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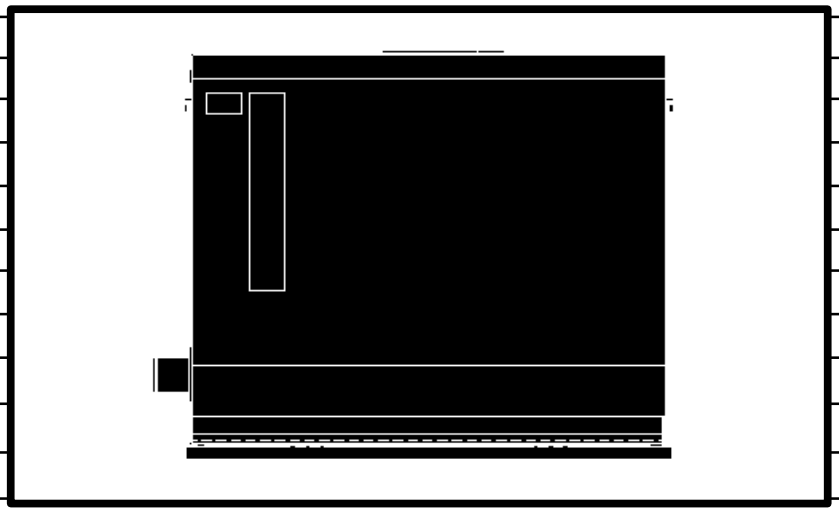
Onan MARINE

# Service Manual

## MDKUB, MDKWB



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981-0512
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# Safety Precautions

**Before operating the generator set,** read the Operator's Manual and become familiar with it and your unit. **Safe and efficient operation can be achieved only if the unit is properly operated and maintained.** Many accidents are caused by failure to follow fundamental rules and precautions.

Throughout this manual you will notice symbols which alert you to potentially dangerous conditions to the operator, service personnel, or the equipment itself.

**⚠DANGER** ***This symbol warns of immediate hazards which will result in severe personal injury or death.***

**⚠WARNING** ***This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.***

**⚠CAUTION** ***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***

**FUEL, ENGINE OIL, AND FUMES ARE FLAMMABLE AND TOXIC.** Fire, explosion, and personal injury can result from improper practices.

- Benzene and lead, found in some gasoline, have been identified by some state and federal agencies as causing cancer or reproductive toxicity. When checking, draining or adding gasoline, take care not to ingest, breathe the fumes, or contact gasoline.
- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.
- Do not fill fuel tanks with the engine running. Do not smoke around the generator set area. Wipe up any oil or gas spills. Do not leave oily rags in engine compartment or on the generator set. Keep this and surrounding area clean.
- Inspect fuel system before each operation and periodically while running.
- Equip the engine fuel supply with a positive fuel shutoff.
- Always disconnect the battery ground (–) lead first and reconnect it last. Make sure you connect the battery correctly. A direct short across the battery terminals can cause an explosion. Do not smoke while servicing batteries. Hydrogen gas given off during charging is very explosive.
- Keep a fire extinguisher available in or near the engine compartment and in other areas throughout the vessel. Use the correct extinguisher for the area. For most types of fires, an extinguisher rated ABC by the NFPA is available and suitable for use on all types of fires except alcohol.

**EXHAUST GASES ARE DEADLY**

- Provide adequate ventilation. Equip the bilge with a power exhauster.
- Be sure propulsion and generator set engine exhaust systems are free of leaks. Perform thorough, periodic inspections of the exhaust system and repair leaks immediately. Exhaust gases are deadly.
- Never sleep in the vessel with the generator set running unless the vessel is equipped with an operating carbon monoxide detector.

**HOT COOLANT CAN CAUSE SEVERE PERSONAL INJURY**

- Hot coolant is under pressure. Do not loosen the coolant pressure cap while the engine is hot. Let the engine cool before opening the pressure cap.

**MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH**

- Do not remove any belt guards or covers with the generator set running.
- Keep hands and loose clothing away from moving parts. Do not wear jewelry while servicing any part of the generator set.
- Never step on the generator set (as when entering or leaving the engine compartment). It can stress and break unit components, possible resulting in dangerous operating conditions. . . from leaking fuel, leaking exhaust fumes, etc.
- Before performing any maintenance on the generator set, disconnect its batteries to prevent accidental starting. do not disconnect or connect battery cables if fuel vapors are present. Ventilate the generator set compartment or bilge thoroughly with the power exhauster.

**ELECTRICAL SHOCK WILL CAUSE SEVERE PERSONAL INJURY OR DEATH**

- Do not make adjustments in the control panel or on engine with unit running. High voltages are present. Work that must be done while unit is running should be done only by qualified service personnel standing on dry surfaces to reduce shock hazard.
- DO NOT CONNECT THE GENERATOR SET TO THE PUBLIC UTILITY OR TO ANY OTHER ELECTRICAL POWER SYSTEM. Electrocution or damage to property can occur at a site remote from the boat where line or equipment repairs are being made if the set is connected to the power system. An approved transfer switch must be used if more than one power source is to be made available to service the boat.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.

**Copy and post these suggestions in potential hazard areas of the vessel.**

# Table of Contents

# Section 1. Introduction

## ABOUT THIS MANUAL

This manual contains troubleshooting and repair data for these components of the MDKUB/MDKWB generator set:

- Engine controls
- Generator
- Exhaust system
- Cooling system

All engine service information is found in the Engine Service Manual (981-0514).

Study this manual carefully. Heed all warnings and cautions. Proper use and maintenance can result in longer set life, better performance and safer operation.

This manual contains basic wiring diagrams and schematics for troubleshooting. Technicians should use the wiring diagram and schematic shipped with each unit. Update these diagrams and schematics when the set is modified.

PC board information is limited; in the field, it is more efficient to replace the boards than to attempt repair.

## ASSISTANCE

When contacting an Onan® distributor, supply the complete model number and serial number shown on the Onan nameplate on the side of the generator control box.

## TEST EQUIPMENT

- Multimeter/digital VOM
- AC voltmeter
- DC voltmeter
- Frequency meter
- Jumper leads
- Load test panel
- Megger or insulation resistance meter
- Wheatstone bridge or digital ohmmeter

**⚠WARNING** ***Incorrect service or replacement of parts can result in severe personal injury, death, and /or equipment damage. Service personnel must be qualified to perform electrical and mechanical service.***

## SAFETY CONSIDERATIONS

Generator sets present safety hazards that the technician must know about. Read the precautions on the inside cover of this manual. Familiarize yourself with the hazards shown in Table 1-1. When the hazards are known, approach the job with a safety-conscious attitude. Being safety-conscious is the best way to avoid injury. **Reduce the chance of an accident with the following safeguards.**

### Safeguards To Avoid Hazards

- **Use Protective Clothing.** Protect your body by wearing protective clothing such as:
  - Safety shoes
  - Gloves
  - Safety glasses
  - Hard hats

  Leave rings and jewelry off. Do not wear loose clothing that might get caught on equipment.

- **Reduce Workshop Hazards.**
  - Keep guards and shields in place on machinery
  - Maintain equipment in good working order
  - Store flammable liquids in approved containers away from open flame, spark, pilot light, cigarette, or other ignition source
  - Keep the workshop clean and well-lighted
  - Provide adequate ventilation
  - Keep a fire extinguisher and safety equipment nearby
  - Be prepared to respond to an emergency

- **Develop Safe Work Habits.**

  Unsafe actions are the source of most accidents with tools and machines. Be familiar with the equipment and know how to use it safely. Use the right tool for the job, and check its condition before starting. Observe the warnings

and cautions in this manual and take special precautions when working around electrical equipment. Do not work alone if possible and do not take unnecessary risks.

- **Be prepared if an accident occurs.**

Agencies such as the Red Cross and local police and fire departments offer courses in first aid, CPR, and fire control. Take advantage of this information to be ready to respond to an accident. Learn to be safety conscious and make safe practices a part of your work routine. Do not work when tired or after consuming any alcohol or drug that makes the operation of equipment unsafe.

**TABLE 1-1**
**HAZARDS AND THEIR SOURCES**

- **Fire and explosions**
  - Leaking fuel
  - Hydrogen gas from charging battery
  - Oily rags improperly stored
  - Flammable liquids improperly stored
  - Any fire, flame, spark, pilot light, arc-producing equipment or other ignition sources
- **Burns**
  - Hot exhaust pipes
  - Hot engine and generator surfaces
  - Hot engine oil
  - Electrical short in DC wiring system
  - Hot engine coolant
- **Poisonous gases**
  - Carbon monoxide from faulty exhaust pipes, joints or hangers
  - Operating generator set where exhaust gases can accumulate
- **Electrical shock (AC)**
  - Improper genset load connections
  - Faulty boat wiring
  - Faulty electrical appliance
  - Faulty genset wiring
  - Working in damp conditions
  - Jewelry touching electrical components
- **Rotating Machinery**
  - Flywheel fan guard not in place
  - Jewelry or loose clothing catching in moving parts
- **Slippery Surfaces**
  - Leaking or spilled oil
- **Heavy Objects**
  - Removing generator set from vessel
  - Removing heavy components

## SET REMOVAL

Some service procedures require removing the generator set from the vessel. Because of the wide variety of installations, it is not possible to specify exact removal procedures for each genset. If a satisfactory method for removing a particular set cannot be determined, contact the boat manufacturer or the set installer for their recommendations.

**⚠WARNING** ***Generator sets are heavy and they can cause severe personal injury or death if dropped during removal. Use adequate lifting devices to provide sufficient support for the set. Keep hands and feet clear while lifting the generator set.***

### Disconnecting Generator Set Systems

Some installations require partial removal of the set to gain access to the battery cable, fuel line, and other connections. Read this entire section before starting set removal. The following steps are a general guideline.

**⚠WARNING** ***Leakage of fuel in or around the generator set compartment presents the hazard of fire or explosion that can cause severe personal injury or death. Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the compartment thoroughly before beginning work.***

1. Disconnect the generator set negative (-) battery cable at the battery terminal.
2. Disconnect the generator set positive (+) battery cable from the wire harness.
3. Disconnect the remote control plug wire from the generator set (if applicable).
4. Disconnect the generator load wires. Tag for identification when reconnecting.
5. Disconnect the exhaust system and support brackets or hangers, to allow set removal.
6. Disconnect the sea water cooling system and its supports.
7. Disconnect the fuel line at the genset housing. Securely plug the end of the fuel line to prevent fuel leakage.
8. Verify that the set is adequately supported before loosening any mounting bolts or support members.

**⚠WARNING** ***Leakage of fuel presents the hazard of fire or explosion that can cause severe personal injury or death. Make certain all fuel line openings are plugged. Before disconnecting the fuel line, be certain there are no ignition sources such as flame, spark, pilot light, cigarette, etc., near the generator set. Keep an ABC type fire extinguisher nearby.***

When reinstalling the set, be sure all mounting hardware and electrical, exhaust, and fuel system components are connected exactly as they were before removal. See the appropriate installation manual during reinstallation for important safety precautions.

Check for oil and fuel leaks. Check the exhaust system audibly and visually with the generator set running. Repair leaks immediately. Replace worn, damaged, or corroded exhaust and fuel line components before leaks occur.

