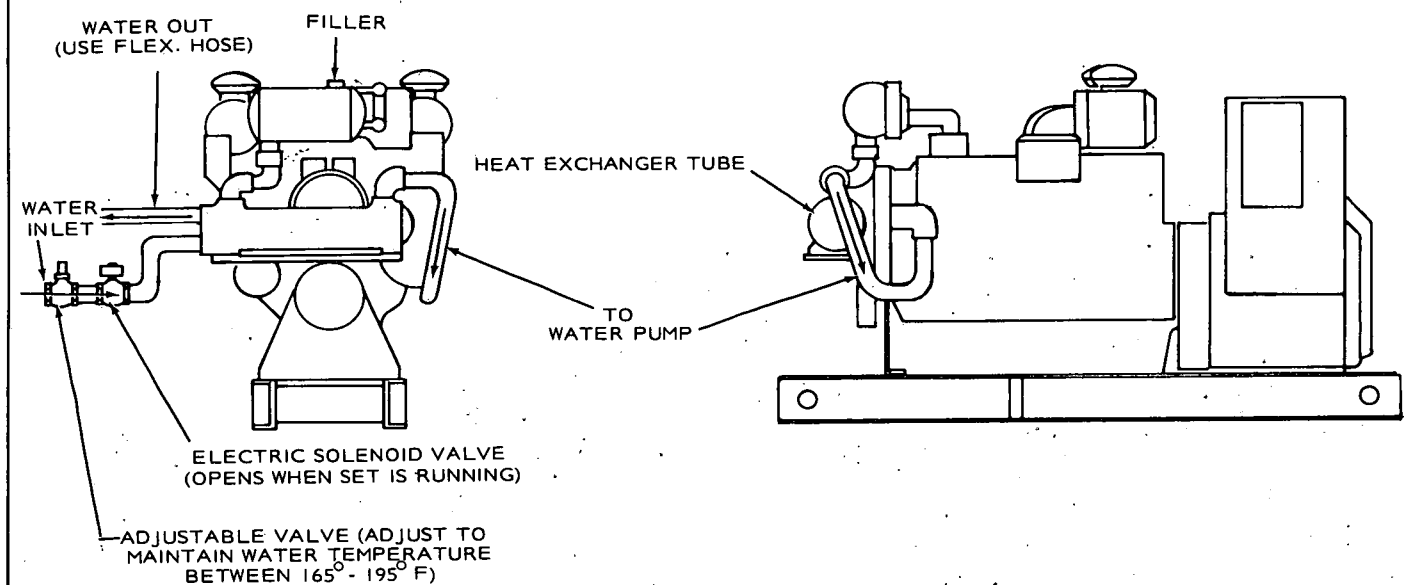


FIGURE 4. HEAT EXCHANGER COOLING

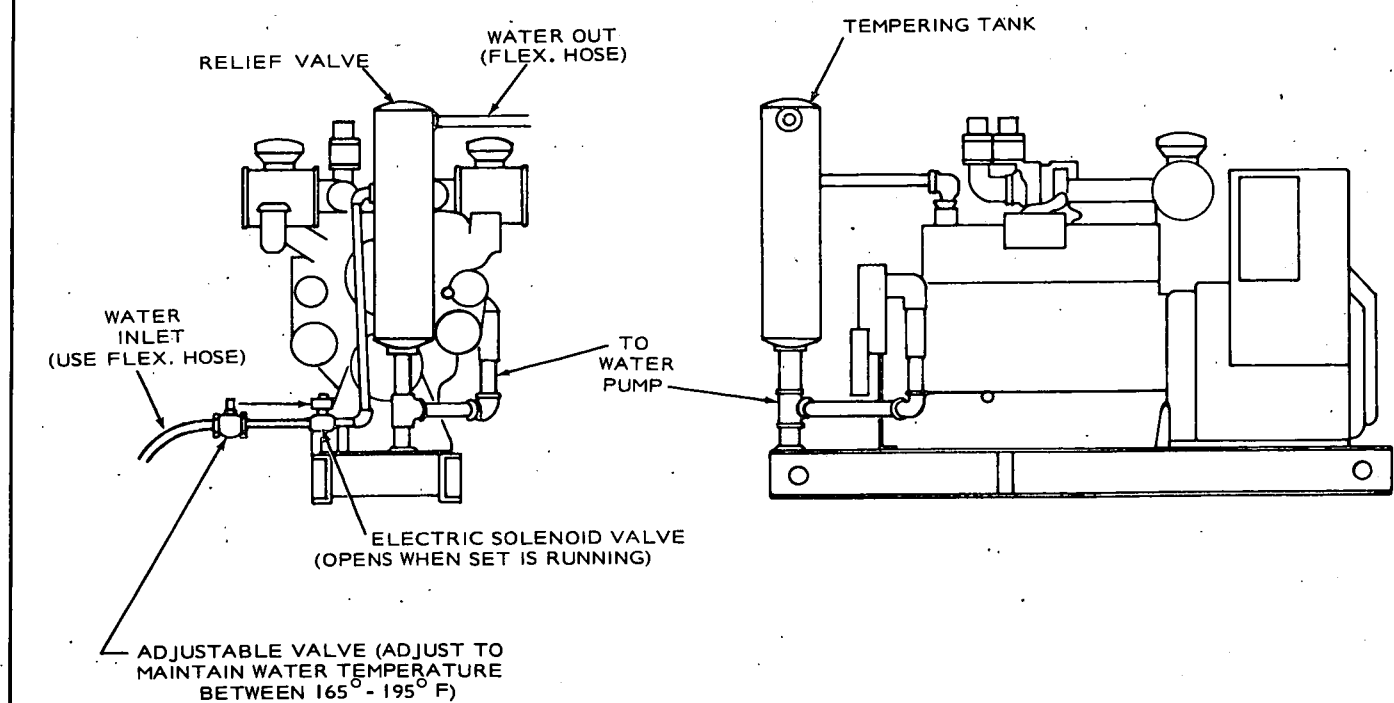


FIGURE 5. STANDPIPE COOLING

## CITY WATER COOLING

An optional method of engine cooling, in place of the conventional radiator and fan, uses a constant pressur water supply. This is referred to as CITY WATER COOLING. There are two varieties of city water cooling: the HEAT EXCHANGER SYSTEM and STANDPIPE SYSTEM. See Figures 4 and 5.

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 set.

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.

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.

## WATER JACKET HEATER (OPTIONAL)

This heater is installed to maintain an elevated engine temperature in lower ambient temperature applications. It heats and circulates engine coolant, and is thermostatically controlled. (Figure 16)

## EXHAUST

### WARNING

Inhalation of exhaust gases can result in death.

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 turbo-charger 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.

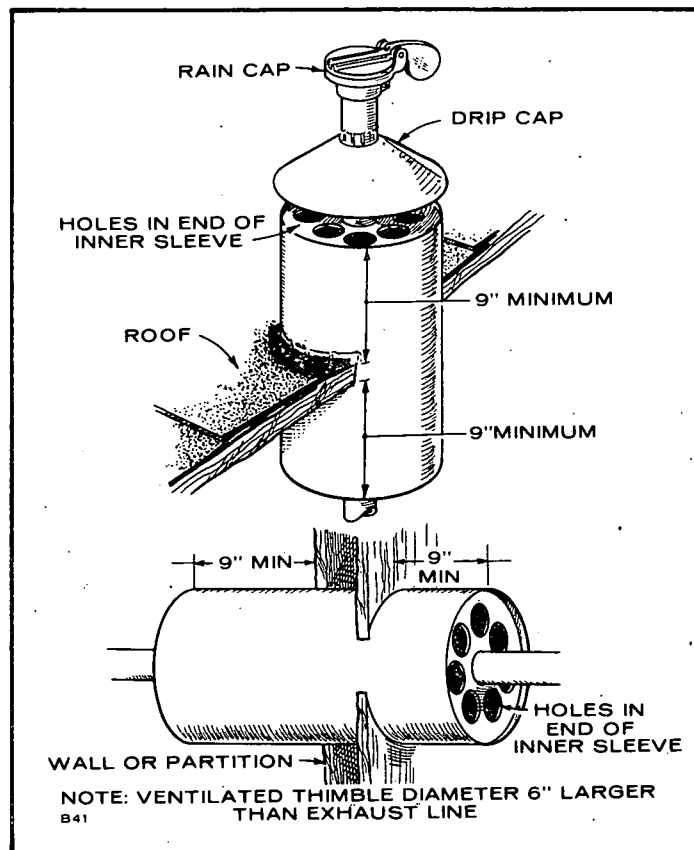


FIGURE 6. EXHAUST THIMBLE

Use sweeping elbows in preference to standard pipe elbows and keep the number of 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 (Figure 7). Shield or insulate the line if there is any danger of personal contact. If the line passes close to a combustible wall or partition, allow at least 4" clearance. Install a suitable muffler.

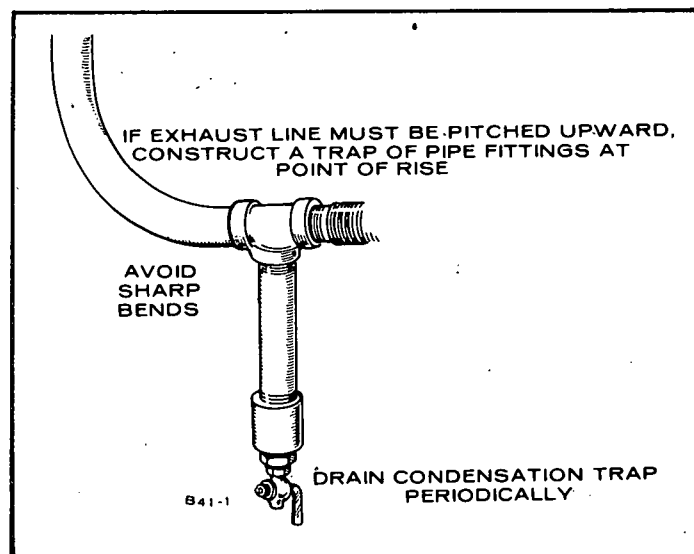


FIGURE 7. EXHAUST CONDENSATION TRAP

## FUEL SYSTEM

The Waukesha engines used on the WF series sets are designed for use only with natural gas fuel at a source pressure of at least 20 psi and thermal rating of 1000 B.T.U./cu. ft. minimum. In some areas, state or local codes prohibit the use of high pressure accumulator tanks within buildings or extended runs of high pressure piping to supply the fuel needed for large natural gas plants. In these situations, or where gas pressure is less than 20 psi, ONAN recommends installation of a plant mounted booster pump (Figure 8).

**Fuel Connection:** 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 valve should be installed to open fuel supply when plant is energized. Install a line pressure regulator between solenoid and pressure reduction valves. Use flexible line between "tee" and engine. DO NOT USE RUBBER HOSE. Provide proper support for entire installation. Refer to Waukesha manual for additional information.

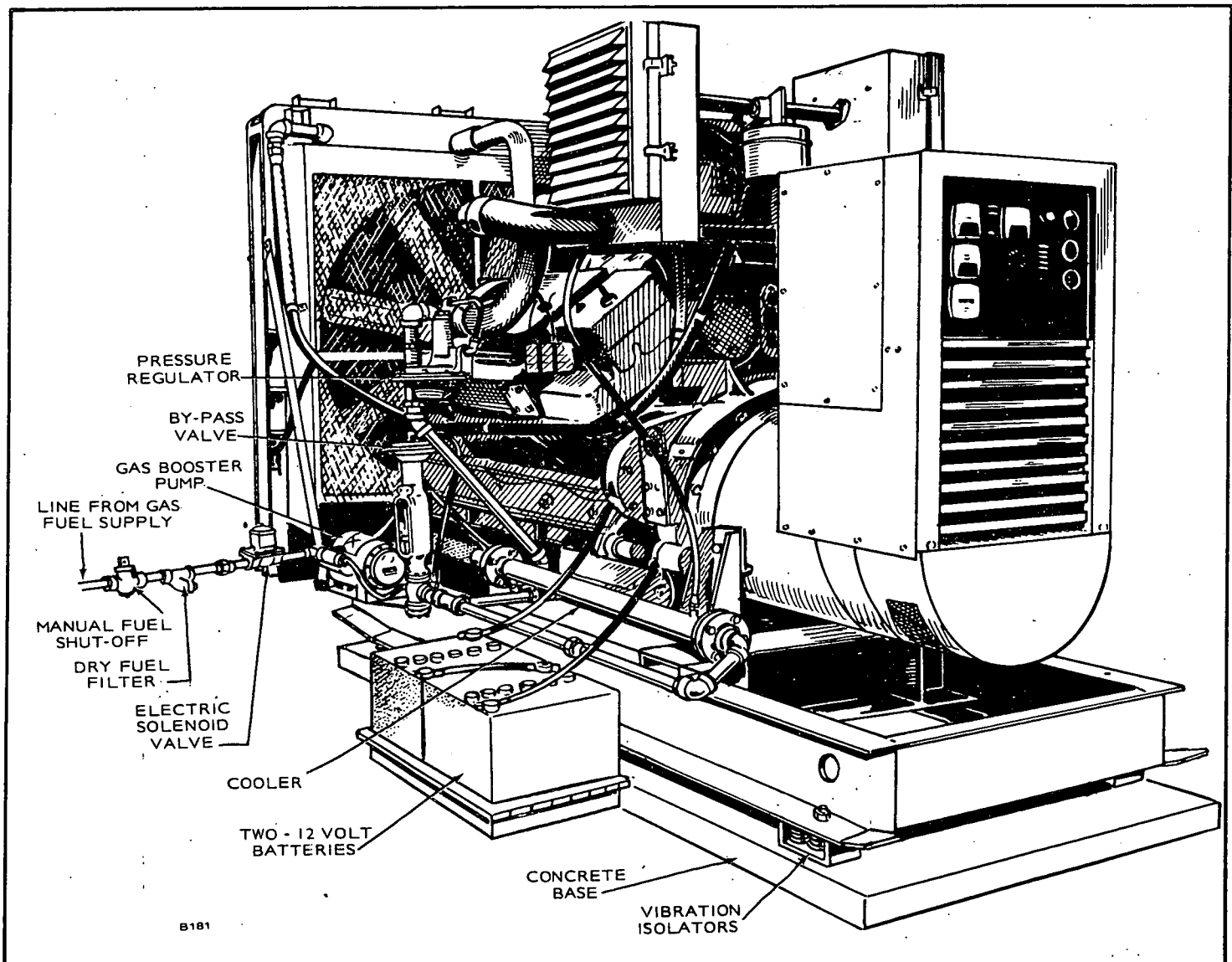


FIGURE 8. GAS BOOSTER PUMP AND FUEL INSTALLATION

## BATTERY (Figure 9)

Starting the plant requires 24-volt battery current. Use two 12 volt batteries (see Specifications). Connect the batteries in series (negative post of first battery to positive post of second) as in Figure 9. Necessary battery cables are on the unit. 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 an automatic transfer switch that has no built-in charge circuit, connect a separate trickle charger. Onan automatic transfer switches include such a battery charging circuit.

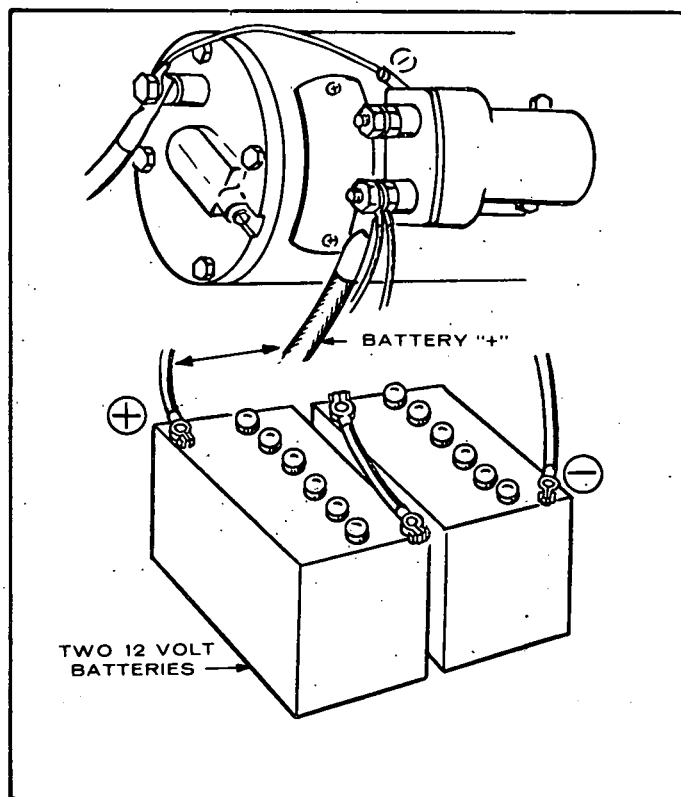


FIGURE 9. BATTERY CONNECTION

## 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.

1. Fully charge the battery.
2. With the battery still on charge, draw off the electrolyte above the plates in each cell. Do not attempt to pour off. Use an hydrometer or filler bulb and dispose of it in a safe manner. Avoid skin or clothing contact with the electrolyte.

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, 4 until the reading is reduced to 1.225. Usually, repeating steps twice is sufficient.

## REMOTE CONTROL CONNECTIONS

Provision is made for addition of remote starting. This is accomplished on a 4 place terminal block situated within the control box. Connect one or more remote switches across remote terminal and B+ terminal as shown in Figure 10. If the distance between the set and remote station is less than 1000-feet, use No. 18 AWG wire, between 1000- and 2000- feet, use No. 16 AWG wire.

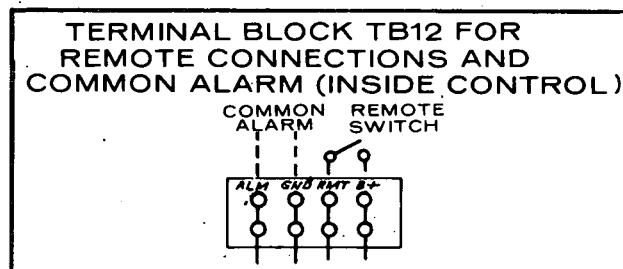


FIGURE 10. REMOTE STARTING

## WIRING CONNECTIONS

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 sizes, 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 must always be used (Figure 11). Connect this switch (either automatic or manual) so that it is impossible for commercial power and generator power to be connected to the load at the same time. Instructions for connecting an automatic transfer switch are included with such equipment.

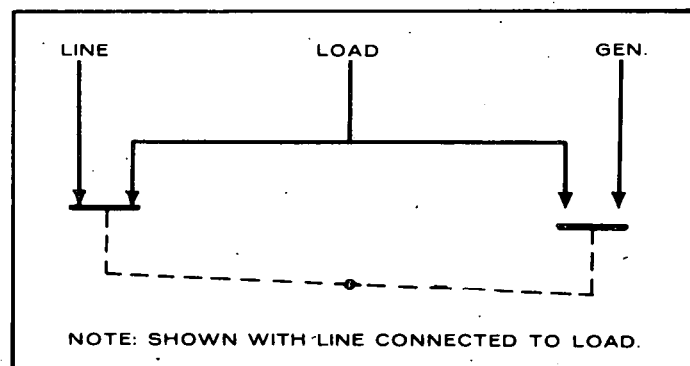


FIGURE 11. LOAD TRANSFER SWITCH

## CONTROL BOX CONNECTION (Figure 12)

Wandering lead W12 on TB21 is a jumper which connects a single phase output from the generator to the appropriate tap on the voltage reference transformer. This lead connects terminal 63 on the terminal board to a terminal marked H3, H4 or H5 depending upon the voltage option required. Refer to Table 1 and Figure 14 for voltages available and correct hookup.

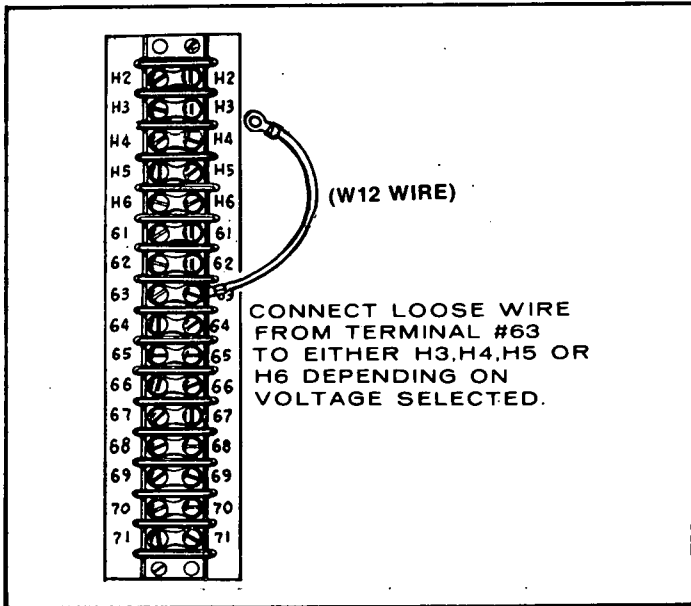


FIGURE 12. CONTROL BOX CONNECTION

## GENERATOR CONNECTIONS

The model YB17/1 generator is a 3-phase 60-hertz (or 50 hertz) set which can be connected in either series wye or parallel wye configuration to give the line to neutral and line to line voltage options referred to in Table 1 and Figure 14. This is accomplished at the generator bus with reconnection bars. The line to neutral voltage is the lower voltage noted on the unit nameplate, while the line to line voltage is the higher nameplate rating. Refer to Figure 15 for an example of 120/208 voltage.

For 3-phase loads connect separate load wires to each of the set terminals L1, L2 and L3 (Figure 13). For a large single phase only, connect between terminals L1 and L2. Available capacity is 2/3 maximum output.

The terminal L0 can be grounded. For 1-phase loads connect the neutral (white) load wire to the L0 terminal. Connect the "hot" (black) load wire to either terminal - L1 or L2. Two separate single phase circuits are available with a total capacity of up to 2/3 of the generator rated 3-phase output.

If using 1-phase and 3-phase loads at the same time, ensure the 1-phase load is properly balanced. Do not exceed rated line current.

ONAN recommends that all connections from the generator to the bus-bars and from the bus-bars to the load be made by a qualified electrician. All applicable local and state laws should be complied with.

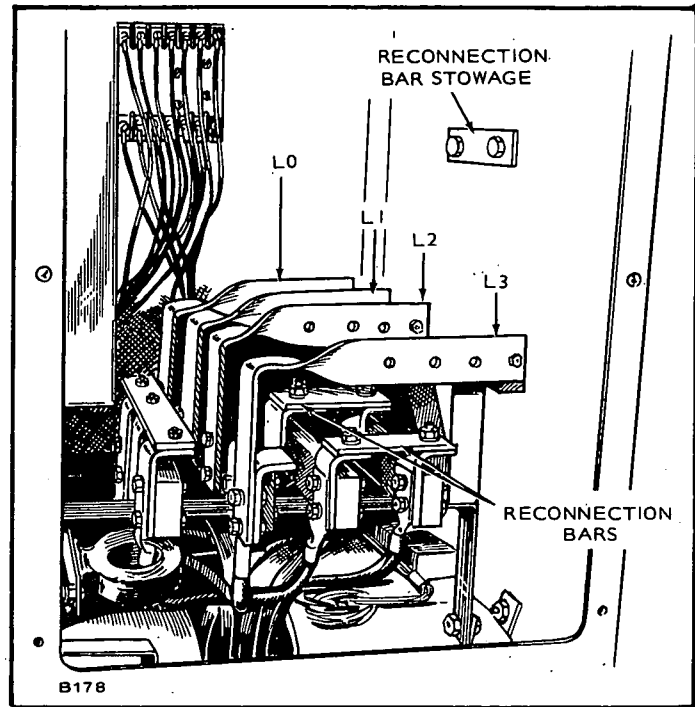


FIGURE 13. LOAD WIRE CONNECTIONS

THIS DIAGRAM APPLIES TO 12 LEAD GENERATORS ONLY					GENERATOR CONNECTION SCHEMATIC DIAGRAM	GENERATOR CONNECTION WIRING DIAGRAM
NAMEPLATE VOLTAGE CODE	VOLTAG	PHASES	CONNECTION	TERMINAL 25 TO:		
17 H	120/208	3	00	H3		
	127/220	3	00	H4		
	130/240	3	00	H5		
	110/190	3	50	H3		
	115/200	3	50	H4		
517 H	120/208	3	50	H4		
	127/230	3	50	H5		
	240/415	3	00	H3		
17 H	234/440	3	00	H4		
	277/480	3	00	H5		
	230/380	3	50	H3		
	230/400	3	50	H4		
	240/415	3	50	H4		
517 H	254/440	3	50	H5		

FIGURE 14. OPTIONAL VOLTAGE CONNECTIONS

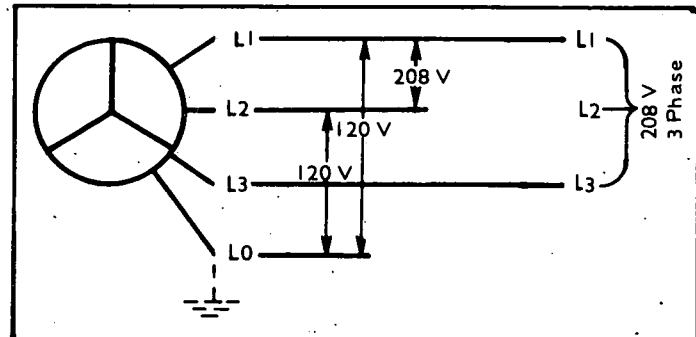


FIGURE 15. 3 PHASE WYE CONNECTION



# OPERATION

## GENERAL

ONAN WF series electric generating sets are given a complete running test under various load conditions and thoroughly checked before leaving the factory. Inspect your unit closely for loose or missing parts and damage which may have occurred in transit. Tighten loose parts, replace missing parts and repair any damage before putting set into operation.

## PRESTART SERVICING

**Lubrication System:** Engine oil was drained and rust inhibiting oil applied to cylinders prior to shipment. Fill engine to capacities shown. After engine has been run, check dipstick, add oil to bring level to full mark. Record total capacity for future oil changes. Refer to Waukesha engine manual for engine oil recommendations. Note that for average operating conditions oils conforming to Military Specifications MIL-L-2104B and MIL-L-45199A (Series 3) are recommended. Do not mix brands or grades of lubricating oils.

Oil viscosity is determined by the oil operating (not ambient) temperature:

OIL OPERATING TEMPERATURE	USE SAE VISCOSITY
210° - 230° F	40
150° - 200° F	30

See engine service manual for more details.

### Oil Capacities (nominal)

Oil Pan .....	13 gallons
Filter and Oil Lines .....	8 gallons
Total .....	21 gallons

### CAUTION

Use a manual, electric pump or air pressure method of filling engine oil system including the turbo-charger oil supply lines. Operation of the turbo without adequate oil flow to the bearings can cause severe damage to turbo within five seconds. Refer to Waukesha manual on turbo-charger operation.

**Cooling System:** Cooling system was drained prior to shipment. Fill cooling system before starting. Total capacity is 60 gallons. For units using either a radiator or heat exchanger (city water cooled), fill the system with clean, soft water. Use a good rust and scale inhibitor additive. If a possibility exists of a radiator cooled set being exposed to freezing temperatures, use anti-freeze with an ethylene-glycol base. During initial engine run, check the coolant level several times and replenish if necessary to compensate for air pockets which may have formed during filling. Refer to Waukesha manual for additional information.