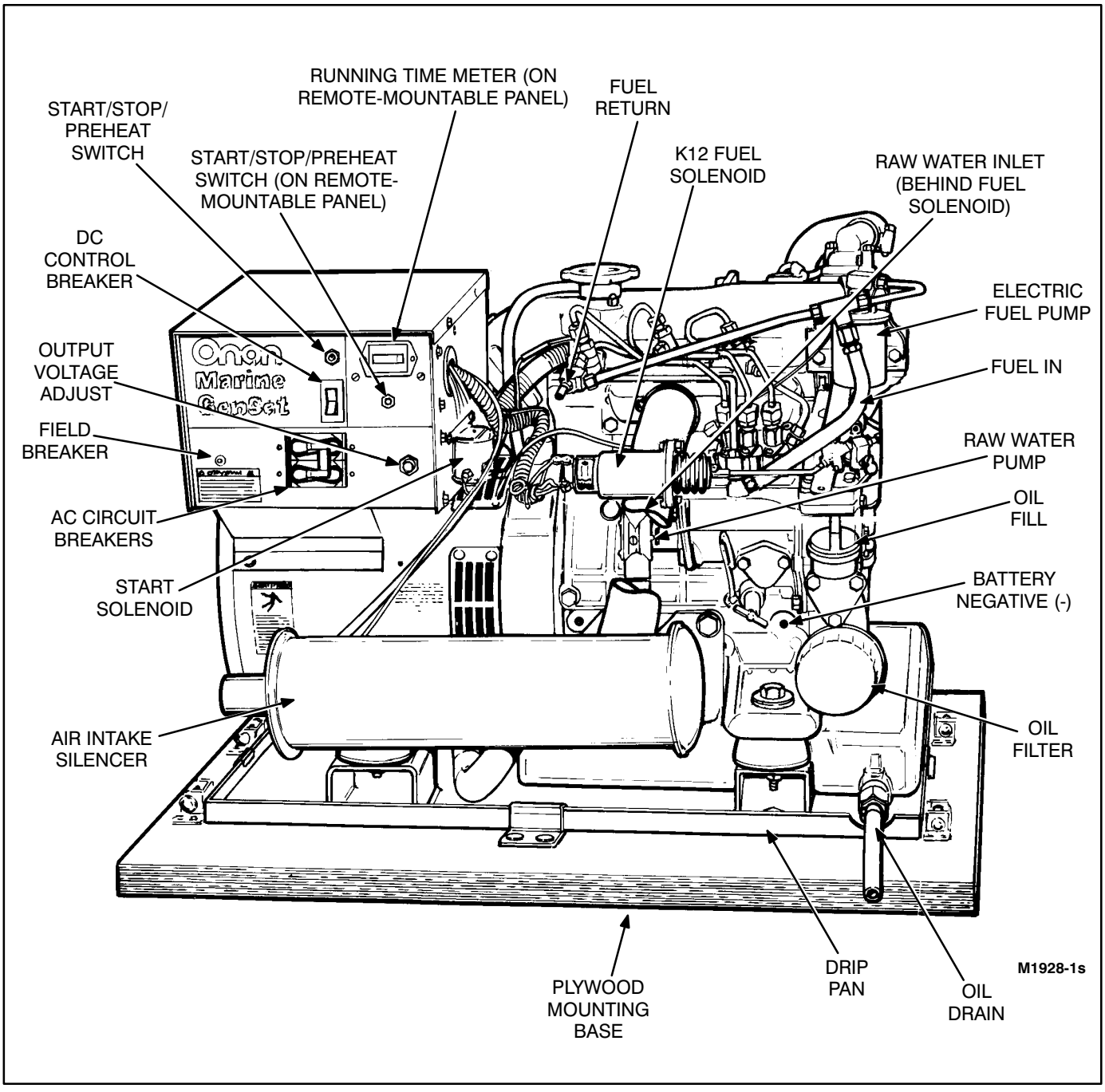


**FIGURE 1-1. SERVICE SIDE COMPONENTS, MDKWB GENERATOR SET**

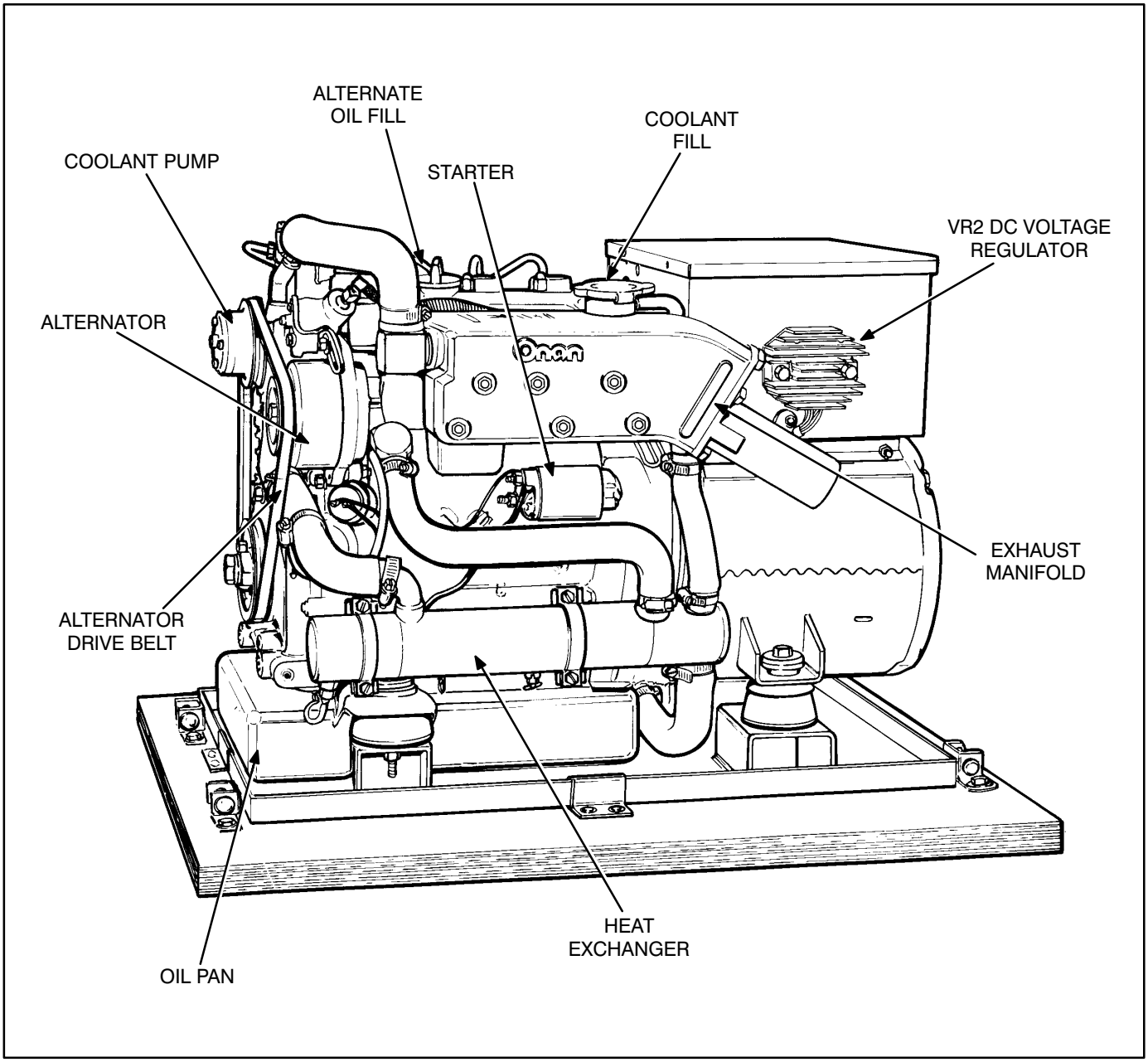


**FIGURE 1-2. MAJOR COMPONENTS AT REAR, MDKWB GENERATOR SET**

# Section 2. Engine Controls

## INTRODUCTION

This section describes the generator set preheat/start/run control system.

The set is started with a Start/Stop/Preheat switch. Two switch assemblies are provided: one is permanently mounted on the front panel of the set, and one may be remotely mounted. Component references are found on wiring/schematic diagrams in the Wiring Diagrams section of this manual.

## CONTROL DESCRIPTIONS

### Switches

***Start-Stop/Preheat Switch S10:*** Starts and stops the unit locally. Preheat function occurs when the switch is held in the Stop position.

***Remote Start-Stop/Preheat Switch S12:*** Starts and stops the unit from another location. Preheat function occurs when the switch is held in the Stop position. This switch is functionally identical to S10.

### Circuit Breaker

***DC Control Breaker CB8:*** A 10 ampere DC breaker provides protection to the control box wiring and remote wiring from short circuits or overload. Also serves as an emergency stop switch.

### Control Components

The following describes the basic engine control components and how they function.

***VR2 DC Voltage Regulator:*** Located at the rear of the genset DC control box (see Figure 2-1). VR2 accepts the output of alternator G3 and provides a steady 12 VDC for battery charging and genset control circuits.

***K9 Start Solenoid:*** Located on the side of the control box (see Figure 2-1). When the Start switch is pushed, K9 contacts close to connect battery B+ to the starter and fuel solenoid K12.

***K4 Preheat Relay:*** Located inside the control box (see Figure 2-2). When the Preheat switch is pushed, K4 contacts close to connect B+ to the engine glow plugs during preheat or cranking.

***K12 Fuel Solenoid:*** Located on the service side of the engine (see Figure 2-1). It opens the fuel control valve when the start/stop switch is placed in the Start position.

***E12 Fuel Pump:*** Located on the service side of the engine (see Figure 2-1). E12 electric fuel pump lifts fuel from the tank to the inlet of the fuel injection pump (injection pump covered in the Engine Service Manual).

***K11 Stop Relay:*** Located inside the control box (see Figure 2-2). When the Stop switch is pushed, K11 is energized, and K11 contacts close, activating K15 shutdown relay, and stopping the set.

***K15 Shutdown Relay:*** Located inside the control box (see Figure 2-2). When fault sensor switches S15, S16 or S17 close, or when K16 Start Disconnect Relay NC contacts (activated by set AC output) close, K15 is energized. NO relays are opened on K15, and power is cut off from run relay K13, de-energizing it. NO contacts are opened on K13 in turn, cutting off power to K12 fuel solenoid and E12 fuel pump.

***K13 Run Relay:*** Located inside the control box (see Figure 2-2). Pressing Start switch S10 applies power to K13 through diode CR12. NO K13 contacts close, supplying power to start solenoid K9 and fuel solenoid K12.

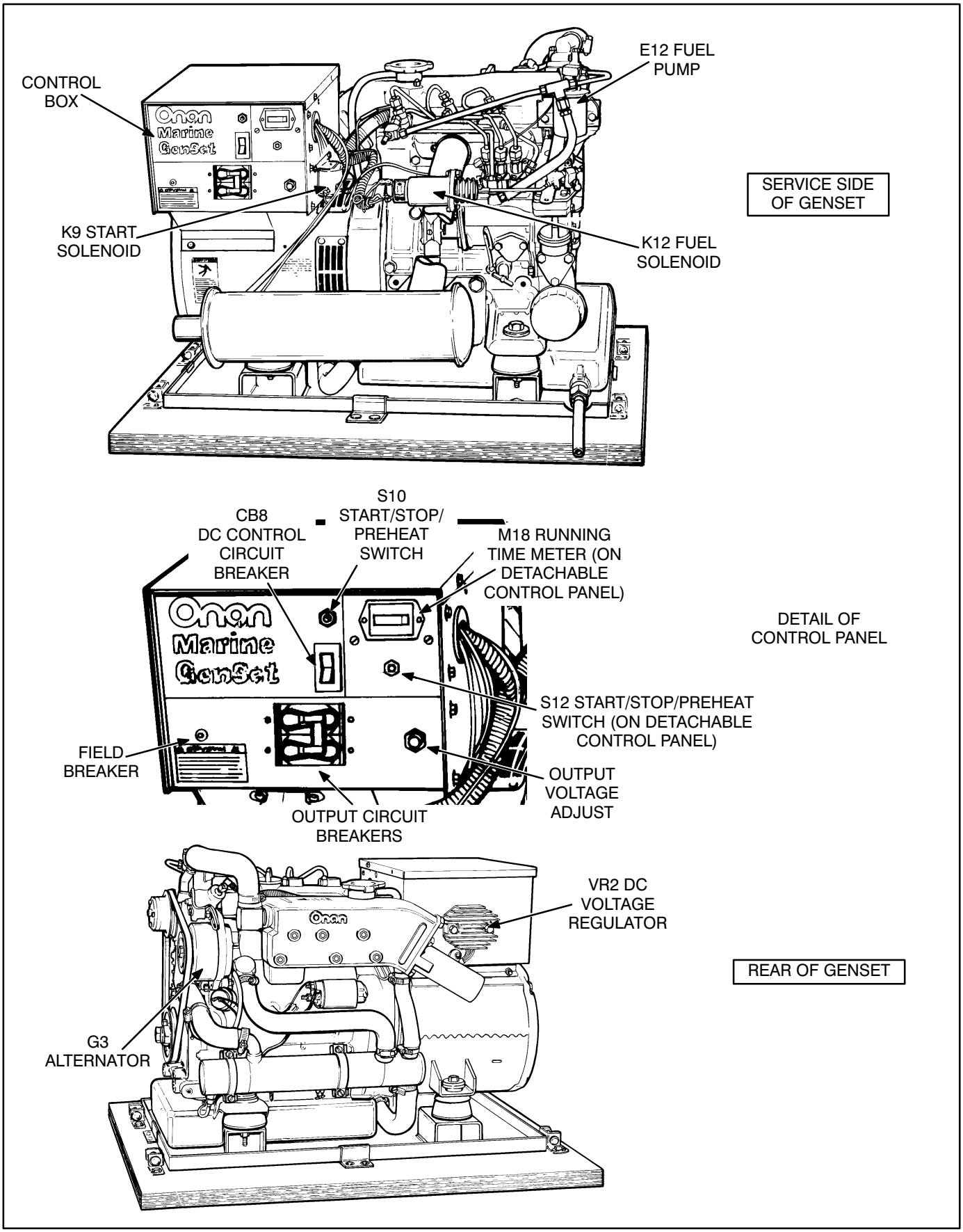


**FIGURE 2-1. POSITION OF CONTROL COMPONENTS**

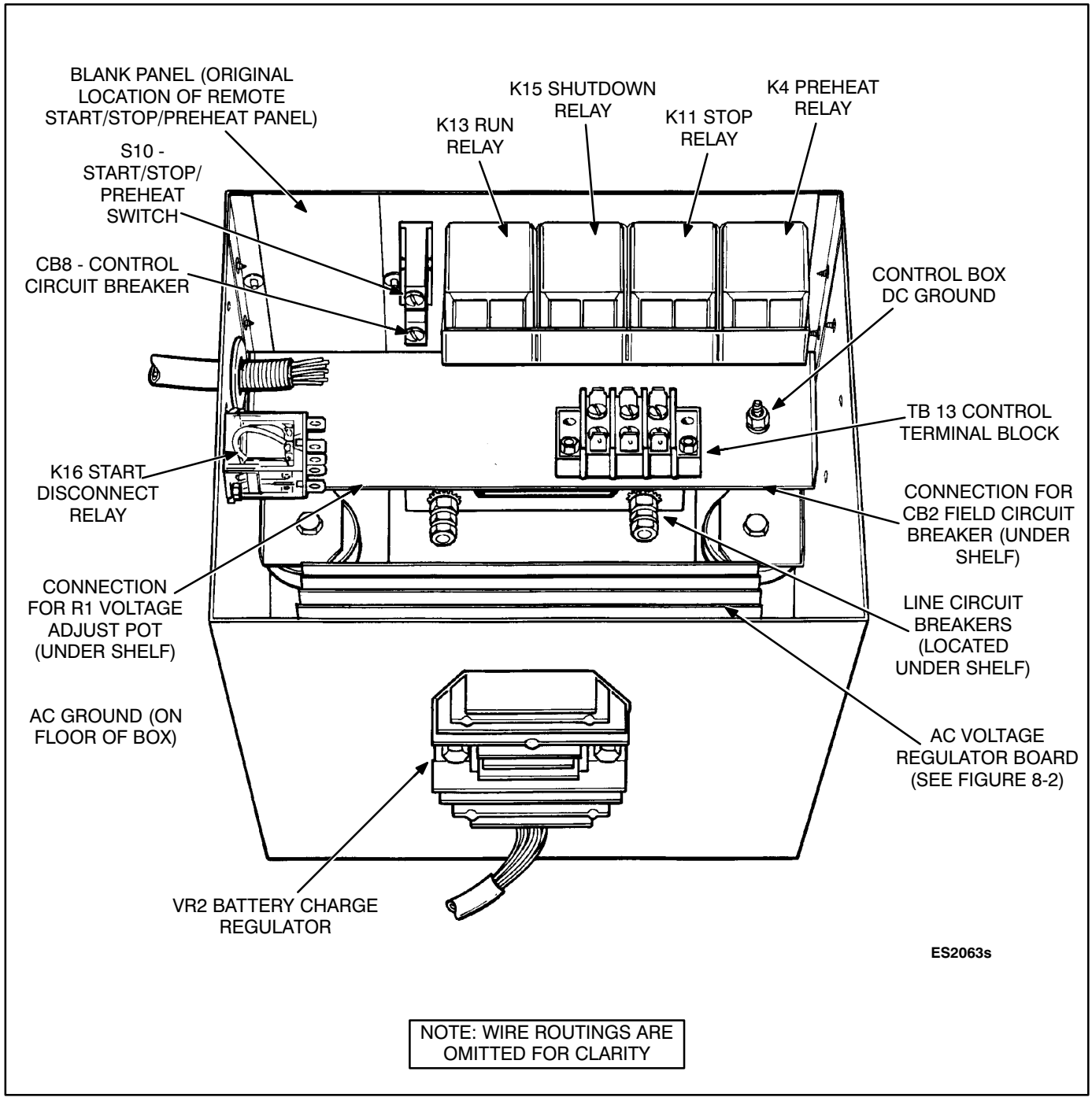


**FIGURE 2-2. COMPONENTS INSIDE GENSET DC CONTROL BOX**

## Engine Monitors

The engine monitors (switches) protect the engine from unfavorable operating conditions. These sealed units are not repairable. Do not use a substitute part if replacement is necessary, since they are close-tolerance parts made for a specific application.

The monitors close the fault circuit to ground if abnormal operating conditions exist, activating shutdown relay K15 to stop the engine. See Figure 2-3 and schematic 612-6604.

***Low Oil Pressure Switch S15:*** This switch closes if oil pressure drops to 10 psi (170.3 kPa), deactivating shutdown relay K15 and stopping the engine.

***High Exhaust Temperature Switch S16:*** This switch closes if the exhaust temperature rises to 250° F (121° C), activating the shutdown relay K15 and stopping the engine.

***High Engine (Coolant) Temperature Switch S17:*** This switch closes if the coolant temperature rises to 222° F (105.6° C), activating the shutdown relay K15 and stopping the engine.

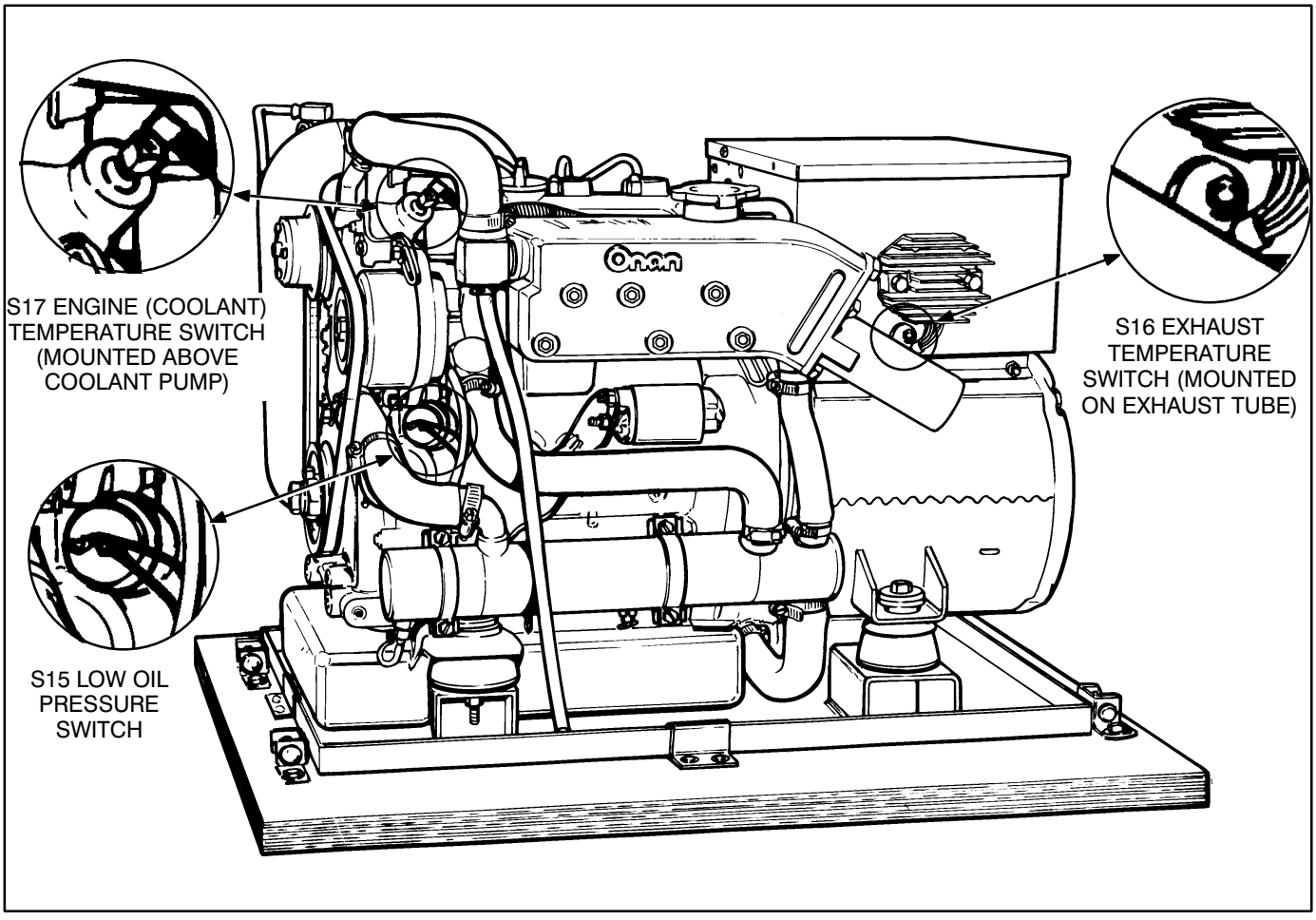


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**FIGURE 2-3. LOCATION OF ENGINE MONITORS**

## CONTROL OPERATION

To understand control operation, refer to the following text and the schematic diagram (Figure 2-4).

### Starting Sequence

When start/stop switch S10 (on set) or S12 (remote panel) is held in the *Stop/Preheat* position, battery B+ voltage is applied to the coil of heater relay K4. energizing it. K4 relay contacts close and connect B+ to the glow plugs (HR5).

After the preheat interval (10 to 30 seconds depending on ambient temperature), S10 (S12) is held in the *Start* position. This removes B+ from the glow plugs and connects B+ to the coils of K9 start solenoid and (through CR12) K13 run relay, activating them. NO contacts on K13 close, applying B+ to K12 fuel solenoid and E12 fuel pump. K12 fuel solenoid opens the fuel line to the engine, E12 fuel pump begins supplying fuel, and the genset starts.

### Start-Disconnect Sequence

As the generator gains speed and output voltage, K16 start disconnect relay energizes at about 70 VAC. (If the generator fails to develop voltage, the engine will attempt to start, but will stop as soon as the Start switch is released.) K16 NC contacts open, disconnecting power from K9 start solenoid, and disconnecting ground from the K15 shutdown relay coil.

### Battery Charge Circuit

Alternator G3, powered by a belt from the engine, supplies B+ voltage to recharge the generator set starting battery through circuit breaker CB8.

### Stopping Sequence

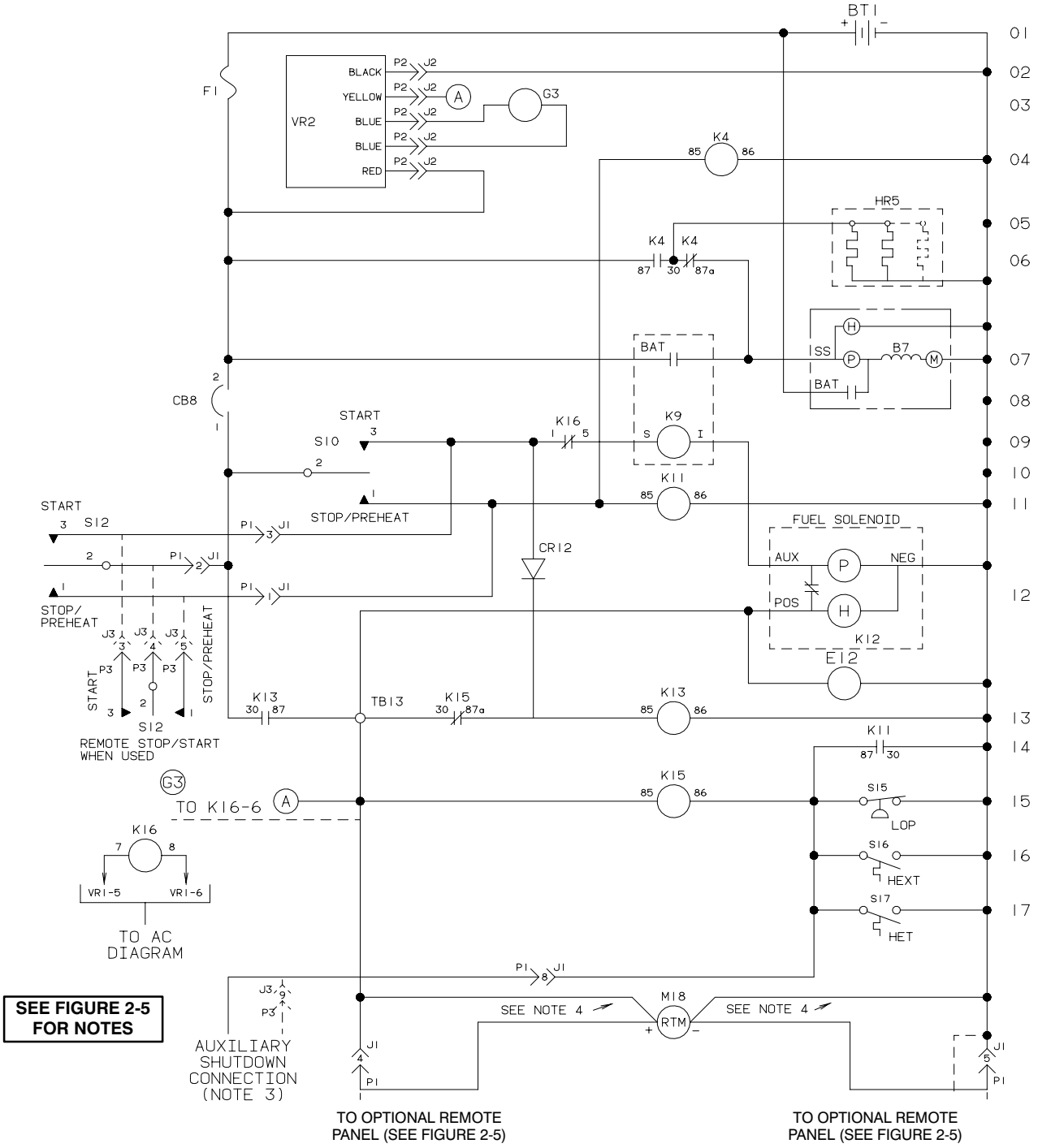
Moving S10 (S12) to the Stop position applies B+ to the coil of stop relay K11, activating it. K11 NO contacts close, providing ground to energize K15 shutdown relay. NC K15 contacts open, removing power from K13 run relay. NO contacts on K13 open, removing B+ from K12 fuel solenoid and E12 fuel pump.

### Fault Shutdown

S15 low oil pressure sensor, S16 high exhaust temperature sensor, S17 high coolant temperature sensor and the auxiliary shutdown connection can all stop the generator set by closing the ground connection to K15 shutdown relay, activating it. When K15 is activated, power is removed from K13 run relay, stopping the generator set (see *Stopping Sequence*, above).

### Remote Meter Panel (Optional)

An optional remote meter panel may be connected to the genset control by means of plug J1-P1. This panel enables the operator to monitor genset B+ voltage, coolant temperature, and oil pressure. See Figure 2-5 for the remote panel wiring diagram.




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 01 | BT01 | BATTERY | 10 | S10 | START-STOP/PREHEAT SWITCH | 15 | K15 | SHUTDOWN RELAY - 13 |
| 02 | VR02 | DC VOLTAGE REGULATOR | | | | | S15 | LOW OIL PRESSURE SWITCH |
| 03 | GO3 | ALTERNATOR | 11 | K11 | STOP RELAY - 14 | 16 | S16 | HIGH EXHAUST TEMPERATURE SWITCH |
| 04 | K04 | PREHEAT RELAY - 06, 06 | 12 | S12 | REMOTE START-STOP/ PREHEAT SWITCH | | K16 | START DISCONNECT RELAY 09 |
| 05 | HR05 | GLOW PLUGS | | CR12 | DIODE | 17 | S17 | HIGH ENGINE TEMPERATURE SWITCH |
| 07 | B07 | STARTER | | K12 | FUEL SOLENOID | 18 | M18 | RUNNING TIME METER |
| 08 | CB08 | CONTROL - CIRCUIT BREAKER | | E12 | FUEL PUMP | | | |
| 09 | K09 | START SOLENOID | 13 | K13 | RUN RELAY - 13 | | | |
| | | | | TB13 | TERMINAL BLOCK | | | |

**FIGURE 2-4. DC CONTROL SCHEMATIC (from 612-6604)**

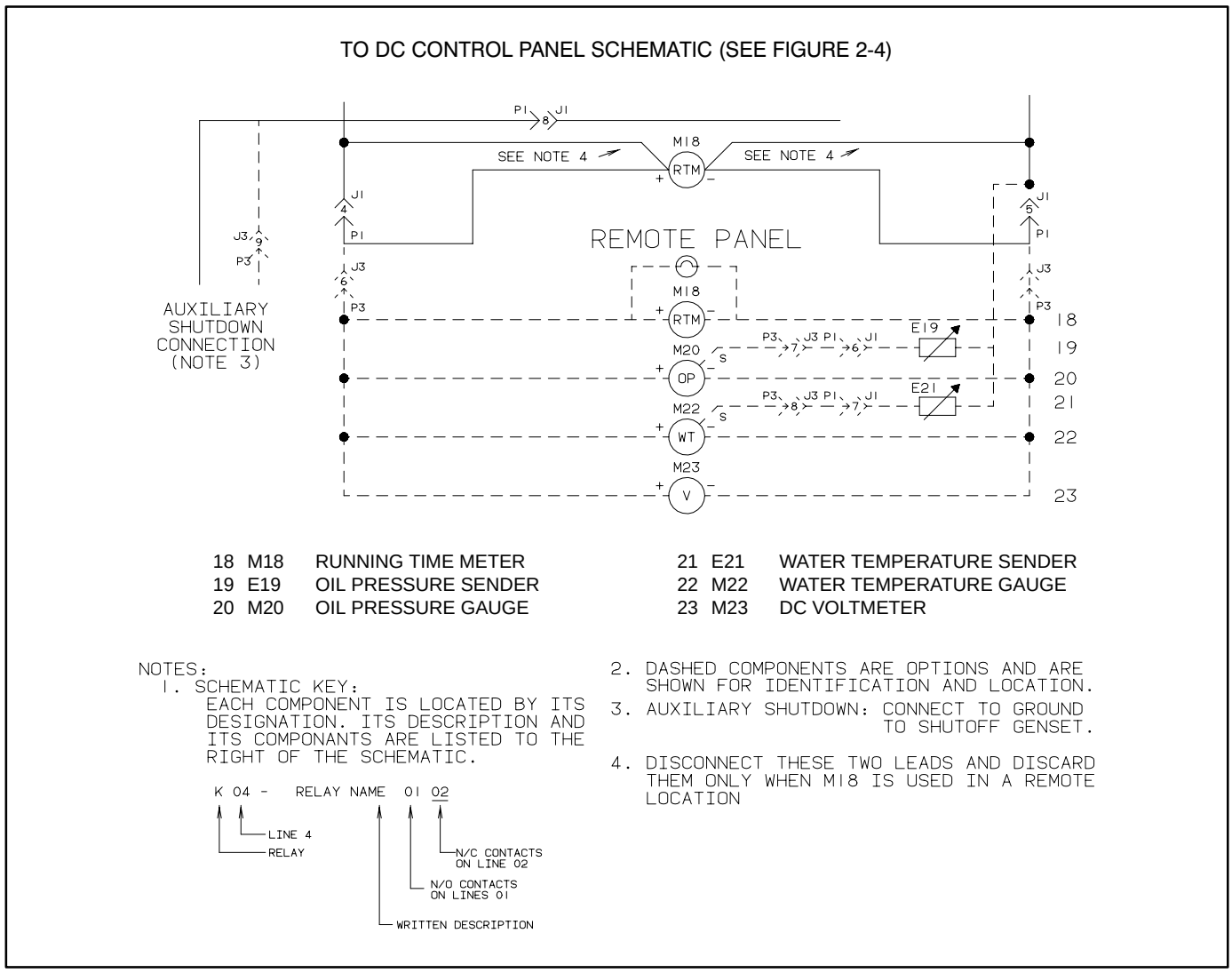



**FIGURE 2-5. REMOTE METER PANEL CONNECTIONS**

## CONTROL TROUBLESHOOTING

The information in this section is divided into three flow charts. Determine the problem and then refer to the appropriate flow chart (A, B, or C) for the troubleshooting procedures.