### CAUTION

Verify that the electric solenoid valve used with city water cooled plants is open before initial starting of plant to allow coolant chambers to fill. Overheating and damage to the engine could result from non-compliance.

Ensure that water supply for city water cooling is turned ON.

**Batteries:** Ensure that the cable connections to the batteries are secure. Coat connections with petroleum based or non-conductive grease to retard formation of corrosive deposits.

Check level of electrolyte to be at split ring mark. Measure specific gravity of electrolyte: SG 1.280 at 80° F. If distilled water has been added or specific gravity is less than 1.280, place batteries on charge until desired reading is reached. Do not over charge.

**Fuel System:** For reasons of safety all gas installations in closed areas or buildings should have a positive shut-off valve to prevent gas leakage when engine is not operating.

Normal fuel pressure to the carburetor is 5 inches water column at idle for 1000 B.T.U. natural gas. For natural gases of different thermal value it may be necessary to adjust carburetor intake pressure. Refer to Waukesha engine manual for further information on fuel system.

## STARTING

When the preceding service functions have been performed, recheck to verify unit is ready to start.

- a. Crankcase filled.
- b. Cooling system filled - input solenoid valve open.
- c. Batteries charged and connected.
- d. Fuel solenoid valve open.

To start, move the "run-stop-remote" switch to the "run" position. The engine should start after a few seconds of cranking. When the engine starts, excessive blue smoke will be exhausted and the engine will run rough for a few minutes. This is caused by the pre-shipping rust inhibitor being burned off. When this has been achieved the engine will run smoothly and the blue exhaust smoke will disappear.

Immediately after start, observe the oil pressure gauge. Normal oil pressure is between 40 and 50 psi. Check the following gauges:

- a. DC Ammeter - 10 to 30 amperes.
- b. AC voltmeter - AC generator output voltage.
- c. Frequency Meter - AC generator output frequency.

After running 10 minutes under load the water temperature gauge should have stabilized at 160° to 180° F. On city water cooled units an adjustable valve is connected in the water supply line. Adjust the hand wheel valve to provide a water flow that will keep the water temperature gauge reading within the range of 165° to 195° F.

## STOPPING

To reduce and stabilize temperatures within the engine and turbocharger run the engine at no load for 3-5 minutes before shutting down.

Move the run-stop-remote switch to stop position to shut down the set.

**Break-in Note:** Run set at 50% rated load for the first half-hour of initial operation after reaching operating temperature.

**Non-Start:** If after a few seconds of cranking engine fails to start, or starts and runs then stops and fault lamp lights, refer to appropriate troubleshooting chart, Table 3 or Table 4.

## EXERCISE PERIOD

If the set is used infrequently, such as in standby service, start and operate for at least 30 minutes once a week. Preferably, run the set under at least 50% load to allow the engine to reach normal operating temperature. This exercise period keeps engine parts lubricated, dries out generator and insures easy emergency starts.

## OUT-OF-SERVICE PROTECTION

Protect a set that will be out-of-service for more than 30 days as follows:

1. Run set 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 1 ounce (two tablespoons) of rust inhibitor (or SAE #10 oil) into each cylinder. Crank engine over several times. Install spark plugs.
4. Service air cleaner 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. Disconnect battery 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 set.
2. Keep cooling system clean.
3. Use correct SAE No. oil for temperature conditions.

**TABLE 3**  
**TROUBLESHOOTING ENGINE SHUTDOWN SYSTEM**  
**(Units with only one fault lamp)**

SYMPTOM	CORRECTIVE ACTION
1. Fault lamp lights and engine stops cranking after approximately 75 seconds.	1. See engine service manual for troubleshooting fuel system, ignition system, etc. After correcting problem, reset the engine monitor by holding run-stop-remote switch in stop position, and depressing reset switch. Release and return to run position.
2. Fault lamp lights immediately after engine starts.	2. Check for: a. overspeed condition as engine starts. b. high temperature condition. c. faulty high engine temperature sensor or overspeed switch. d. faulty starter disconnect.
3. Fault lamp lights after engine is running.	3. Check the following: a. Oil level-engine will shut down after approximately 12-1/2 seconds if low oil pressure sensor does not open. b. Oil pressure sensor may be defective. c. High engine temperature - caused by low coolant level, faulty thermostat, etc. d. Faulty high engine temperature sensor. e. Faulty starter disconnect.
4. Fault lamp lights - no fault condition exists.	4. Be certain that no fault condition exists. Disconnect lead 30 and 31 from TB11 inside control box (refer to wiring diagram). If fault lamp still lights with leads disconnected, remove and replace engine monitor plug-in printed circuit board.

**TABLE 4**  
**TROUBLESHOOTING ENGINE SHUTDOWN SYSTEM**  
**(Units with five fault lamps)**

SYMPTOM	CORRECTIVE ACTION
1. Overcrank fault lamp lights and engine stops cranking after approximately 75 seconds.	1. See engine service manual for troubleshooting fuel system, ignition system, etc. After correcting problem, reset the engine monitor by moving run-stop-remote switch to stop position, and depressing reset switch. PENN STATE. Move and hold run-stop-remote switch to OFF. Press reset, release and move switch to ON.
2. Overcrank fault lamp lights after engine has run for approximately 75 seconds.	2. Replace start-disconnect circuit board.
3. High engine temperature lamp lights as soon as engine starts.	3. Check for defective sensor or actual high temperature condition.
4. Low oil pressure lamp lights after engine is running.	4. Check: a. Oil level - engine will shut down after approximately 12-1/2 seconds if oil pressure is low.
5. High engine temperature lamp lights after engine is running.	5. Check for: a. Defective thermostat/thermostats. b. Low coolant level. c. Defective high engine temperature sensor.
6. Overspeed lamp lights - no fault condition exists.	6. Replace overspeed circuit board.
7. Low oil pressure fault lamp lights - no fault condition exists.	7. Be certain that no fault condition exists. Disconnect lead 30 from TB11 inside control box (refer to wiring diagram). If low oil pressure lamp still lights, remove and replace engine monitor plug-in printed circuit board.
8. High engine temperature fault lamp lights - no fault condition exists.	8. Be certain that no fault condition exists. Remove lead 31 from TB11 inside control box (refer to wiring diagram). If high engine temperature lamp still lights, remove and replace engine monitor plug-in printed circuit board.
9. When pressing test lamp button - one or more fault lamps do not light.	9. Fault lamp/lamps burned out - replace. Engine not running.

## LOW TEMPERATURES

1. Use correct SAE No. oil for temperature conditions. Change oil only when engine is warm.
2. Keep fuel system clean, and batteries in a well charged condition.
3. Partially restrict cool air flow but use care to avoid overheating.
4. Connect water jacket heater when set is not running.
5. Refer to Waukesha manual for further information.

**Engine Heater:** The function of this optional heater is to keep the engine warm enough to assure starting under adverse weather conditions. Connect the heater to a source of power that will be ON during the time the engine is not running. Be sure the voltage rating is correct for the heater element rating. (Figure 16).

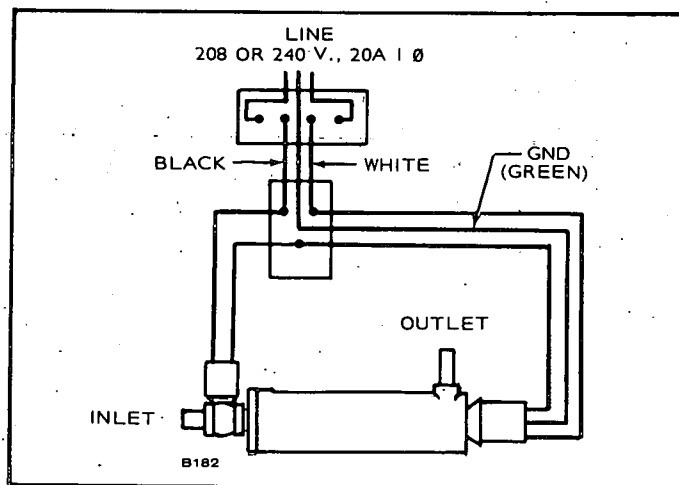


FIGURE 16. ENGINE HEATER

### CAUTION

Do not energize heater until engine cooling system is filled with coolant.

## DUST AND DIRT

1. Keep set clean. Keep cooling system free of dirt, etc.
2. Service air cleaners regularly.
3. Change crankcase oil at proper intervals.
4. Ensure air inlet system is leak free.

## ALTITUDE AND TEMPERATURE

Ratings apply to altitudes up to 1000 feet, ambients up to 100 ° F and with natural gas fuel. Consult factory or nearest authorized Onan distributor for operating characteristics under other conditions.

## 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.

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# GENERAL MAINTENANCE

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## GENERAL

Follow a definite schedule of inspection and servicing, based on operating hours (Table 5). Keep an accurate logbook of maintenance, servicing, and operating time. Use the running time meter (optional equipment) to keep a record of operation and servicing. Service periods outlined below are recommended 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. Refer to Waukesha engine manual for details of engine service and maintenance procedures.

### CAUTION

Before commencing any maintenance work on the engine, generator, control panel, automatic transfer switch or associated wiring, disconnect batteries. Failure to do so could result in damage to the unit or serious personal injury in the event of inadvertent starting.

## ENGINE SPEED

Generator frequency is in direct ratio to engine speed, which is controlled by the governor.

Refer to instructions in Waukesha manual for governor adjustments of speed and droop. Engine speed is 1800 rpm for 60 Hertz operation, and 1500 rpm for 50 Hertz 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:  $30 \times 61$  (Hertz) equals 1830 rpm.

## AC GENERATOR

There are no brushes, brush springs or collector rings on these generators, therefore they require very little servicing. Periodic inspections, to coincide with engine oil changes, will ensure good performance.

**Generator Bearing:** Inspect the bearing every 1000 hours with the unit running.

If using the unit for "prime power", replace the bearing every 10,000 hours or two years. If using the set for "standby", replace the bearing every five years.

Check generator voltage. It may be necessary to make a slight readjustment of the voltage rheostat to obtain the preferred voltage at average load.

## INSPECTION AND CLEANING

When inspecting the rotating rectifier assembly, make sure diodes are 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 out the assembly 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.

## BATTERIES

Check the condition of the starting batteries at least every two weeks. See that connections are clean and tight. A light coating of non-conductive grease will retard corrosion at terminals. Keep the electrolyte at the proper level above the plates by adding distilled water. Check specific gravity, recharge if below 1.280.

## CONNECTIONS (FUEL, EXHAUST, ETC.)

Operator should periodically make a complete visual inspection of the set 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 or daily, drain moisture from condensation traps.
4. Inspect water lines and connections for leaks and security.
5. Inspect electrical wires and connections for security and fray damage.

If generator requires major repair or servicing, contact an authorized Onan dealer or distributor.

**TABLE-5. OPERATOR MAINTENANCE SCHEDULE**

MAINTENANCE ITEMS	OPERATIONAL HOURS			
	8	50	100	200-250
Inspect Plant	x			
Check Radiator Coolant	x			
Check Oil Level	x			
Check Air Cleaner (Clean if Required)		x1		
Clean and Inspect Crankcase Breather			x	
Inspect Fan and Alternator Belt			x2	
Check Cooling System			x3	
Clean and Inspect Battery Charging Alternator				x
Change Crankcase Oil				x1
Replace Oil Filter Element				x1
Check Batteries		x		

x1 - Or every 3 months, perform more often in extremely dusty conditions.

x2 - Or every 3 months, adjust to 1/2 inch depression between pulleys.


x3 - Or every 3 months, check for rust or scale formation. Flush if necessary.

# PARTS CATALOG

## INSTRUCTIONS FOR ORDERING REPAIR PARTS


### ONAN PARTS

All parts in this list are Onan parts. For Onan parts or service, contact the dealer from whom you purchased this equipment or your nearest authorized service station. To avoid errors or delay in filling your order, please refer to the Onan nameplate and give the complete MODEL, SPECIFICATION and SERIAL NUMBER.

<b>Onan</b> <b>ELECTRIC GEN SET</b>			
MODEL <input type="text"/>		SERIAL NO. <input type="text"/>	
<b>IMPORTANT</b> - ALWAYS GIVE ABOVE NOS. WHEN ORDERING PARTS			
CONTINUOUS <input type="text"/>		RATING <input type="text"/>	
HERTZ-60 RPM - 1800			
3 PHASE		1 PHASE	
KW <input type="text"/>	KVA <input type="text"/>	KW <input type="text"/>	KVA <input type="text"/>
VOLTS 120/208 127/220 139/240 120/240/416			
AMPS <input type="text"/>			
VOLTS 254/440 277/480 347/600		120/240	
AMPS <input type="text"/>		10 <input type="text"/>	
BAT. <input type="text"/> VOLTS			
MANUFACTURED BY <b>ONAN</b> DIV. OF STUDEBAKER CORPORATION MINNEAPOLIS, MINN. 55432, U.S.A. FOR ELECT. EQUIPMENT ONLY  95A1C34			

### WAUKESHA PARTS

All Waukesha parts must be ordered from the Waukesha Motor Company of Waukesha, Wisconsin, or their nearest authorized distributor. When ordering parts, refer to the Waukesha nameplate and give the complete MODEL, SIZE and SERIAL NUMBER.

<b>GAS OR GASOLINE ENGINE</b>					
					
MODEL <input type="text"/>			SIZE <input type="text"/>		
SERIAL <input type="text"/>	LOG <input type="text"/>	GAGE <input type="text"/>			
GOV'D SPEED <input type="text"/>		FT VALVES COLD INT <input type="text"/> EXH <input type="text"/>			
OIL SPEC SAE NO. WINTER <input type="text"/>	SUMMER <input type="text"/>	SPARK ADV <input type="text"/>	DEC. AT <input type="text"/>	R.P.M. <input type="text"/>	
WAUKESHA MOTOR COMPANY			WAUKESHA, WISCONSIN		
MADE IN U.S.A.					



This catalog applies to the WF generator sets listed below. 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 part illustrations are typical. Using the Model and Specification from the Onan nameplate, select the parts from this catalog that apply to your set.

**MODEL AND SPECIFICATION\*\***

**WATTS**

290.0WF-517R/\*  
350.0WF-17R/\*

290,000  
350,000

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

\*\* Refer to Specifications Section (Generator Details) in Operators Manual for Electrical Data.

**REPLACEMENT ENGINE**

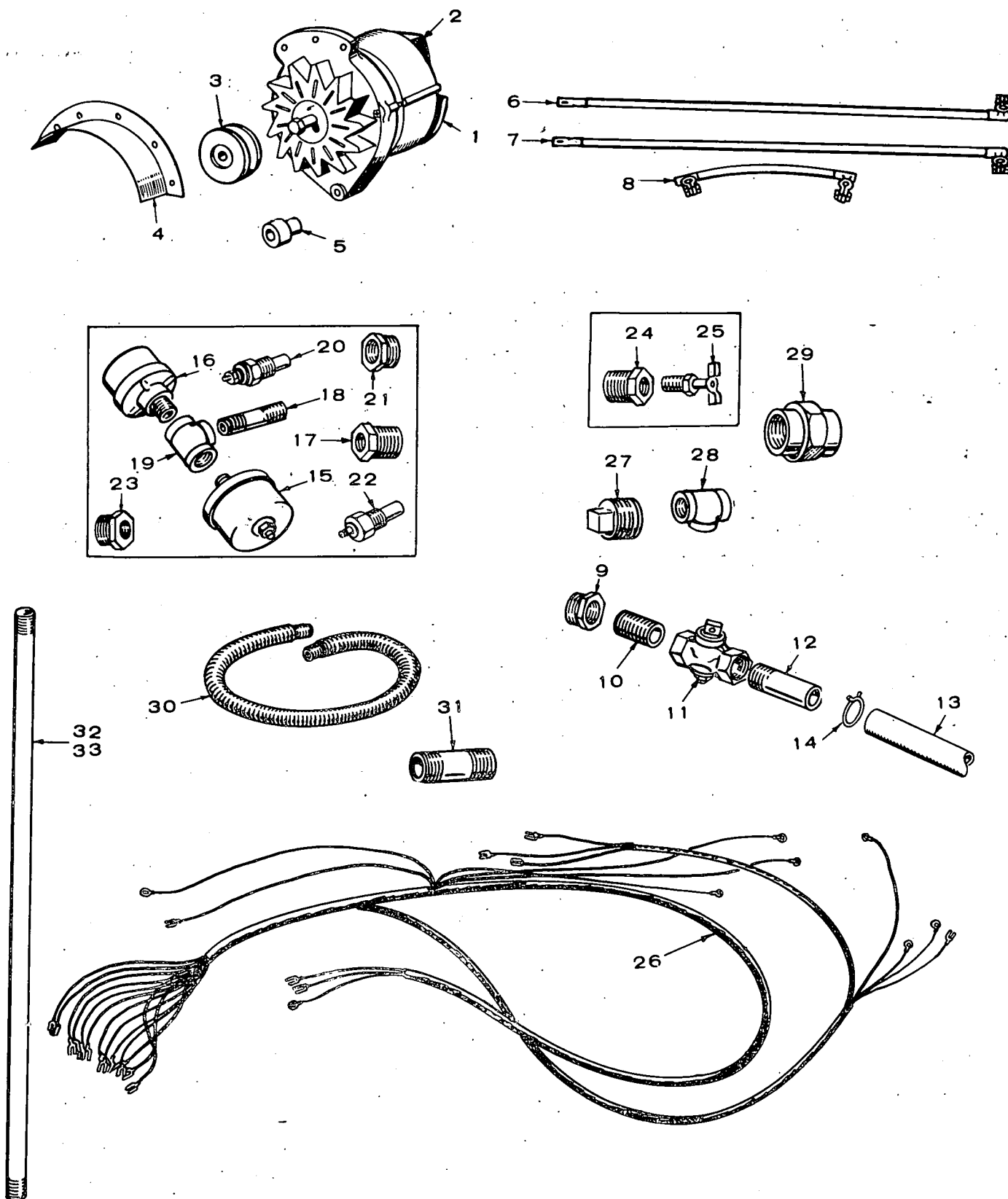
100-0815

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★ Engine, Replacement - Waukesha Motor Company  
Model L1616-GSI.

★ Refer to Waukesha Parts List for engine parts not covered in this manual.

# MISCELLANEOUS ENGINE PARTS GROUP

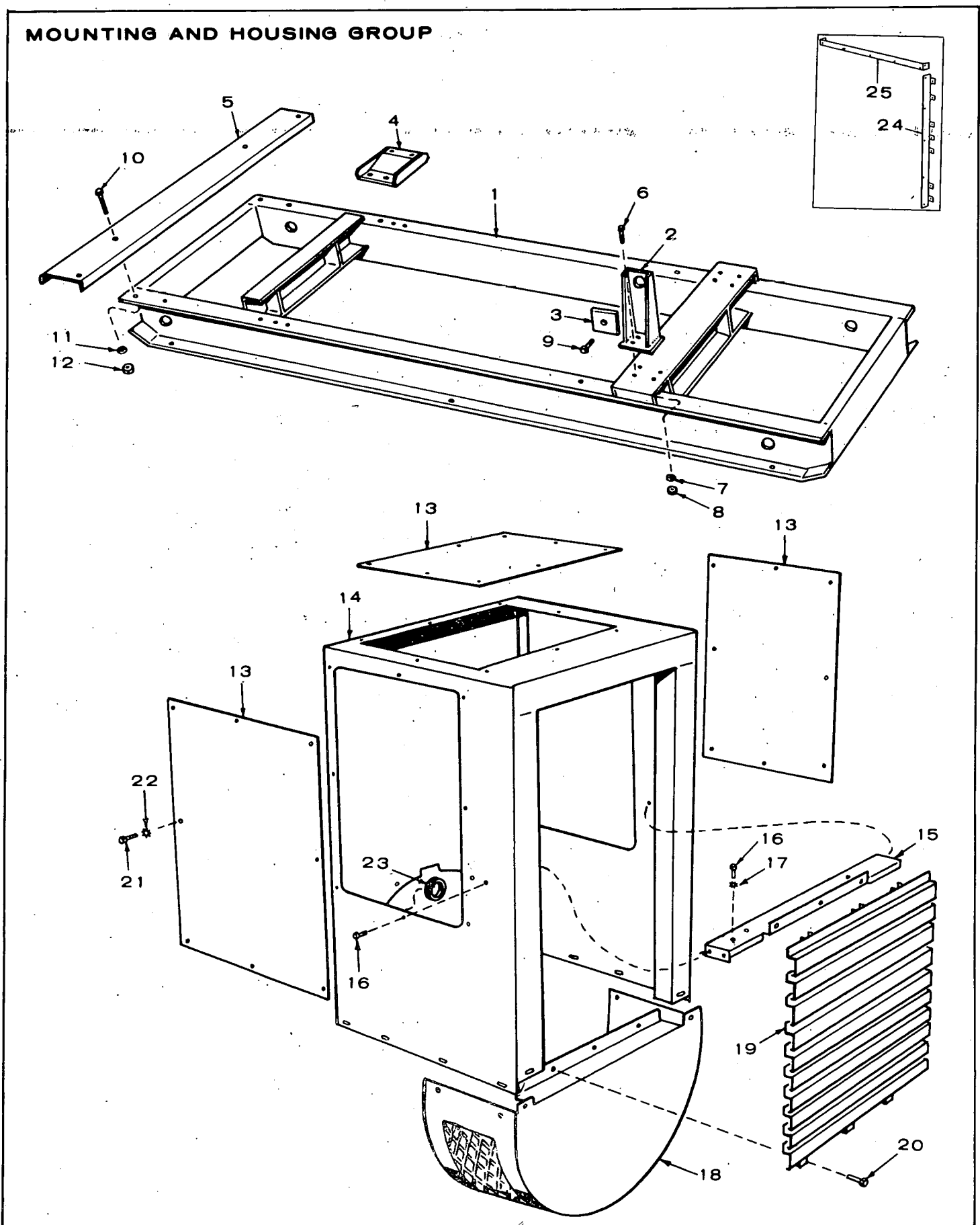


REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	191-0688	1	*Alternator, Charge - Includes Regulator & Fan (Motorola #70D44039B04)
2	191-0733	1	Regulator, Alternator
3	191-0781	1	Pulley, Alternator
4	191-0725	1	Guard, Alternator Belt
5	232-1813	1	Spacer, Alternator Mounting
6	416-0444	1	Cable, Battery - Positive
7	416-0445	1	Cable, Battery - Negative
8	416-0446	1	Cable, Jumper
9	505-0021	1	Bushing, Reducer (3/4 x 1/2")
10	505-0100	1	Nipple, Close (1/2 x 1-1/8")
11	504-0011	1	Valve, Shutoff - Oil Drain
12	505-0185	1	Nipple, Half (1/2 x 1-1/2")
13			Hose, Drain (3/4 x 1") - Order 12" of Bulk Hose #503-0098
14	503-0197	1	Clamp, Hose
15	193-0108	1	Sender, Oil Pressure
16	309-0169	1	Switch, Oil Pressure Cutoff
17	505-0007	1	Bushing (1/4 x 1/8"), Reducer
18	505-0098	1	Nipple (1/8"), Close
19	505-0059	1	Tee (1/8"), Pipe

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
20	193-0109	1	Sender, Water Temperature
21	505-0021	1	Bushing (3/4 x 1/2"), Reducer - Water Temperature Sender
22	309-0178	1	Switch, High Water Temperature
23	505-0455	1	Bushing (1 x 3/8"), Reducer - High Water Temperature Switch
24	505-0131	2	Bushing (3/4 x 3/8"); Reducer - Radiator Drain
25	504-0028	2	Valve, Drain - Radiator Drain
26	338-0707	1	Harness Engine
27	505-0402	1	Plug (1-1/2"), Square Head Pipe
28	505-0317	2	Tee (1-1/2")
29	505-0458	1	Union (1-1/2")
30	503-0331	1	Hose (1-1/2 x 14"), Flex
31	505-0109	1	Nipple (1-1/2 x 2-1/2"), Short
32	505-0706	1	Nipple (1-1/2 x 40"), Pipe
33	505-0707	2	Nipple (1-1/2 x 26-3/4")

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

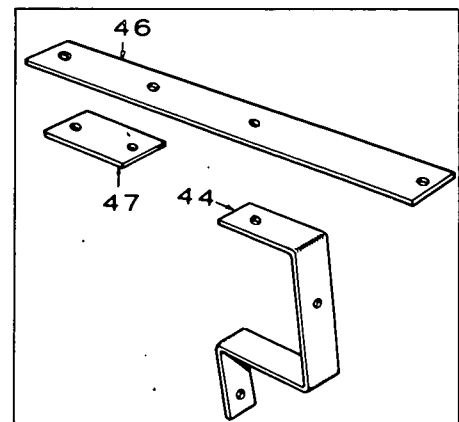
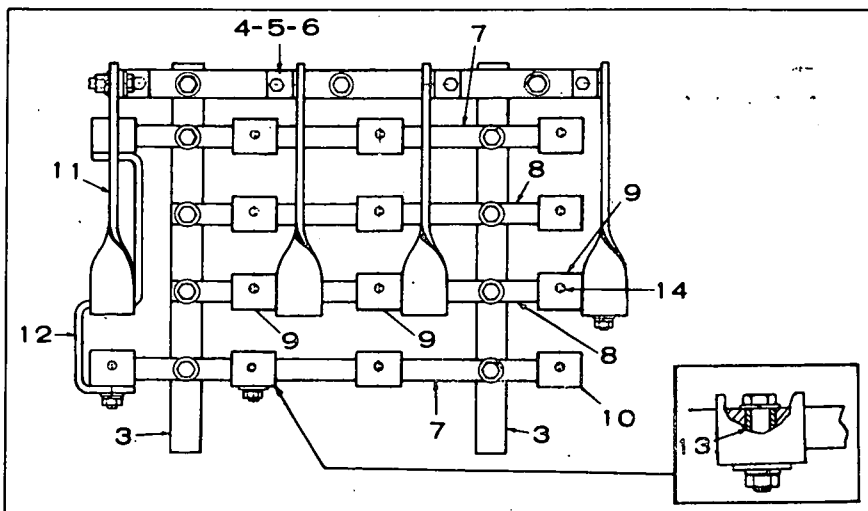
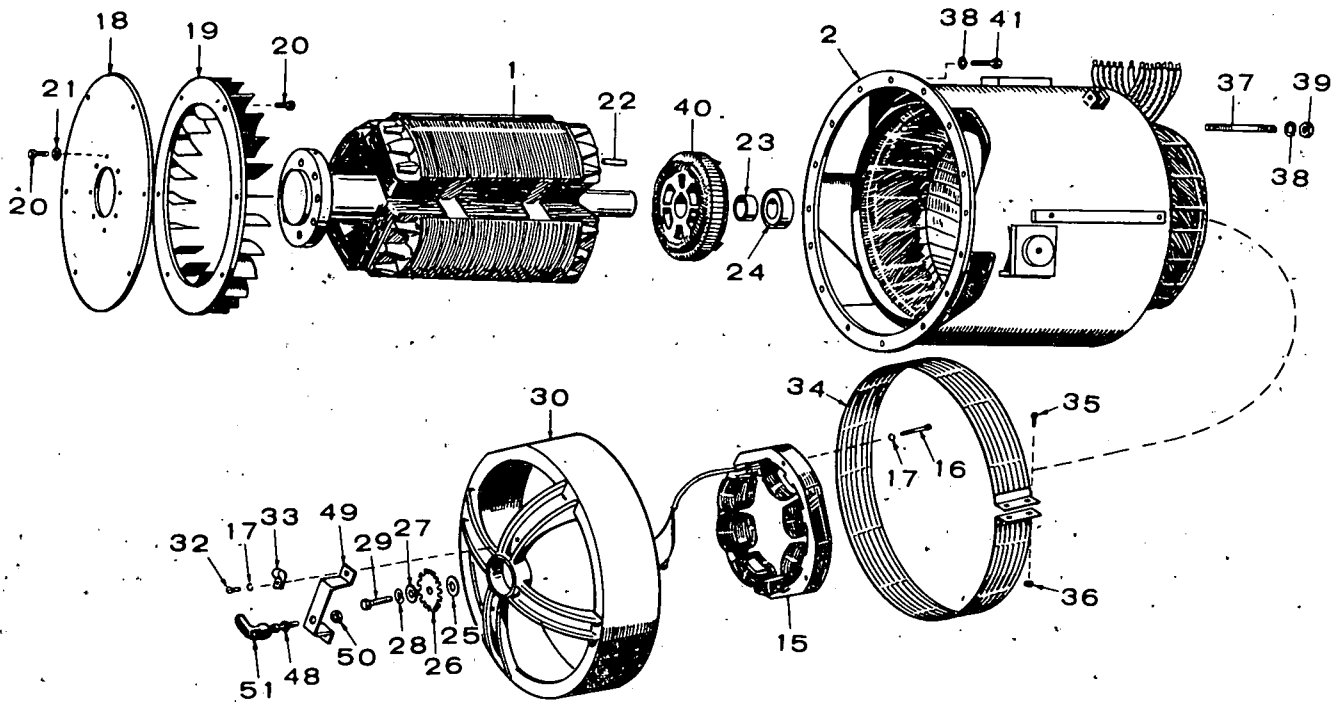
# MOUNTING AND HOUSING GROUP