A. Engine does not crank.
B. Engine cranks but does not start.
C. Engine starts but stops after running several seconds.

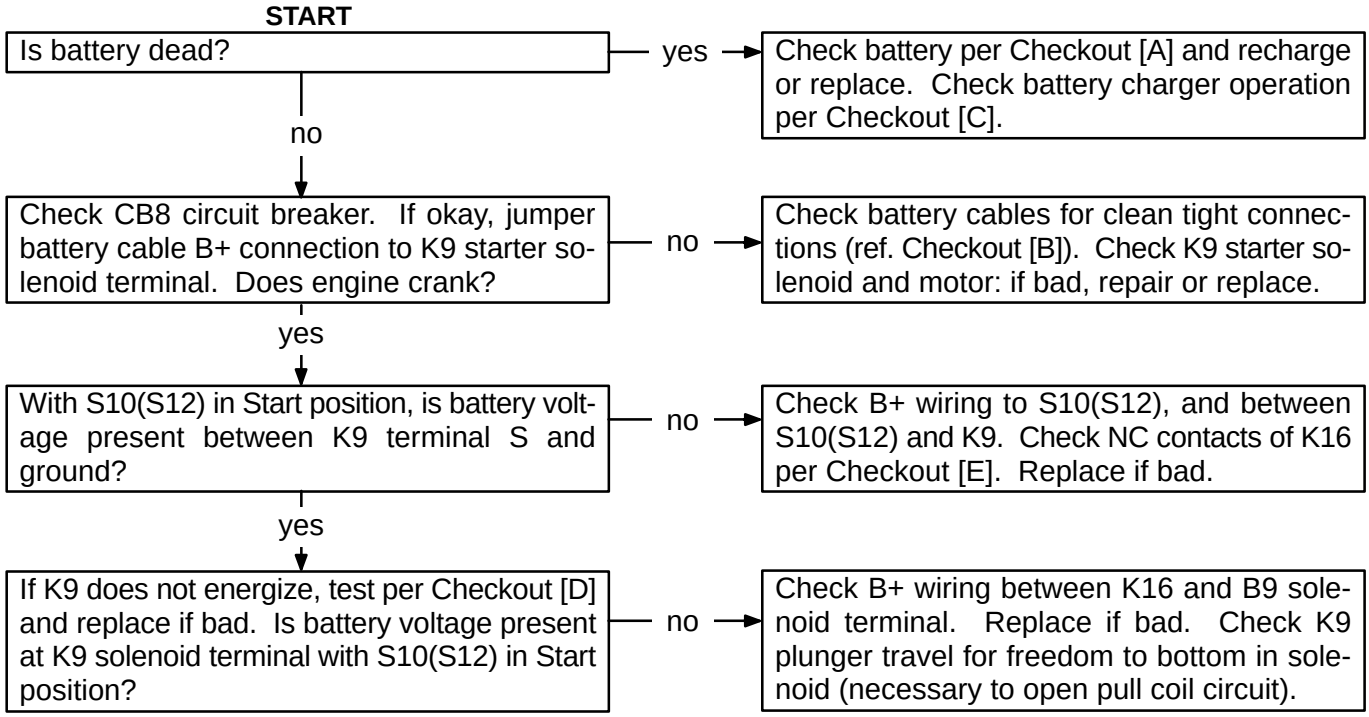
Before starting a troubleshooting procedure, make a few simple checks that may expose the problem and cut down on troubleshooting time.

Check all modifications, repairs, and replacements performed since last satisfactory operation of set. A loose wire connection overlooked when installing a replacement part could cause problems. An incorrect connection, an opened switch or circuit breaker, or a loose plug-in are all potential problems that can be eliminated by a visual check.

To troubleshoot a problem, start at the upper-left corner of chart and answer all questions either YES or NO. Follow the chart until the problem is found, performing referenced adjustments or test procedures. Refer to Figures 2-1 through 2-4 for locating control components, leads, terminals and other check points.

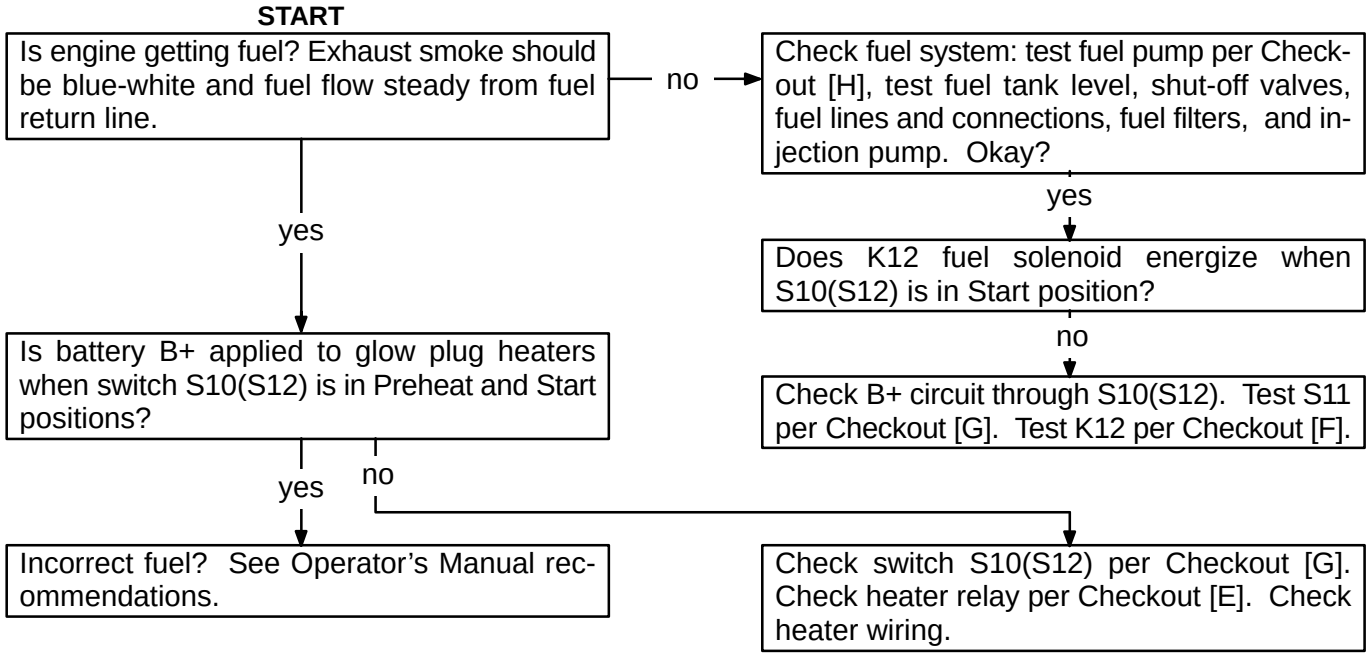
## FLOW CHART A. ENGINE DOES NOT CRANK

**⚠WARNING** ***Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***



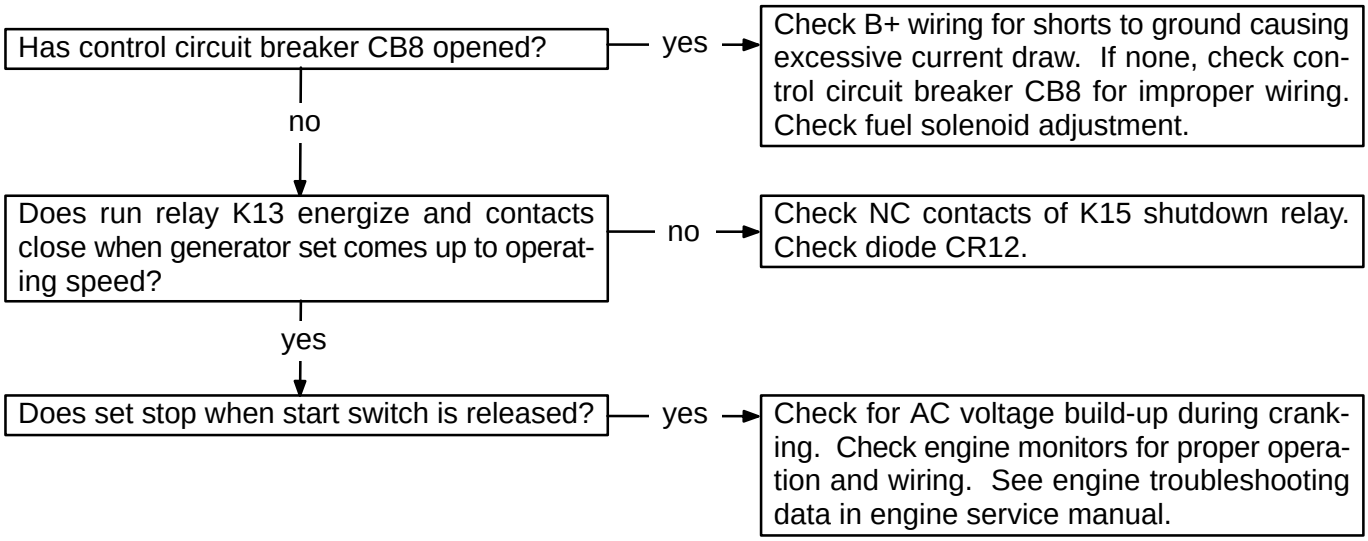

## FLOW CHART B. ENGINE CRANKS BUT DOES NOT START

**⚠WARNING** ***Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***



## FLOW CHART C. ENGINE STARTS BUT STOPS AFTER RUNNING SEVERAL SECONDS

***⚠WARNING Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***



# Section 3. Engine Control Service

## GENERAL

The following checks are referred to in the Control Troubleshooting troubleshooting charts. They isolate circuit problems caused by faulty engine control components. Disconnect leads before testing components.

**⚠WARNING** ***Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

## [A]

## BATTERY CHECK

Check the battery charge condition with a hydrometer. Electrolyte specific gravity should be about 1.260 for a fully charged battery at 80°F (27°C). If not, add distilled water to keep electrolyte at proper level, then recharge the battery. If the battery will not recharge, replace it.

If the battery loses excess water, the charge rate may be too high. If the battery charge is not maintained, the charge rate may be too low. See procedure [C].

**⚠WARNING** ***Ignition of explosive battery gases can cause severe personal injury. Do not permit any flame, spark, cigarette, or other ignition source near the battery.***

## [B]

## BATTERY CABLE CHECK

With the starter motor running, check these voltage drops:

1. From the battery negative post (not the cable clamp) to the cylinder block
2. From the battery positive post to the battery terminal stud on the solenoid

Normally these should be less than 0.3 volts. If extra-long battery cables are used, slightly higher voltage drops may result. Thoroughly clean all connections in any part of the circuit showing excessive voltage drop.

## [C]

## BATTERY CHARGING CHECK

With the engine running, check the DC voltmeter (control option). The 12-volt system should read 13.5 to 15 volts.

The power source is a belt-driven alternator. The charge rate/voltage is determined by voltage regulator VR2, located on the back of the control box.

Improper output may be caused by a loose drive belt, poor terminal connections, broken wires, bad regulator or alternator.

If the output voltage is high (over 15 volts), check for loose or corroded voltage regulator leads. If this does not correct the problem, the regulator is probably shorted and should be replaced.

## [D]

## START SOLENOID CHECK

1. Apply battery positive (B+) to the terminal marked S.
2. Connect a ground wire to the solenoid terminal marked I. The solenoid should activate.
3. If the contacts are good, battery voltage should be present between terminal 1 and ground. The voltage drop measured across the contacts should never exceed one volt in circuit application.

## [E]

## RELAY CHECK

1. Connect the relay coil voltage across the relay coil terminals. The relay should activate if coil is okay.

2. Connect a voltage source to one side of relay contacts.

3. Connect a voltmeter to other side of relay contact and voltage source. If voltage appears when relay energizes, the contact is good. The voltage reading appears in reverse order when checking normally closed (NC) contacts.

## [F]

## FUEL SOLENOID CHECK

If there is fuel to the injection pump, but no fuel at the injection nozzle, the fuel solenoid may be defective.

To check solenoid operation, watch for solenoid actuation when B+ is applied (start switch in start or run position). If there is no actuation when B+ is applied, the fuel solenoid must be replaced. When B+ is removed, the solenoid must de-activate.

## [G]

## SWITCH CHECK

1. Remove battery B+ cable.

2. Place ohmmeter leads across switch.

3. Open and close switch while observing the ohmmeter. Normally open (NO) contacts should indicate infinite resistance when open and continuity when closed. Normally closed (NC) contacts should indicate continuity when closed and infinite resistance when open.

4. Replace switch if defective.

## [H]

## FUEL PUMP TEST

1. Disconnect the fuel line at the outlet of the fuel pump and connect a pressure gauge at the pump outlet. A gauge calibrated for 0 to 15 psi (0 to 100 kPa) is recommended. Do not tee into the fuel line. This is a static pressure test.
2. Push the Start/Stop switch to START and hold it there for several seconds until the fuel pressure stabilizes. Fuel pressure should stabilize between 3.5 and 6 psi (24 and 41 kPa).
3. Repeat the test with the vehicle engine running.
4. If the fuel pressure is less than 3.5 psi (24 kPa), check for fuel restrictions in the system. the pump will have to be relocated closer to the fuel tank if it is located more than 3 feet (0.9 meters) above the end of the fuel pickup tube in the fuel tank. If the pump is defective, replace it with an identical Onan pump. The pump is not serviceable.

# Section 4. Generator/Voltage Regulator

## GENERAL DESCRIPTION

The YVB generator (Figure 4-1) is a two-pole, revolving field, brush-type design with drip-proof construction.

The generator rotor is directly coupled to the engine flywheel with a rigid drive disc. Engine speed determines generator output voltage and frequency. A centrifugal blower on the drive disc circulates generator cooling air which is drawn in through the end bell and discharged through an outlet in the blower end.