<u>REF. NO.</u>	<u>PART NO.</u>	<u>QTY. USED</u>	<u>PART DESCRIPTION</u>
1	403-1030	1	Base, Skid
2	232-2386	2	Bracket, Generator Mounting
3	232-2385	2	Plate, Generator Mounting Retainer
4	130-0788	2	Brace, Radiator Mounting
5	130-0789	2	Support, Radiator
6	800-0156	8	Screw (3/4-10 x 2-1/4") - Generator to Skid
7	850-0079	10	Washer (3/4"); Lock
8	862-0020	8	Nut (3/4-10)
9	800-0153	2	Screw (3/4-10 x 1-1/2") - Retainer Plate
10	800-0176	2	Screw (7/8-9 x 3") - Engine Mounting
11	850-0084	2	Washer (7/8"), Lock
12	862-0009	4	Nut (7/8-9)

<u>REF. NO.</u>	<u>PART NO.</u>	<u>QTY. USED</u>	<u>PART DESCRIPTION</u>
13	301-2905	3	Plate, Control Box
14	301-3605	1	Housing, Control Box
15	301-3604	1	Shelf, Control Box Housing
16	821-0010	6	Screw (1/4-20 x 1/2") - Housing Shelf
17	856-0006	2	Washer (1/4") - Shakeproof EIT
18	234-0489	1	Cover, End Bell
19	234-0490	1	Grille, Generator Air Inlet
20	821-0010	9	Screw (1/4-20 x 1/2")
21	815-0241	24	Screw (1/4-20 x 1/2") Truss Head
22	853-0013	24	Washer (1/4"), Shakeproof ET
23	508-0001	1	Grommet, Rubber
24	405-1816	2	Flange, Radiator - Optional
25	405-1817	2	Flange, Radiator - Optional

# GENERATOR GROUP

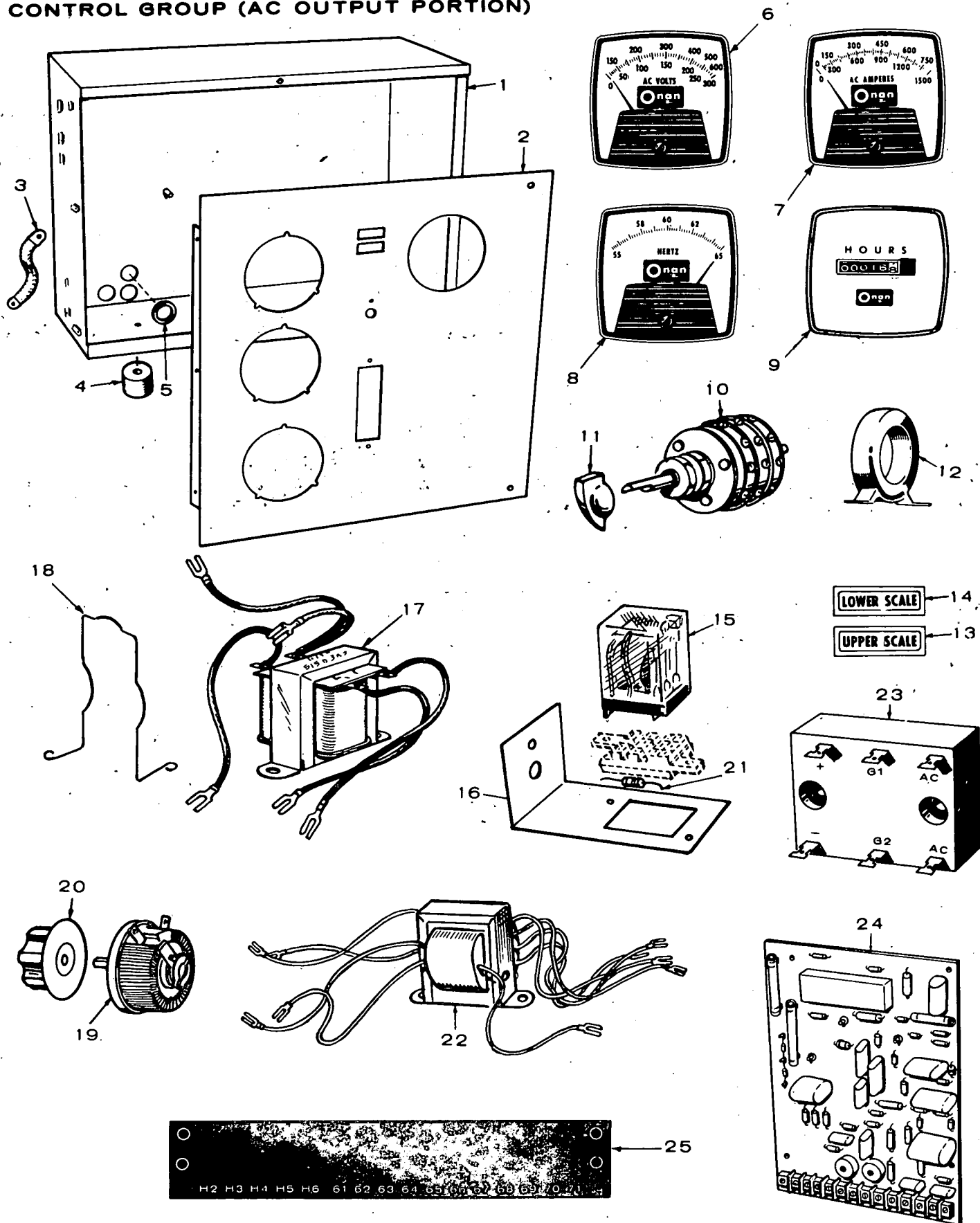


REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	★	1	Rotor Assembly, Wound
2	★	1	Stator Assembly, Wound
3	232-2249	2	Bracket, Terminal Board Mounting
4	232-2237	1	Bracket, Bus Bar Support
5	232-2245	1	Board, Insulating - Bus Bar Support
6	232-2387	4	Bracket, Bus Bar
7	232-2243	2	Board, Insulating
8	232-2242	2	Board, Insulating
9	232-2343	3	Bar, Bus
10	232-2241	11	Bar, Bus
11	232-2240	4	Bar, Bus
12	232-2238	1	Bracket, Bus Bar
13	232-2344	32	Spacer, Terminal Connection
14	520-0142	14	Stud (5/16-18 x 1-1/4")
15	220-1920	1	Stator Assembly, Wound-Exitor
16	800-0009	4	Screw (1/4-20 x 1-1/2") - Stator Assembly
17	850-0040	12	Washer (1/4"), Lock
18	232-2309	1	Disc, Generator Drive
19	205-0103	1	Fan, Generator
20	805-0035	14	Bolt (5/8-11 x 1-1/2"), Drive - (8) Drive Disc to Hub (6) Fan to Drive Disc
21	526-0259	8	Washer - Drive Disc to Hub
22	515-0145	1	Key, Exitor Rotor
23	232-2317	1	Spacer, Bearing
24	510-0106	1	Bearing

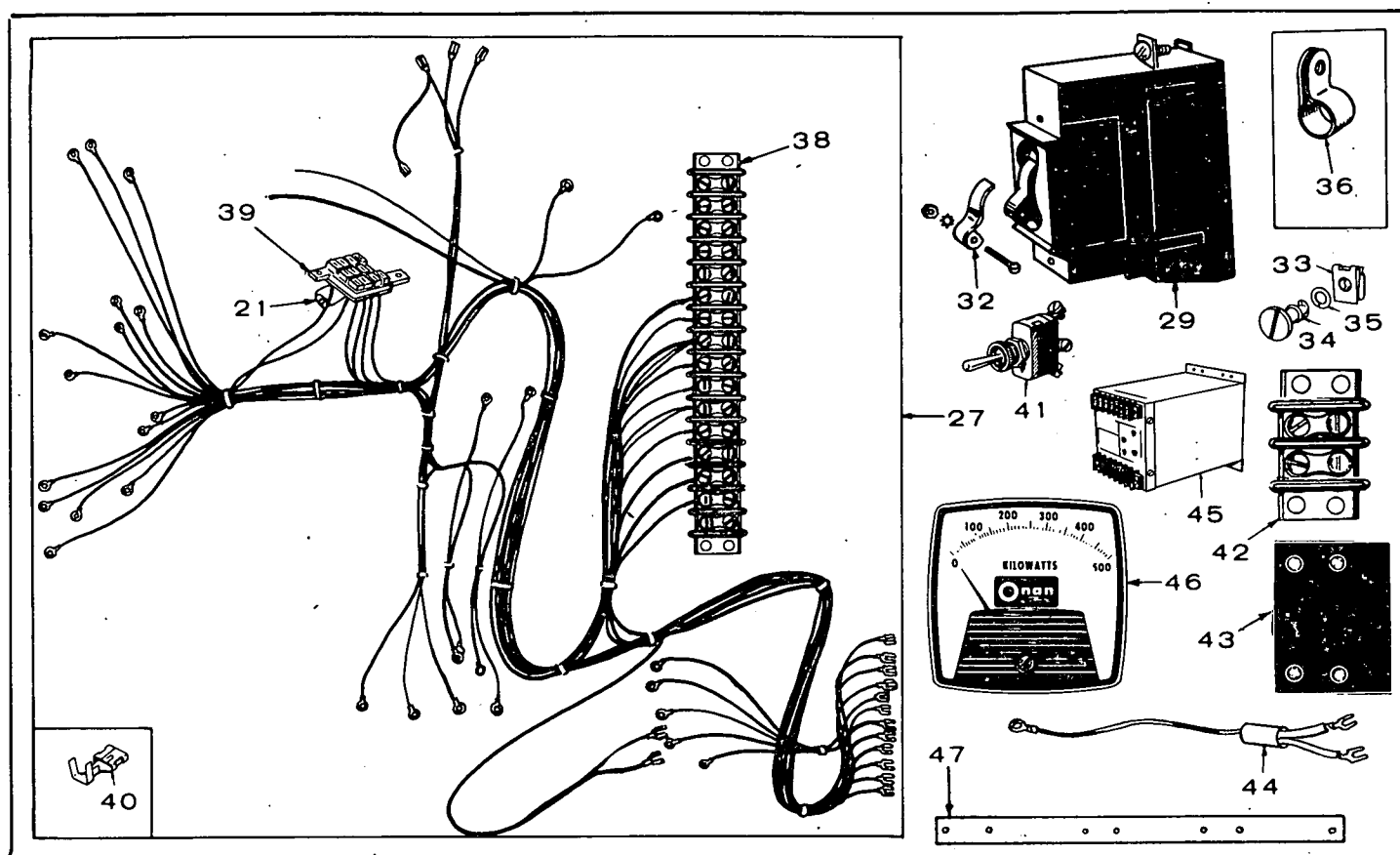
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
25	526-0252	1	Washer (3/4")
26	150-1405	1	Wheel, Speed Sensor
27	526-0028	1	Washer (1/2")
28	850-0060	1	Washer (1/2"), Lock
29	800-0092	1	Screw (1/2-13 x 1-1/2")
30	211-0214	1	End Bell, Generator
32	800-0005	2	Screw (1/4-20 x 3/4") - Speed Sensor Mounting
33	332-1554	1	Clamp, Loop
34	234-0455	1	Screen Assembly, Fan
35	800-0008	2	Screw (1/4-20 x 1-1/4") - Screen Mounting
36	862-0001	2	Nut (1/4-20)
37	520-0780	4	Stud (1/2" x 6-1/2") - End Bell Mounting
38	850-0060	20	Washer (1/2"), Lock
39	862-0016	4	Nut (1/2-13)
40	201-1902	1	Rotor Assy. - Wound-Exitor
41	800-0092	16	Screw (1/2-13 x 1-1/2") - Stator to Engine Adapter
44	232-2342	2	Bracket, Terminal Board Mtg.
45	332-1402	1	Clamp
46	232-2246	2	Bar, Reconnection
47	232-2248	3	Bar, Reconnection
48	150-1406	1	Sensor, Speed
49	150-1407	1	Bracket, Speed Sensor
50	870-0289	1	Nut (3/4-16)
51	150-1410	1	Cap, Insulator

★ - Refer to factory giving complete Model, Spec and Serial Number from the Onan nameplate.

# CONTROL GROUP (AC OUTPUT PORTION)





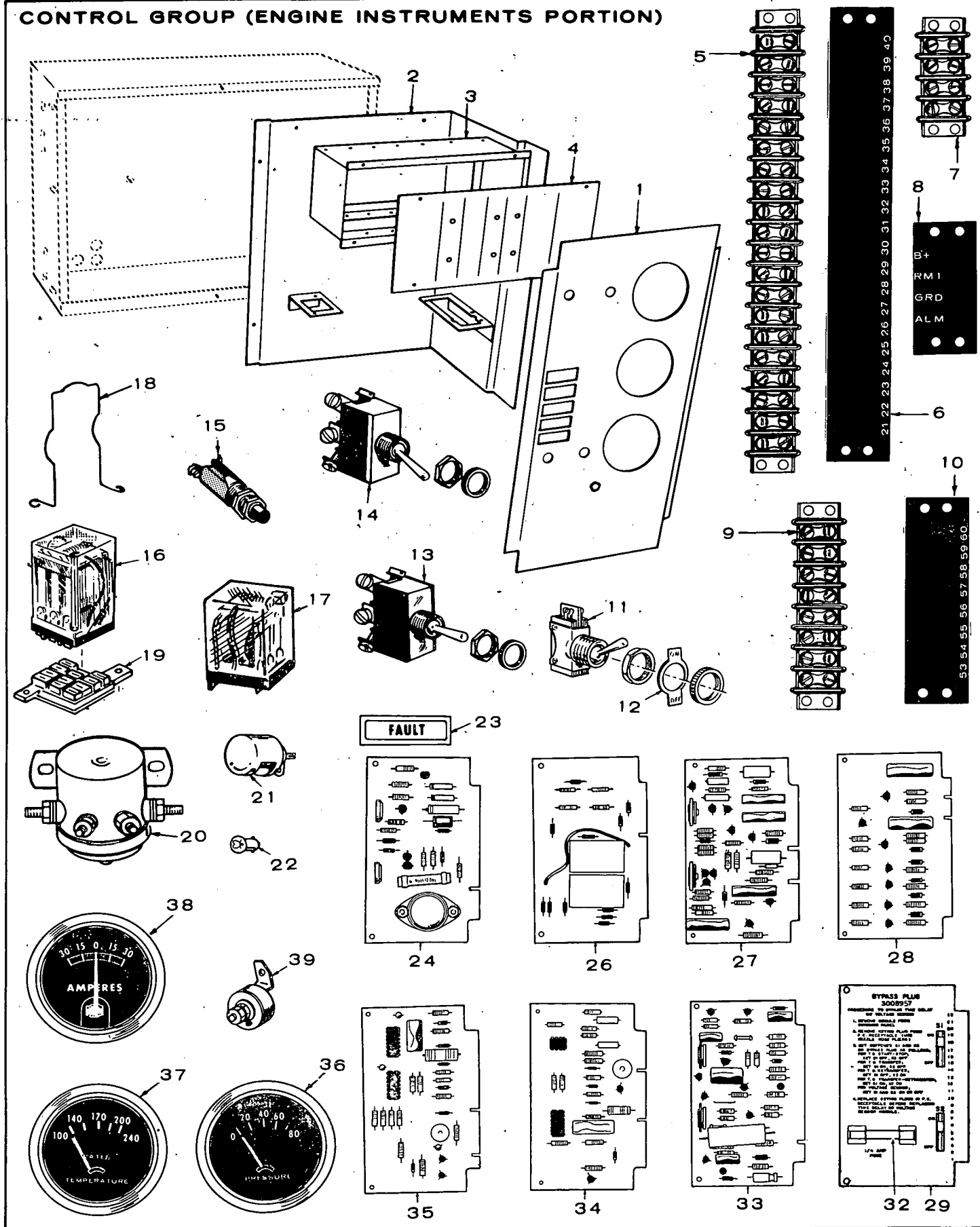


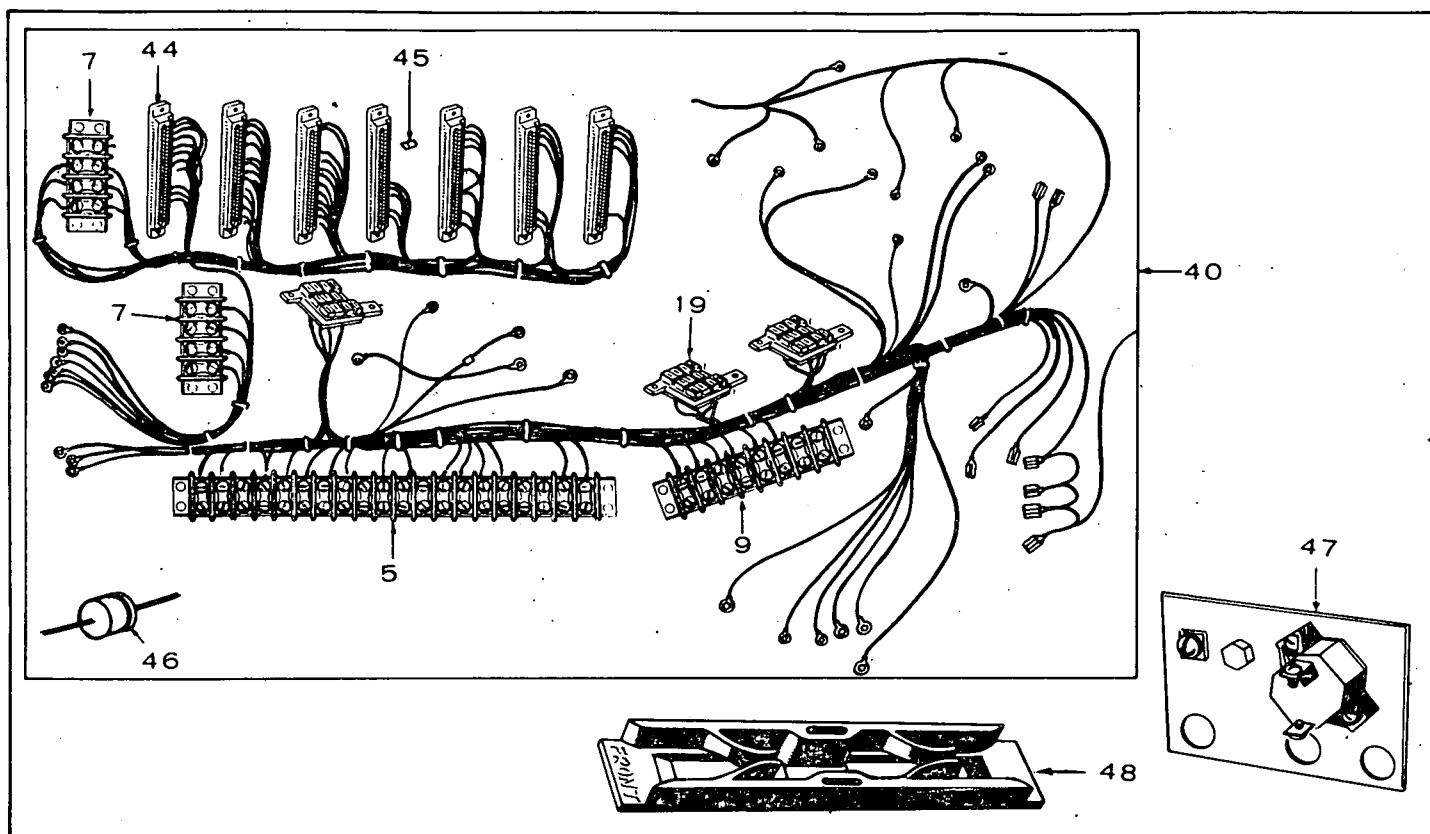
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	301-3158	1	Box, Control
2	PANEL, CONTROL BOX		
	301-3170	1	Standard Units
	301-3312	1	Units With Wattmeter
3	337-0049	1	Strap, Bond
4	402-0070	4	Dampener, Vibration
5	508-0001	4	Grommet (1-1/16"), Rubber
6	302-0718	1	Voltmeter, AC - Dual Scale 0-300, 0-600
7	AMMETER, AC		
	302-0880	1	350 KW - Dual Scale 0-750, 0-1500
	302-0879	1	300 KW - Dual Scale. 0-600, 0-1200
8	METER, FREQUENCY		
	302-0810	1	60 Hertz
	302-0894	1	50 Hertz
9	METER, RUNNING TIME		
	302-0466	1	60 Hertz
	302-0469	1	50 Hertz
10	308-0284	1	Switch, Voltage & Ammeter
11	303-0076	1	Knob
12	TRANSFORMER, CURRENT		
	302-0471	3	350 KW
	302-0876	3	300 KW
13	322-0131	1	Light, Upper Scale
14	322-0130	1	Light, Lower Scale
15	307-1061	1	Relay, Voltage Selector
16	301-3244	1	Bracket, Relay Mounting
17	315-0384	1	Reactor Assembly, Comm
18	307-1157	1	Spring, Relay Holddown
19	303-0170	1	Rheostat, Voltage Adj.
20	303-0032	1	Knob, Rheostat
21	350-0556	1	*Resistor
22	315-0342	1	Transformer, Voltage

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
23	305-0524	1	Bridge, Rectifier
24	332-1268	1	Board Assembly, Printed Circuit Voltage Regulator
25	332-1242	1	Strip, Marker (H2-H6, 61-71)
27	338-0730	1	Harness, Wiring - AC Control (Includes Parts Marked *)
29	320-0455	1	Circuit Breaker (3 Amp)
32	320-0307	1	Lock, Circuit Breaker Handle (Penn State Models) - Optional
33	406-0332	2	Receptacle, Fastener
34	406-0333	2	Stud, Fastener
35	406-0334	2	Washer, Stud Fastener
36	332-0050	1	Clip, Tinnerman
38	332-0795	1	*Block, Terminal - 16 Place
39	323-0764	1	*Socket, Relay
40	332-1280	As Req.	*Terminal, Crimp
41	308-0154	1	Switch, Governor Control - Optional (Used With Motorized Governor)
42	332-0609	1	Block, Terminal (2 Place) - Optional
43	332-0610	1	Strip, Marker (2 Place) - Optional
44	357-0019	1	Diode Assembly - Optional (Used With Motorized Governor)
45	302-0921	1	Transducer, Watt - Optional
46	WATTMETER, AC		
	302-0929	1	350 KW (Scale Reads 0-500)
	302-0928	1	300 KW (Scale Reads 0-500)
47	315-0389	1	Plate, Transformer Mounting

\* - Included in Wiring Harness Assembly.