A ball bearing in the end bell supports the outer end of the rotor shaft. The end bell is attached with four studs that thread into the generator adapter casting. The genset brushes are mounted in the end bell (see Figure 4-2).

Figure 4-3 shows the generator output and control/meter leads for parallel and series connections. Voltage reconnection diagrams appear in Section 6. Generator/Regulator Tests, and in Section 7, Wiring Diagrams.

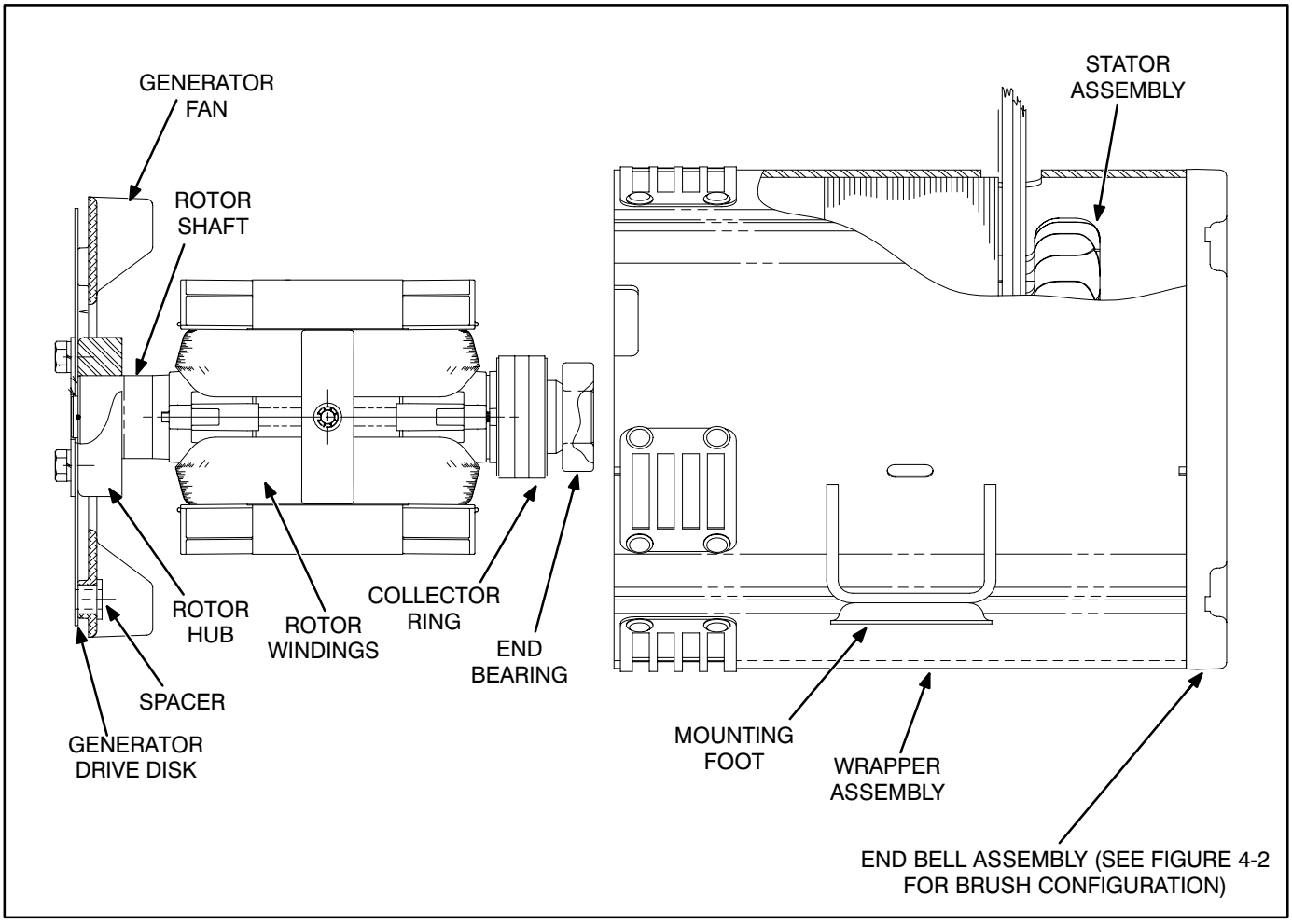



**FIGURE 4-1. YVB GENERATOR**

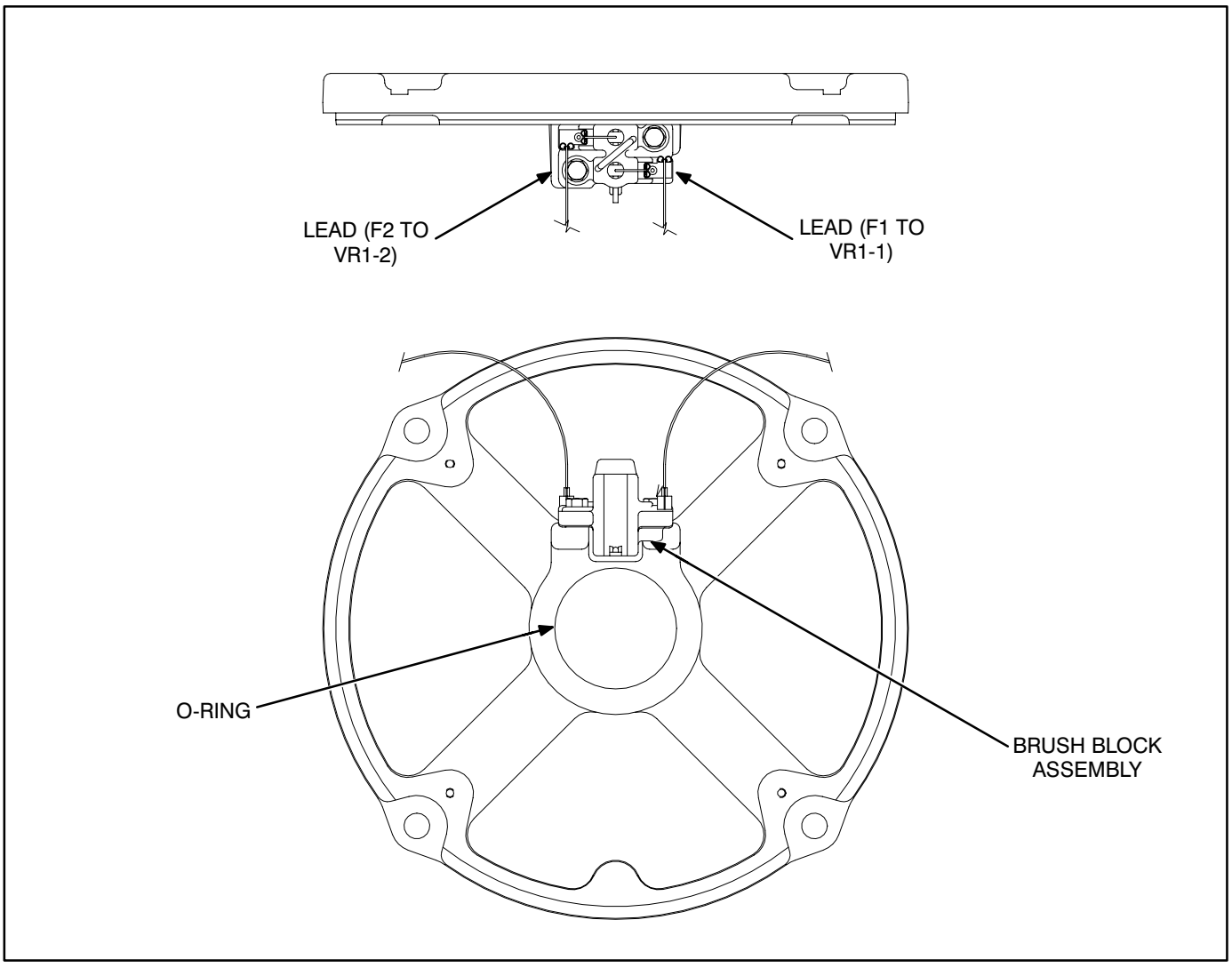
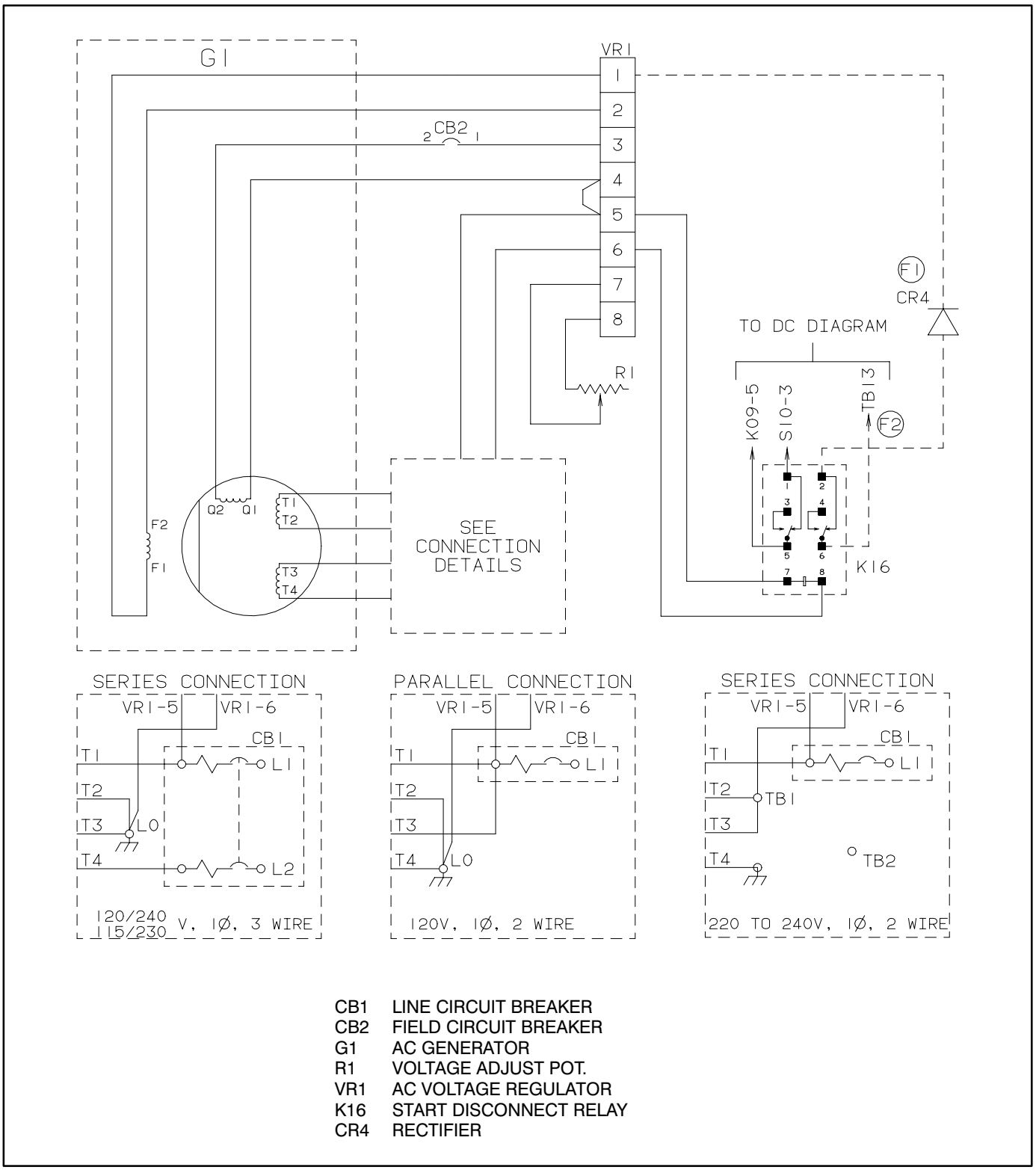



**FIGURE 4-2. GENSET END BELL WITH BRUSHES**




| | |
|---|---|
| CB1 | LINE CIRCUIT BREAKER |
| CB2 | FIELD CIRCUIT BREAKER |
| G1 | AC GENERATOR |
| R1 | VOLTAGE ADJUST POT. |
| VR1 | AC VOLTAGE REGULATOR |
| K16 | START DISCONNECT RELAY |
| CR4 | RECTIFIER |

**FIGURE 4-3. GENERATOR SCHEMATIC (from 612-6621)**

## GENERATOR OPERATION

Refer to Figure 4-3, the generator schematic, while working through the following description.

1. Voltage regulator VR1 supplies DC to the field winding (F1 - F2 leads) through brushes and slip rings, thereby establishing a revolving 2-pole magnetic field. The battery is connected during startup to initiate field excitation. Voltage regulator VR1 supplies field current during operation. Rated output voltage is maintained as the generator load varies, by varying field current to maintain field strength proportional to the load.
2. The revolving magnetic field induces AC in the stator windings (T1 - T2 and T3 - T4) which are connected to the load.
3. Under light load, the stator windings can supply sufficient current for the field to maintain rated output voltage.
4. As the load increases, load currents increase, resulting in a proportional increase of current, which in turn supplies the field. Rated output voltage is thereby maintained as the load varies.

## VOLTAGE REGULATOR

The voltage regulator controls the output of the generator so that a constant voltage is maintained under varying load conditions.

Only the basic functions of the regulator are described (Figure 4-4). Voltage from quadrature windings Q1/Q2 supply power to the voltage regulator itself. The voltage regulator in turn supplies an excitation voltage (F1/F2) that is directly proportionate to the output voltage (L1/L0) it senses. Any changes in the generator output voltage produce a corresponding change in the excitation voltage provided by the regulator.

On the MDKUB/MDKWB, the voltage regulator assembly includes a potentiometer connected between pins 7 and 8 (see wiring diagram). This enables a slight degree of output voltage adjustment.

The voltage regulator assembly contains no user-serviceable parts. If the assembly fails, it must be replaced.

## CHANGING GENSET FREQUENCY

Changing the generator set's output voltage frequency from 50 Hz to 60 Hz, or from 60 Hz to 50 Hz, is a complex procedure that can involve the following factors:

- Identifying the frequency and voltage to which the set will be changed
- Replacing the original output circuit breaker with a new one that is sized for the new load (if necessary)
- Switching the frequency on the generator set regulator board (check the load type first)
- Readjusting the genset engine speed for the new frequency (50 Hz: 3000 RPM; 60 Hz: 3600 RPM), under both no-load and full-load conditions

These steps are covered below.

**⚠WARNING** ***Incorrect electrical connections/adjustments can cause equipment damage, severe injury or death. Make certain that the generator set is turned off before beginning these adjustments. Disconnect the genset starting battery, positive (+) terminal first, to disable the genset and prevent it from being started.***

### Identifying New Frequency and Voltage

Determine the new frequency and voltage to which the generator set will be converted, before beginning the procedure of converting the MDKUB/MDKWB frequency. Consider the following factors:

- Where (in what country) will the set be operated?
- What equipment will it be powering?
- How large will the genset load be?

For other genset load considerations, consult the MDKUB/MDKWB Installation Manual, Onan publication #981-0602.

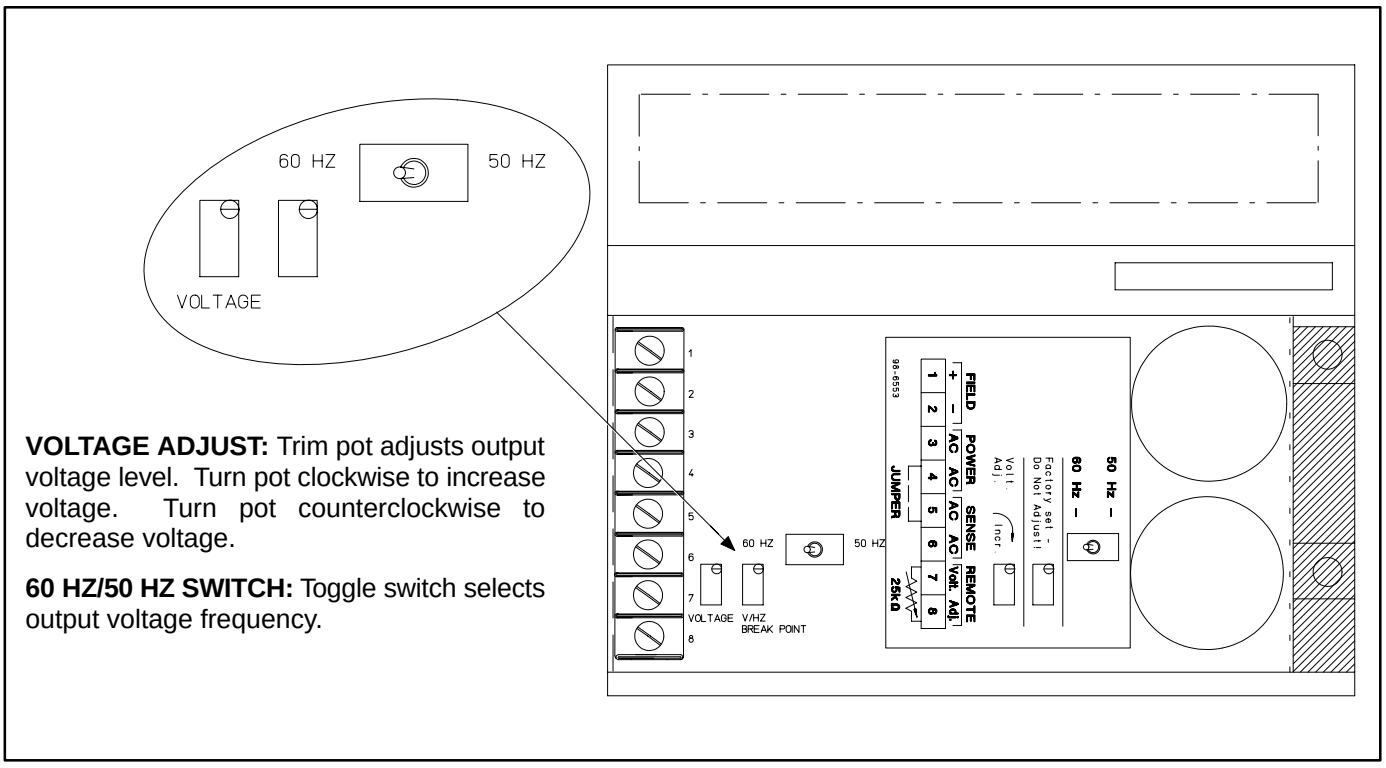



**FIGURE 4-4. ADJUSTMENTS ON GENSET VOLTAGE REGULATOR BOARD**

## Reconnecting Set Output Leads

Figure 4-3 shows the output reconnection schematic, from drawing 612-6621. Reconnect the output leads, if required, according to the selected output diagram on Figure 4-3.

## Replacing the Output Circuit Breaker

The generator AC output (line) circuit breaker may need to be replaced by one that is the correct size for the generator output voltage and amperage. Consult your Onan distributor for the correct rating and type of output circuit breaker.

## Switching the Frequency at the Regulator Board

1. Turn the generator set off.
2. Open the generator set control box and locate the voltage regulator board (Figure 4-4).
3. Move the 60 Hz/50 Hz switch to the desired value.

## Readjusting Engine Speed

Once the electrical adjustments have been made, the genset engine speed must be readjusted to the correct RPM for the selected frequency. This figure is 3000 RPM for 50 Hz, and 3600 RPM for 60 Hz sets, at full load.

Have the following instruments ready:

- Digital volt-ohmmeter
- Frequency meter

Figure 4-5 illustrates the genset governor control lever that must be adjusted to change the genset frequency.

**Note: Perform all mechanical adjustments on the generator set while it is warm: run the set for roughly 15 minutes at 50 - 75% load before beginning to adjust the throttle lever illustrated in Figure 4-5.**

1. Remove all load from the generator set output. Connect the frequency meter across the generator set output.
2. Loosen and back off the lock nuts on the speed adjustment screws (see Figure 4-5).
3. Turn the generator set on, with no load.
4. **a. 60 to 50 Hz conversion:** Turn the low-speed adjustment screw out, watching the frequency shown on the meter. Spring tension on the lever will lower the frequency as the screw is turned out. When the frequency reaches 53 Hz, stop. Tighten the lock nut down on the adjustment screw to hold it in place.

   **b. 50 to 60 Hz conversion:** Turn the high-speed adjustment screw out until there is room for the low-speed screw to be adjusted. Turn the low-speed adjustment screw in, watching the frequency shown on the meter. When the frequency reaches 63 Hz, stop. Tighten the lock nut down on the adjustment screw to hold it in place.
5. Screw in the high-speed adjustment screw until it is lightly touching the lever.
6. Tighten the high-speed adjustment screw lock nut.

## Readjusting Set Voltage Output

1. Roughly center the voltage adjustment pot on the front panel.
2. Adjust the voltage adjustment screw on the regulator board (Figure 4-4) to the rated output voltage ± 5 VAC.
3. Fine tune the voltage output with the pot on the genset front panel, if needed. Lock the pot on the front panel.
4. Recheck the output voltage.

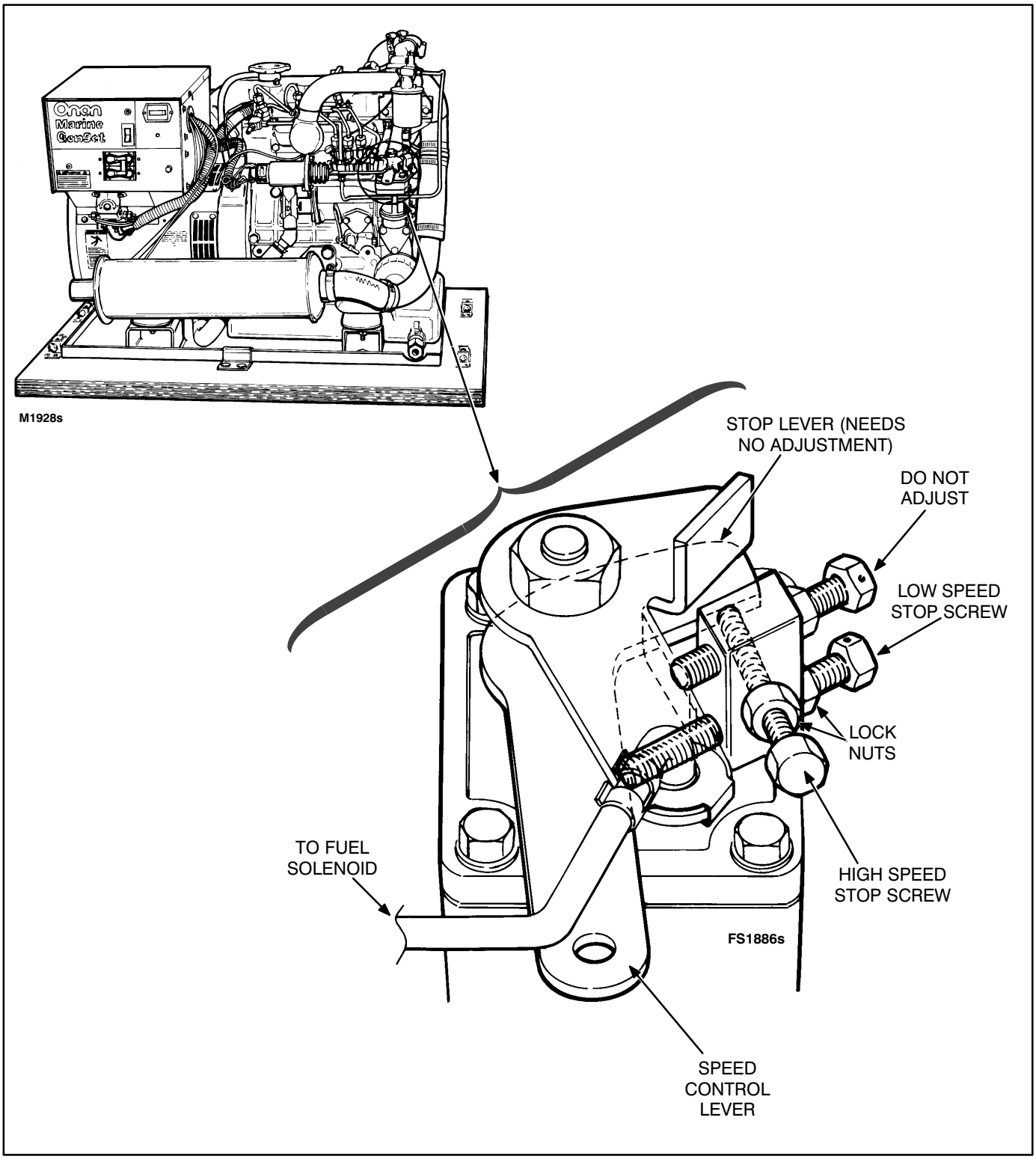



**FIGURE 4-5. THROTTLE CONTROL LEVERS**

## GENERATOR SERVICE

Always disconnect the battery cables (negative [-] first) from the battery to prevent accidental starting of the set while servicing the generator.

**⚠WARNING** ***Accidental starting of the set while working on it can cause severe injury. To prevent accidental starting, disconnect the battery cables (negative [-] first) from the battery.***

***The negative (-) cable is always disconnected first, and connected last, to prevent arcing if a tool accidentally touches the frame or other grounded metal parts of the set while disconnecting or connecting the positive (+) cable. Arcing can ignite the explosive hydrogen gas given off by the battery, and cause severe injury.***

### Brush Inspection/Replacement

The generator should be inspected for brush wear and cleaning every six months.

**⚠WARNING** ***Accidental starting of the generator set can cause severe personal injury or death. Stop the generator set and disable by disconnecting the starting battery cables (negative [-] cable first) before inspecting the generator.***

1. Remove the access cover for the brush assembly.
2. Check the brushes for wear with a piece of wire marked off 1 inch (25 mm) from one end (Figure 4-6). Replace the brush and the spring if the wire goes into the brush holder 1 inch or more.
3. To replace brushes, remove the brush holder by disconnecting the two leads to the holder and removing the two mounting screws.
4. Install the new brushes and springs in the holder and keep them in place during assembly by inserting a piece of wire through the holder, as shown in Figure 4-7.
5. Install the brush holder. After tightening the mounting screws, pull out the brush retaining wire.
6. Connect the F1 lead to the inner brush terminal (nearest the rotor windings). Connect the F2 lead to the outer brush terminal (nearest the end bell).

### Slip Ring Inspection/Replacement

Inspect the slip rings for grooves, pits or other damage. If dust has accumulated on any generator components, they can be cleaned with filtered low-pressure air.

1. Examine the slip rings while servicing the brushes.
2. If the rings need cleaning or service, remove the rotor from the generator and dress the rings on a lathe.

**⚠ CAUTION** ***Dressing the slip rings on a lathe improperly may damage the generator rotor. Make certain that only an experienced technician performs this job.***

### Generator Bearing

Inspect the bearing for evidence of outer case rotation every 1000 hours of use. The bearing should be replaced every five years, because the bearing grease gradually deteriorates due to oxidation.

Replace the O-ring if it shows evidence of wear or deterioration. Renew grease if necessary (moly only).

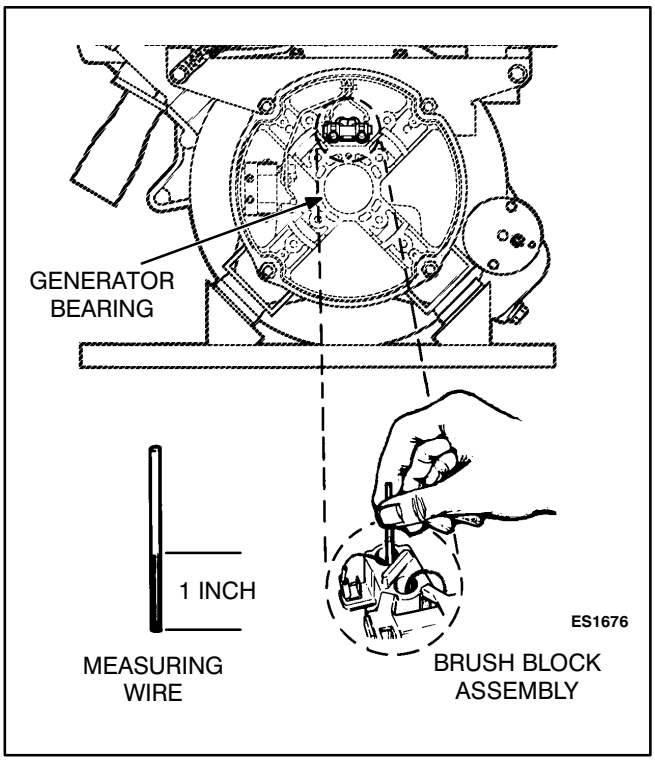



**FIGURE 4-6. CHECKING GENERATOR BEARING AND BRUSH BLOCK**

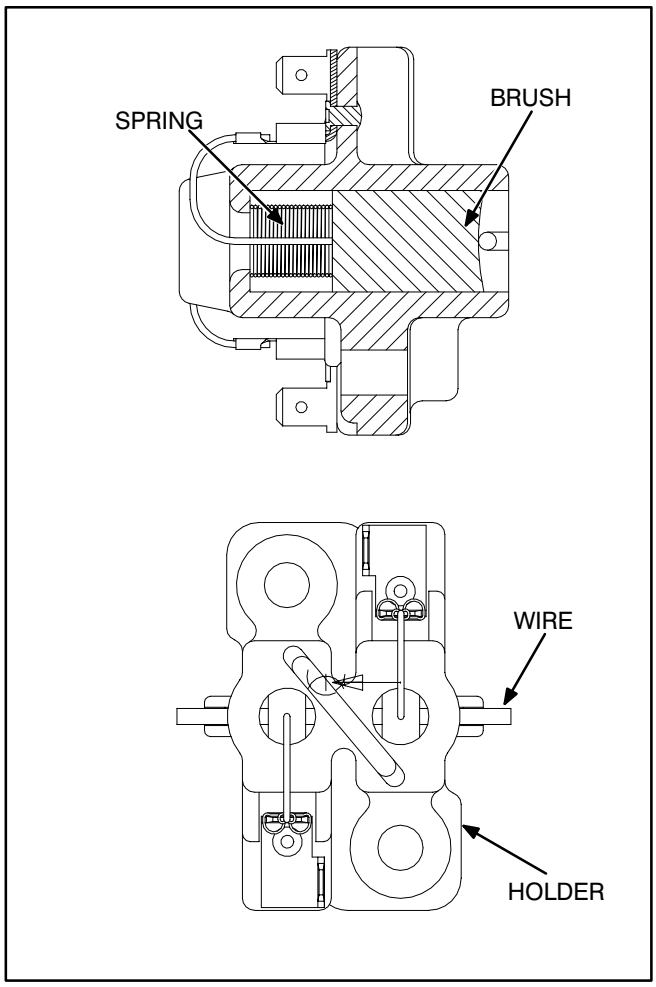



**FIGURE 4-7. BRUSH REPLACEMENT**

## GENERATOR DISASSEMBLY/ASSEMBLY

The following sections describe the disassembly and reassembly procedures for the generator. Figure 4-8 illustrates generator disassembly.