# CONTROL GROUP (ENGINE INSTRUMENTS PORTION)





REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
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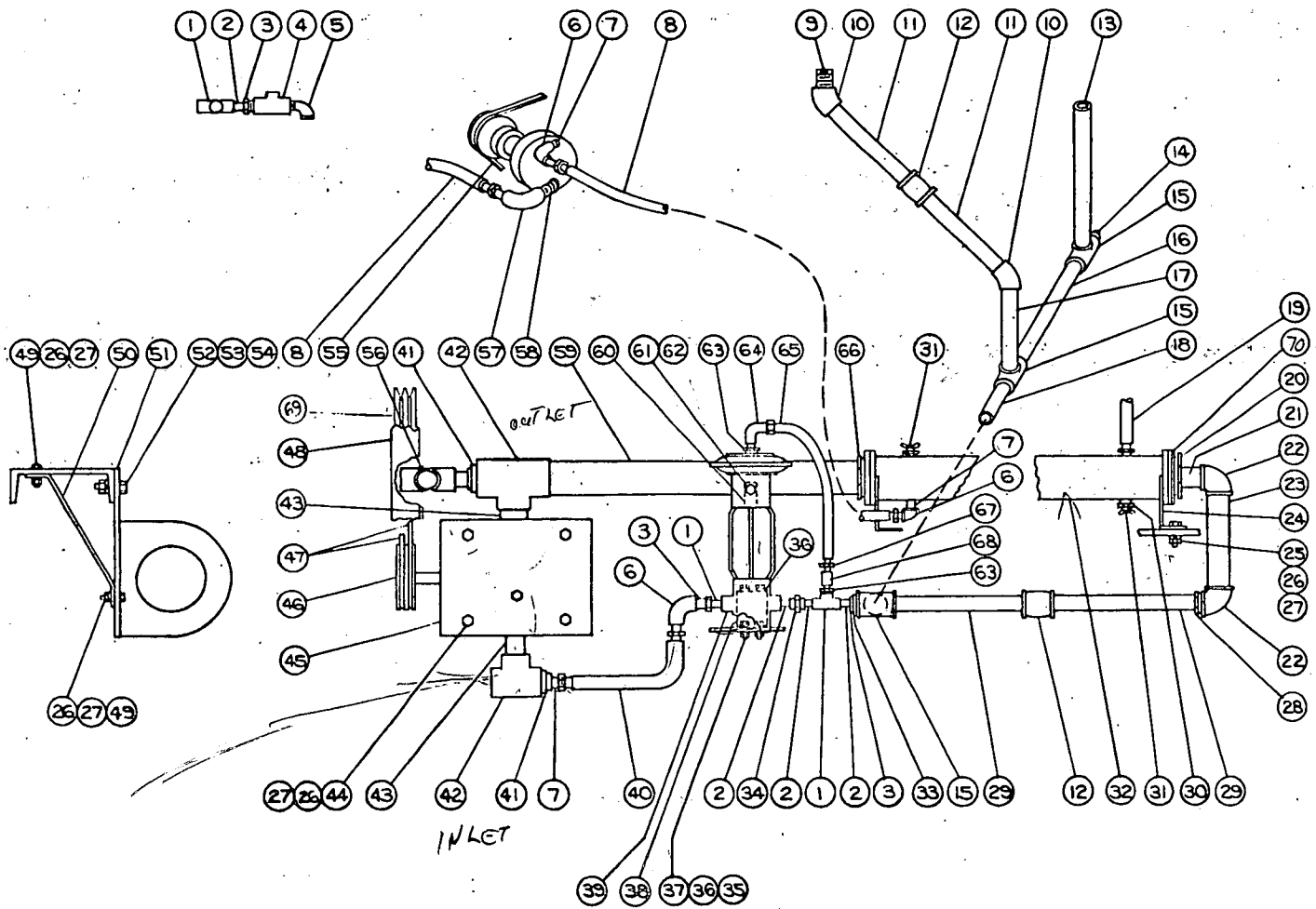
1	PANEL, ENGINE CONTROL		
	301-3661	1	Sets With One Fault Light
	301-3629	1	Sets With Five Fault Lights
2	301-3621	1	Bracket, Engine Control
3	301-3588	1	Rack, Module
4	301-3635	1	Cover Assembly, Rack
5	332-1005	1	*Block, Terminal - 20 Place
6	332-1559	1	Strip, Terminal Block Marker (21-40)
7	332-0537	2	*Block, Terminal - 4 Place
8	STRIP, TERMINAL BLOCK MARKER (4-Place)		
	332-1239	1	B+, Remote, Ground, Alarm
	332-1561	1	1-4
9	332-0699	1	*Block, Terminal - 8 Place - Set With Five Fault Lights
10	332-1560	1	Strip, Terminal Block Marker (53-60) - Sets With Five Fault Lights
11	308-0002	1	Switch, Panel Light
12	308-0003	1	Plate, On-Off Switch
13	SWITCH, SELECTOR		
	308-0220	1	Standard Control
	308-0347	1	Penn State Models (Optional)
14	308-0337	1	Switch, Lamp Test
15	308-0091	1	Switch, Reset
16	307-1056	3	Relay (1) Start Disconnect (1) Ignition (1) Stop
17	307-1061	1	Relay, Starter Protection
18	307-1157	3	Spring, Relay Holddown (4 Used on Sets With Five Fault Lights)
19	323-0765	3	*Socket, Relay - 11 Place (4 Used On Sets With Five Fault Lights)
20	307-0061	1	Relay, Start Solenoid
21	322-0073	1	Holder, Lamp
22	322-0081	1	Lamp, Panel
23	LAMP, FAULT		
	322-0129	1	Standard
	322-0119	1	Overcrank (Optional)
	322-0123	1	Overspeed (Optional)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
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	322-0120	1	Low Oil Pressure (Opt.)
	322-0121	1	High Engine Temperature (Optional)
	322-0122	1	Low Engine Temperature (Optional)
24	CONTROL, CRANKER		
	300-0977	1	Standard Cranker
	300-0956	1	Cycle Cranker (Optional)
26	300-0954	1	Control, Engine Shutdown -
27	300-0953	1	Control, Engine Monitor -
28	300-0955	1	Control, Remote Indicator - Sets With Five Fault Lights
29	300-0987	1	Module, Bypass Plug
32	321-0168	1	Fuse, 1/4 Amp (Part of 300-0987 Module)
33	300-0973	1	Module, Time Delay Start-Stop :
34	300-0957	1	Control, Overspeed Sensor
35	300-0958	1	Control, Starter Disconnect -
36	193-0107	1	Gauge, Oil Pressure
37	193-0106	1	Gauge, Water Temperature
38	302-0061	1	Ammeter, Charge (30-0-30)
39	193-0189	2	Resistor, Gauge
40	Harness, Wiring (Includes Parts Marked *)		
	338-0715	1	Sets With One Fault Light
	338-0705	1	Sets With Five Fault Lights
44	332-1271	6	*Housing, Printed Circuit Board Terminal (Seven on Sets With Five Fault Lights)
45	332-1276	As Req.	*Plug, Keying
46	357-0004	2	Rectifier, Diode
47	332-1383	1	Bracket Assembly, Terminal
48	323-0814	12	Guide, Printed Circuit Board (14 Used on Sets with Five Fault Lights)

\* - Included in Wiring Harness Assembly.

## GAS BOOSTER INSTALLATION

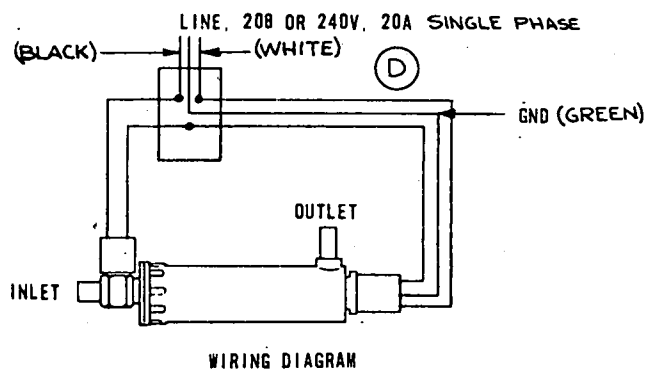
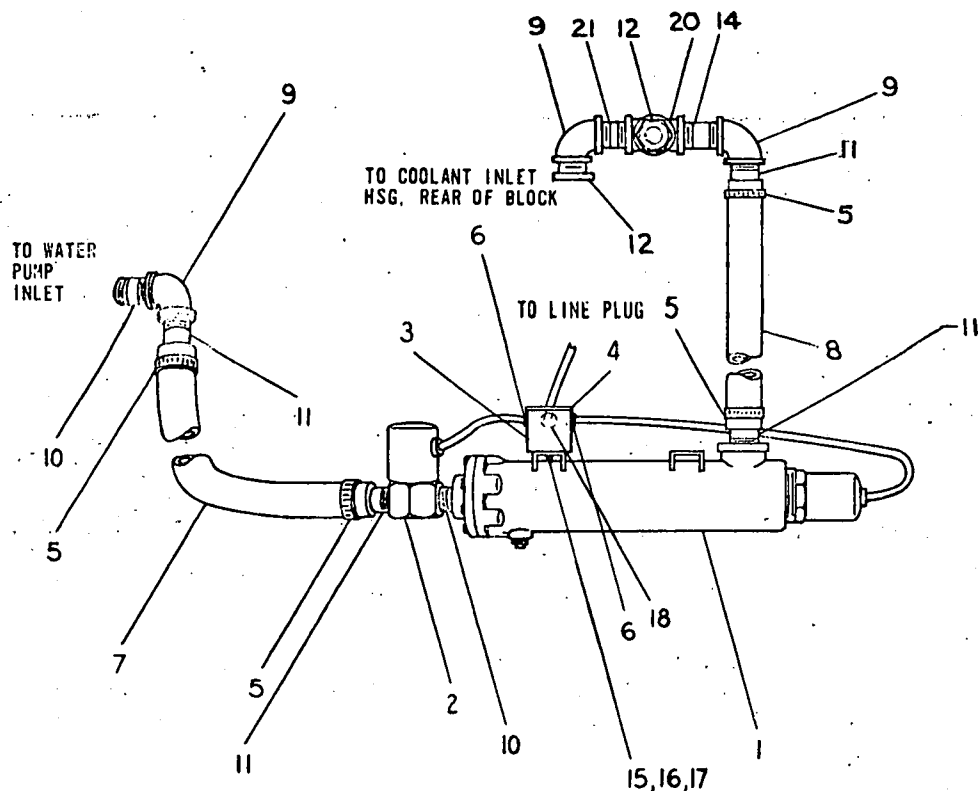


REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	505-0108	3	Tee (1/2"), Pipe
2	505-0100	5	Nipple (1/2 x 1-1/8"), Close
3	505-0021	4	Bushing, (3/4 x 1/2"), Reducer
4	307-0312	2	Valve (3/4"), Magnetic
5	505-0051	2	Elbow (3/4"), Street
6	505-0132	3	Elbow (90° x 3/4"), Pipe
7	505-0102	3	Nipple (3/4 x 1-3/8"), Close
8	501-0183	2	Line, Flexible
9	505-0220	1	Nipple (1-1/2 x 1-3/4"), Close
10	505-0191	2	Elbow (45° x 1-1/2"), Pipe
11	505-0737	2	Nipple (1-1/2 x 11-1/2"), Half
12	505-0735	2	Coupling, Compression
13	505-0707	1	Nipple (1-1/2 x 26-3/4"), Pipe
14	505-0402	1	Plug (1-1/2"), Square Head
15	505-0317	3	Tee (1-1/2"), Pipe
16	505-0706	1	Nipple (1-1/2 x 40"), Pipe
17	505-0261	1	Nipple (1-1/2 x 4-1/2"), Pipe
18	505-0094	1	Nipple (1-1/2 x 7"), Pipe
19	501-0184	1	Line, Flexible
20	505-0738	1	Bushing (3 x 2"), Reducer
21	505-0172	1	Nipple (2 x 2"), Close
22	505-0175	2	Elbow (90° x 2"), Pipe
23	505-0173	1	Nipple (2 x 4"), Pipe
24	148-0701	2	Bracket, Aftercooler
25	800-0092	2	Screw (1/2-13 x 1-1/2")
26	850-0060	8	Washer (1/2"), Lock
27	862-0005	8	Nut (1/2-13)
28	505-0187	1	Bushing (2 x 1-1/2"), Reducer
29	505-0736	2	Nipple (1-1/2 x 22-1/2"), Half
30	505-0019	1	Bushing (1/2 x 3/8"), Reducer
31	504-0028	2	Valve (3/8"), Drain
32	148-0699	1	Booster Package, Gas
33	505-0289	1	Bushing (1-1/2 x 3/4"), Reducer
34	505-0150	1	Union (1/2"), Pipe
35	862-0003	2	Nut (3/8-16)
36	850-0050	4	Washer (3/8"), Lock

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
37	800-0052	2	Screw (3/8-16 x 1-1/2")
38	148-0702	1	Bracket, Regulator Valve
39	Part of Item 32		Pressure Regulator (1/2"), By-Pass
40	501-0182	1	Line, Flexible
41	505-0397	2	Bushing (2-1/2 x 3/4"), Reducer
42	505-0227	2	Tee (2-1/2"), Pipe
43	505-0103	2	Nipple (2-1/2 x 2-1/2"), Close
44	800-0093	4	Screw (1/2-13 x 1-3/4")
45	Part of Item 32		Cycle Blower
46	512-0053	1	Pulley, Booster Pump
47	511-0096	2	Belt, Vee
48	148-0706	1	Guard, Belt
49	800-0090	2	Screw (1/2-13 x 1")
50	148-0704	1	Bracket, Booster Pump
51	148-0705	1	Base, Booster Pump
52	800-0135	3	Screw (5/8-11 x 2-1/4")
53	850-0070	3	Washer (5/8"), Lock
54	862-0007	3	Nut (5/8-11)
55	511-0089	1	Belt, Vee
56	Part of Item 32		Relief Valve (3/4")
57	505-0356	1	Elbow (1 x 3/4"), Reducer
58	505-0004	1	Nipple (1 x 1-1/2"), Close
59	503-0577	1	Tubing, Flexible
60	148-0703	1	Bracket, Regulator Valve
61	800-0026	1	Screw (5/16-18 x 3/4")
62	850-0045	1	Washer (5/16"), Lock
63	505-0018	2	Bushing (1/2 x 1/4"), Reducer
64	502-0165	1	Elbow (1/2-20), Male
65	501-0188	1	Line, Flexible
66	505-0480	1	Bushing (3 x 2-1/2"), Reducer
67	502-0193	1	Connector Male Flare
68	505-0027	1	Coupling (1/4"), Pipe
69	512-0055	1	Pulley, Pump Drive
			Mounts on Engine)
70	Part of Item 32		Flange Package