**⚠WARNING** ***Generator components are heavy and can cause severe personal injury if dropped during service. Be careful, use appropriate lifting techniques, keep hands and feet clear during service, and use the recommended service procedures.***

### Disassembly

1. Remove the generator set from the boat and place it on a sturdy work bench. Refer to Section 1 of this manual for removal guidelines.

   **⚠WARNING** ***Accidental starting of the set can cause severe personal injury or death. Disconnect the battery cables, negative (-) lead first, when repairs are made to the engine, controls or generator.***

2. Remove the cover from the control box and disconnect all stator leads (Q1-Q2, T1-T2-T3-T4, F1-F2). Disconnect leads at the load circuit breaker(s). If the lead markings do not clearly identify reconnection, mark the leads with tape.

3. Remove the bonding strap between the stator assembly and the drip pan.

4. Remove the four bolts, two on each side of the stator housing, that hold the saddle and control box.

5. Pull the saddle and control box together off the stator housing. Set the control box and the saddle on top of the engine without removing the wiring harness.

6. Loosen and remove the two bolts that extend through the rear genset mounts (under the stator housing).

7. Lift the rear of the set and place a wooden block under the oil pan to hold the stator and housing in place. Remove the two rubber vibration isolators whose bolts were removed in the last step.

8. Remove the end bell cover and disconnect F1 (outer) and F2 (inner) lead wires from the brush holder terminals.

9. Pull each brush away from the commutator rings and insert a piece of stiff wire into the small hole in the brush holder. See Figure 4-7.

10. Remove four nuts and lock washers from the generator stud bolts. Pry the end bell free of the rotor bearing. Be careful not to damage the brush holder.

11. Pull the stator/wrapper assembly off the rotor and away from the engine. Set it aside.

12. Loosen the five bolts that hold the rotor drive disk to the engine flywheel. Loosen these bolts in an alternating pattern, so that the drive disk does not bend from the weight of the rotor.

13. Pull the rotor, fan and drive disk assembly off the flywheel and set them aside. Make sure to retain the five metal spacers that prevent the bolts from being tightened down onto the plastic fan.

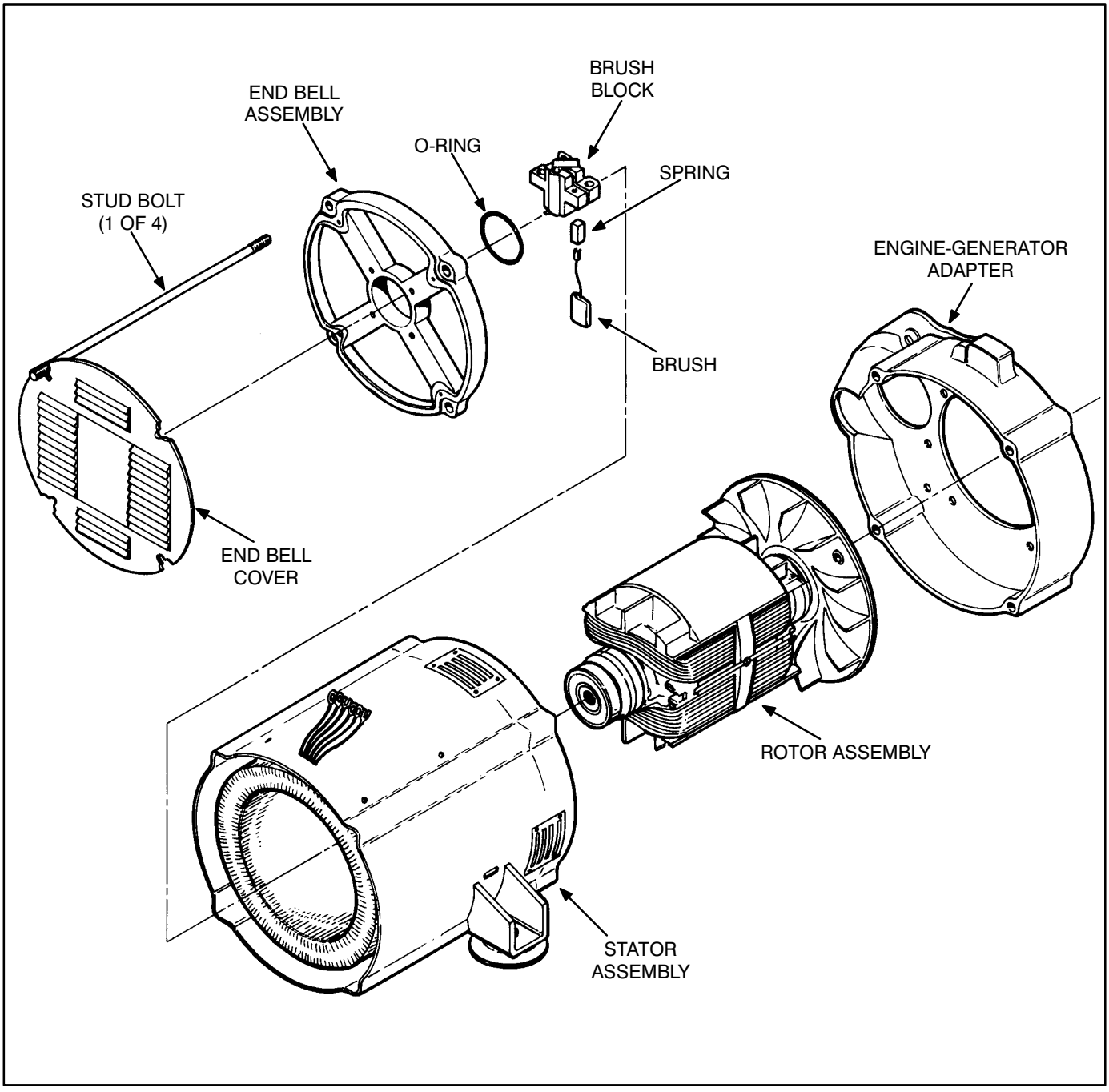



**FIGURE 4-8. GENERATOR DISASSEMBLY/REASSEMBLY** ES2067s

## Rotor Disassembly

1. Place the rotor assembly on a wood block in the horizontal position. **The drive disc and fan should not be resting on anything, or distortion may occur.**
2. Remove the five bolts that hold the drive disc and fan to the rotor hub. Remove the drive disc and fan.
3. Use a gear puller to remove the end bearing from the rotor shaft (Figure 4-9).

   **⚠ CAUTION** ***The end bearing will be damaged if pulled on the outer race. If the bearing must be removed, replace it; this bearing should not be reused.***

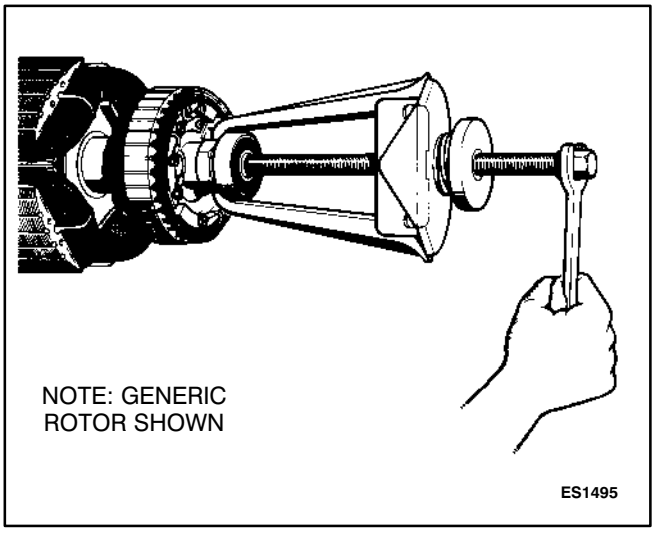



**FIGURE 4-9. END BEARING REMOVAL**

## Rotor Bearing Replacement

1. Clean the bearing and shaft mating surfaces.
2. Apply Loctite #680 adhesive to the shaft mating surface.
3. Apply Loctite #747 activator to the bearing mating surface.
4. Install the bearing and allow ten minutes curing time before handling the assembly.

## Rotor Reassembly

After necessary service checks and repairs are made, the rotor and generator are reassembled using the reverse procedure of disassembly except for the rotor as noted below. Regrease the O-ring using moly grease only. Apply required torque value shown in Figure 4-10.

**⚠ CAUTION** ***The drive disk will be damaged if the bolts are tightened and it is not properly centered. Center the disk accurately before beginning to tighten the drive disk.***

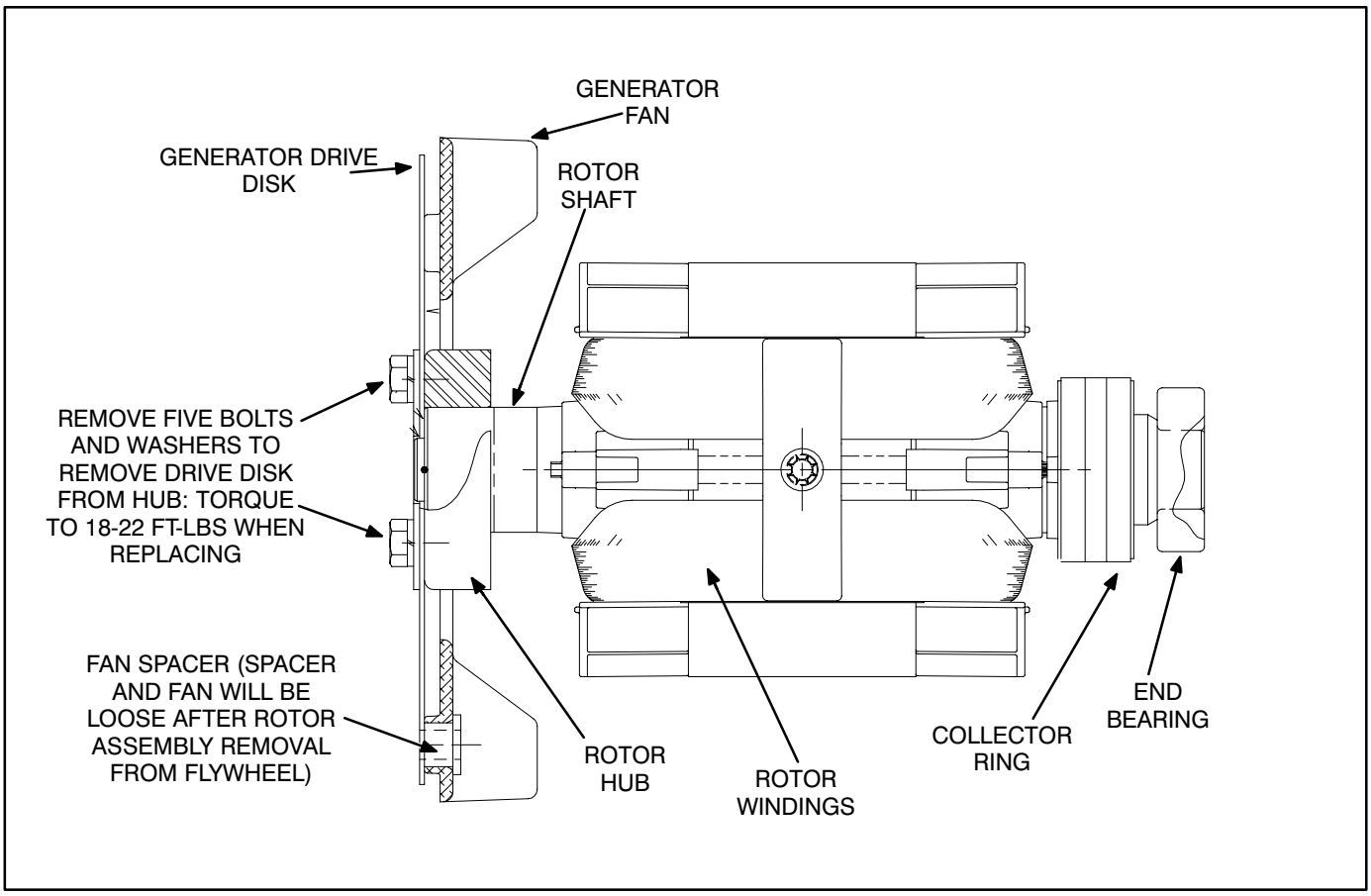



**FIGURE 4-10. ROTOR ASSEMBLY COMPONENTS**

# Section 5. Generator/Regulator Troubleshooting

## GENERAL

This section contains troubleshooting information for the MDKUB/MDKWB generator and voltage regulator. Make the following visual checks before starting:

- Check any modification or repair that was done since the last satisfactory operation of the set. Verify that it was done properly.
- Check to see that generator leads are connected correctly. Also check the voltage regulator and control component connectors. A loose, contaminated, or misplaced wire connection can be detected by close inspection.
- Check for an open circuit breaker. If the breaker is open, check for an overloaded circuit and correct load problems before resetting the breaker.

## TROUBLESHOOTING PROCEDURES

Determine the type of problem, then refer to the corresponding flow chart (A, B, C, or D) for troubleshooting procedures.