179-0428

## WATER JACKET HEATER INSTALLATION - 240 VOLT

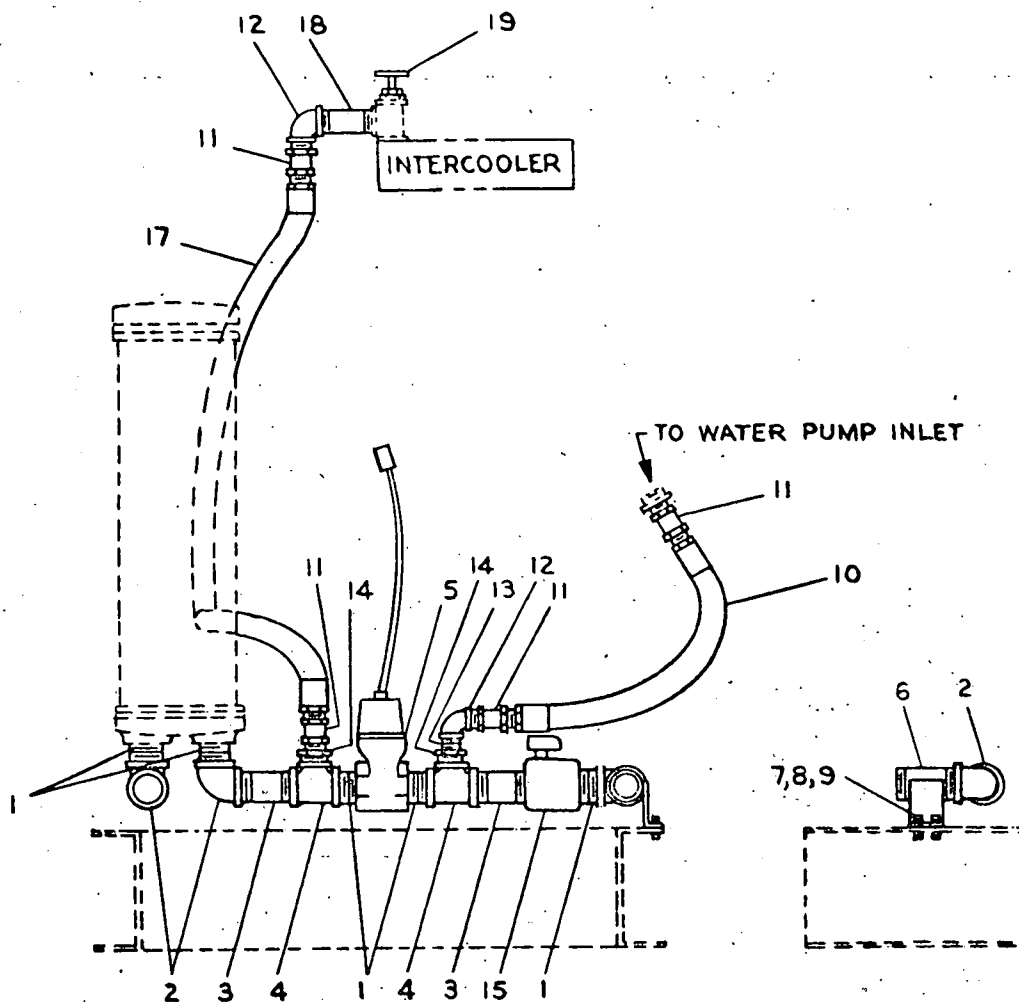


REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	333-0138	1	Heater, Engine (4000 Watts, 240 Volts)
2	309-0253	1	Thermostat
3	330-0005	1	Box, Outlet
4	330-0004	1	Cover, Box
5	503-0429	4	Clamp, Hose
6	503-0008	2	Grommet (1/2" I.D. x 1-1/16" O.D.)
7		1	Hose (Order 27" of Bulk Hose #503-0249)
8		1	Hose (Order 95" of Bulk Hose #503-0249)
9	505-0041	3	Elbow, Pipe (1" x 90°)
10	505-0107	2	Nipple, Pipe (1 x 2")
11	505-0759	4	Nipple, Half (1 x 4-3/4")
12	505-0129	3	Bushing, Reducer (1 x 3/4)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
14	505-0086	1	Nipple, Pipe (1 x 2-1/2")
15	813-0103	2	Screw, RHM (10-32 x 3/4")
16	850-0030	2	Washer, Lock (#10)
17	870-0053	2	Nut, Hex (10-32)
18	331-0027	1	Connector, Romex (1/2")
20	505-0719	1	Cross, Pipe (1")
21	505-0004	1	Nipple, Pipe (1 x 1-1/2")
22	309-0271	1	*Switch, Oil Pressure
	333-0142	1	*Support, Pressure Switch
	502-0287	2	*Elbow
	501-0188	1	*Line, Flexible (24")
	505-0099	1	*Nipple (1/4 x Close)

\* - These parts are not illustrated.

## HEAT EXCHANGER INSTALLATION

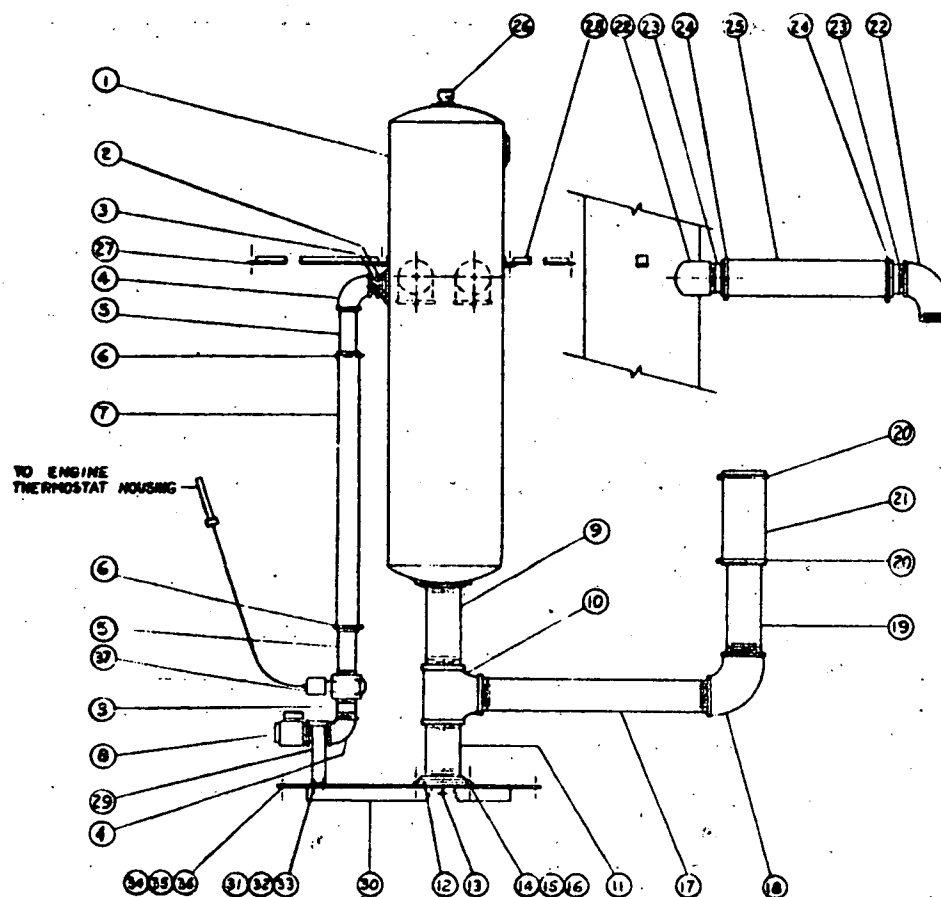


REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	505-0172	5	Nipple, Close (2 x 2")
2	505-0175	3	Elbow, Pipe (2 x 90°)
3	505-0405	2	Nipple, Pipe (2 x 5")
4	505-0374	2	Tee, Pipe (2")
5	309-0245	1	Valve, Marsh
6	130-0801	1	Nipple Assembly
7	800-0007	2	Screw (1/4-20 x 1")
8	850-0040	2	Washer, Lock (1/4")
9	862-0001	2	Nut (1/4-20)
10	501-0186	1	Line, Flexible
11	502-0391	4	Adapter, Hose
12	505-0041	2	Elbow, Pipe (1" x 90°)
13	505-0004	1	Nipple, Close (1 x 1-1/2")
14	505-0394	2	Bushing, Reducer (2 x 1")
15	307-0844	1	Valve, Solenoid
17	501-0187	1	Line, Flexible
18	505-0088	1	Nipple, Pipe (1 x 4-1/2")
19	504-0003	1	Valve, Drain (1/4")

## NOTES:

1. Do Not Remove Thermostats.
2. Expansion Tank Removed.

## STANDPIPE INSTALLATION (With Marsh Regulator)



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	130-0687	1	Standpipe
2	505-0270	1	Bushing, Reducer (2 x 1-1/4")
3	505-0258	2	Nipple (1-1/4 x 3")
4	505-0042	2	Elbow (90°)
5	505-0437	2	Nipple, Half (1-1/4 x 4")
6	503-0011	2	Clamp
7	503-0359	1	Hose (1-5/8" I.D. x 3')
8	307-0839	1	Valve, Solenoid
9	505-0679	1	Nipple (3 x 12")
10	505-0669	1	Tee
11	505-0328	1	Nipple (3 x 6")
12	130-0740	1	Flange Assembly
13	504-0006	1	Valve, Drain
14	800-0091	4	Screw (1/2-13 x 1-1/4") - Not Shown
15	862-0005	4	Nut (1/2-13) - Not Shown
16	850-0060	4	Washer, Lock (1/2") - Not Shown
17	505-0615	1	Nipple (3 x 24")
18	505-0453	1	Elbow (90°)
19	505-0604	1	Nipple (3 x 9-3/4")
20	503-0622	2	Clamp
21	503-0569	1	Hose (3-1/2" I.D. x 10")

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
22	505-0216	2	Elbow, Street (90°)
23	505-0178	4	Nipple, Half
24	503-0059	4	Clamp
25	503-0512	2	Hose (2-7/8" I.D. x 18")
26	504-0062	1	Valve, Relief
27	130-0465	1	Brace
28	130-0466	1	Brace
29	110-1168	1	Bracket & Nipple Assembly
30	130-0461	1	Support
31	800-0006	2	Screw (1/4-20 x 7/8") - Not Shown
32	862-0001	2	Nut (1/4-20) - Not Shown
33	850-0040	2	Washer, Lock (1/4") - Not Shown
34	800-0092	4	Screw (1/2-13 x 1-1/2") - Not Shown
35	862-0005	4	Nut (1/2-13) - Not Shown
36	850-0060	4	Washer, Lock (1/2") - Not Shown
37	309-0243	1	Valve, Marsh (1-1/4")

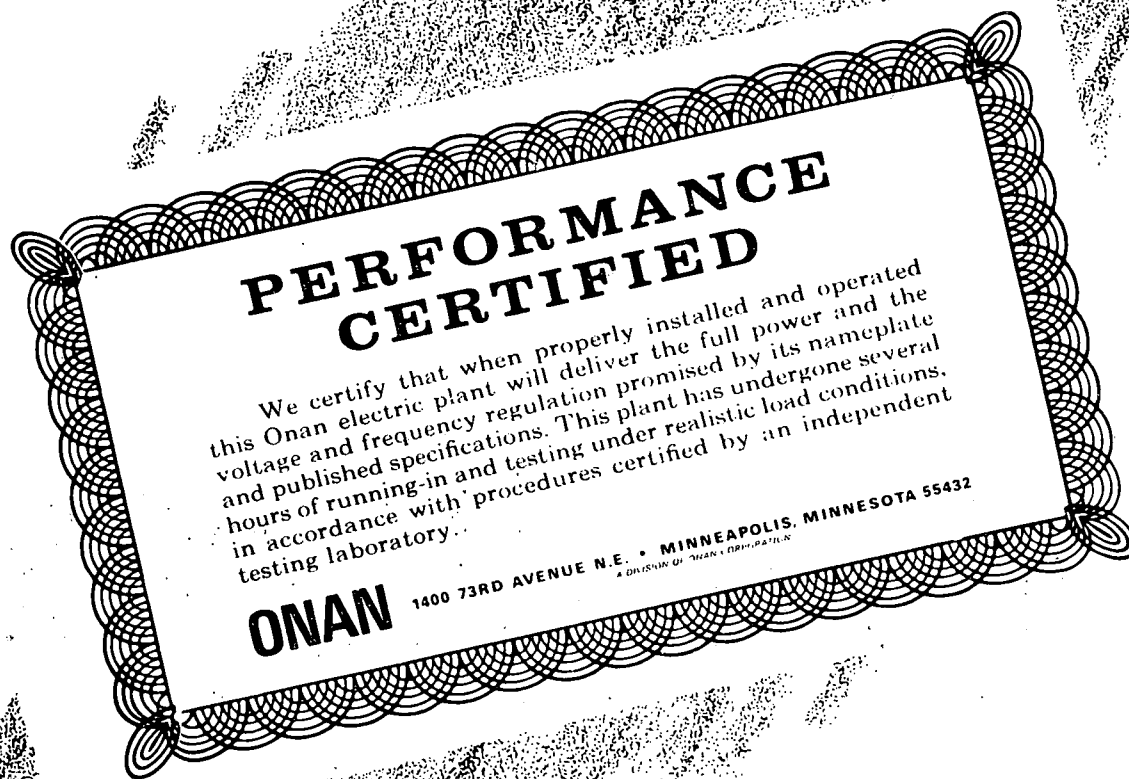
NOTE: Remove Thermostat From Engine.

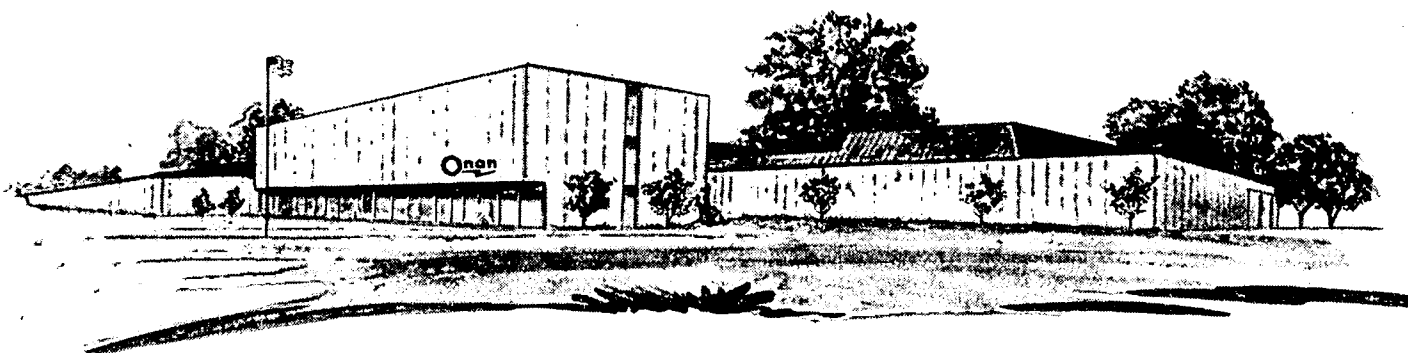


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