A. NO AC OUTPUT VOLTAGE AT RATED ENGINE RPM

B. UNSTABLE OUTPUT VOLTAGE, ENGINE SPEED STABLE

C. OUTPUT VOLTAGE TOO HIGH OR TOO LOW

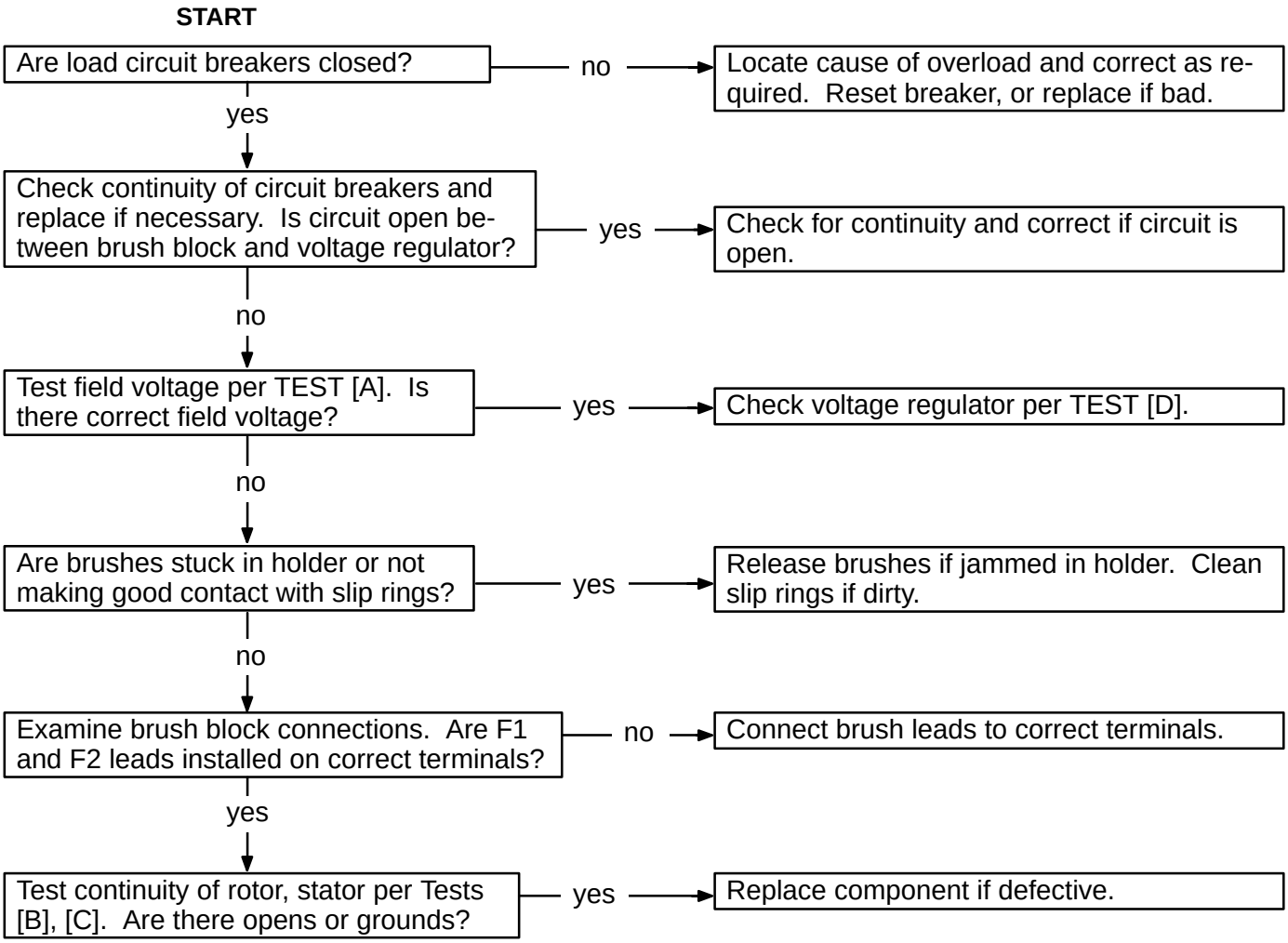
D. UNBALANCED OUTPUT VOLTAGE

To troubleshoot a problem, start at the upper left corner of the chart that corresponds to the problem, and answer all questions either YES or NO. Follow the chart until the problem is found. Perform the referenced test or adjustment procedures in the Generator/Regulator Tests section.

Components referenced in the flow charts, tests and adjustment procedures are found in the schematics and wiring diagrams in Section 9 of this manual.

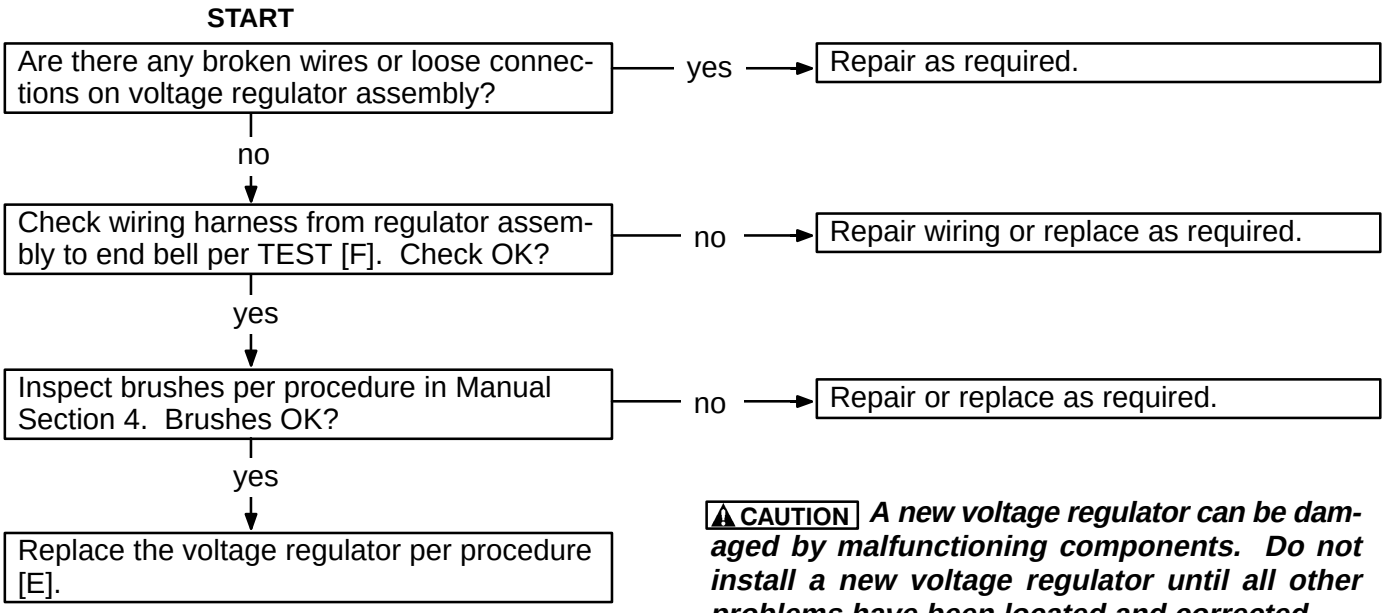
## FLOW CHART A. NO AC OUTPUT VOLTAGE AT RATED ENGINE RPM

***⚠WARNING Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***



## FLOW CHART B. UNSTABLE VOLTAGE, ENGINE SPEED STABLE

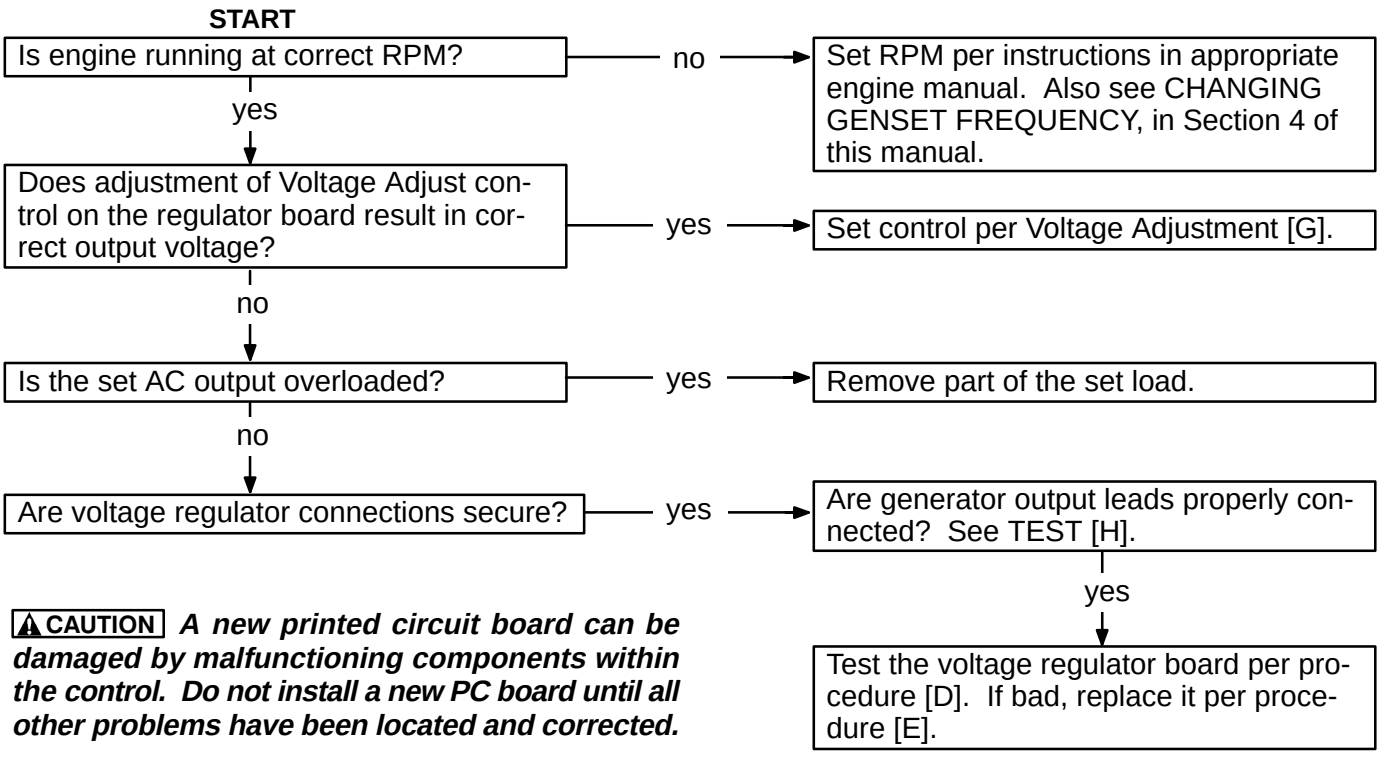
***WARNING** Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.*




***CAUTION** A new voltage regulator can be damaged by malfunctioning components. Do not install a new voltage regulator until all other problems have been located and corrected.*

## FLOW CHART C. OUTPUT VOLTAGE TOO HIGH OR TOO LOW

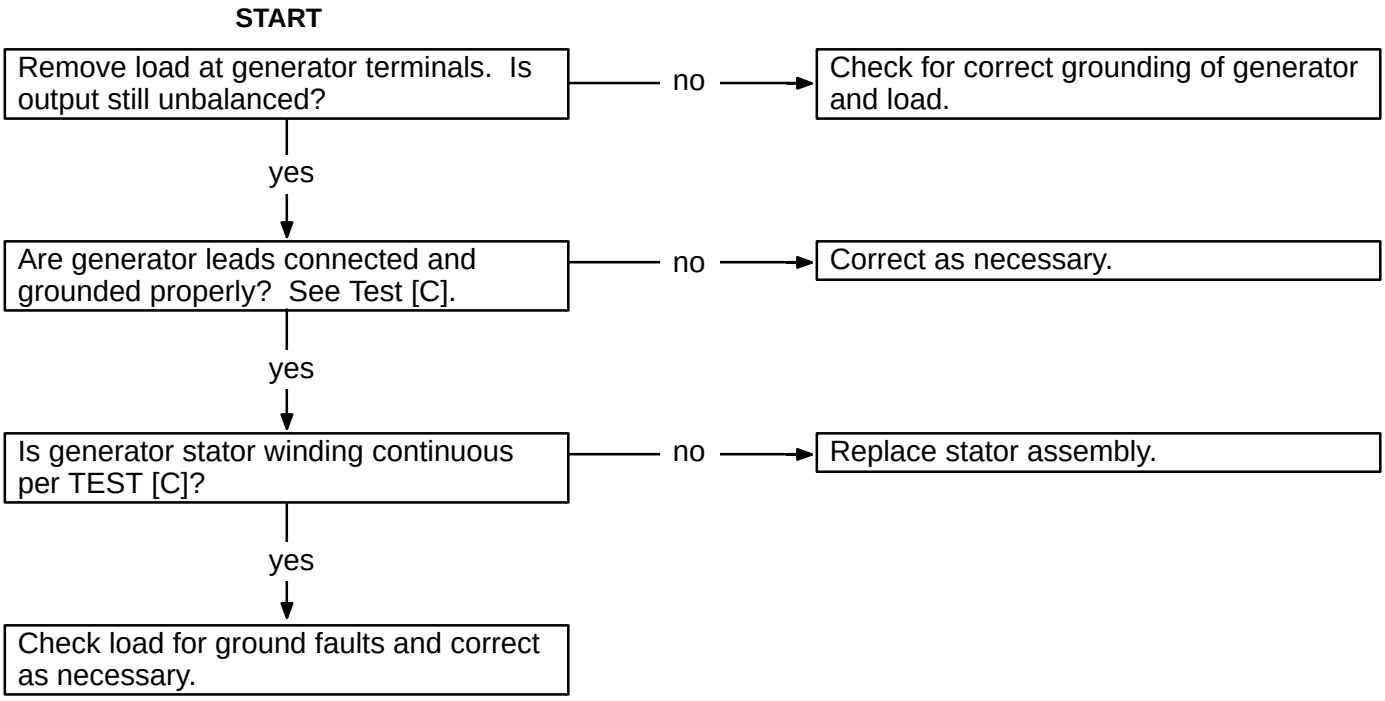
**⚠WARNING** ***Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***




**⚠CAUTION** ***A new printed circuit board can be damaged by malfunctioning components within the control. Do not install a new PC board until all other problems have been located and corrected.***

## FLOW CHART D. UNBALANCED GENERATOR OUTPUT VOLTAGE

***WARNING** Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.*



# Section 6. Generator/Regulator Tests

## GENERAL

The following tests and adjustments can be performed without disassembly of the generator. These procedures should be used for testing the generator components and the regulator in conjunction with the Troubleshooting Flow Charts in the Generator/Regulator Troubleshooting section.

**⚠WARNING** ***Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

## [A] TESTING FIELD VOLTAGE

Field voltage can be tested at the brush holder terminals with a DC voltmeter. Field voltage should fall between 18 and 60 volts. Test at no load and at full load. See Figure 6-1.

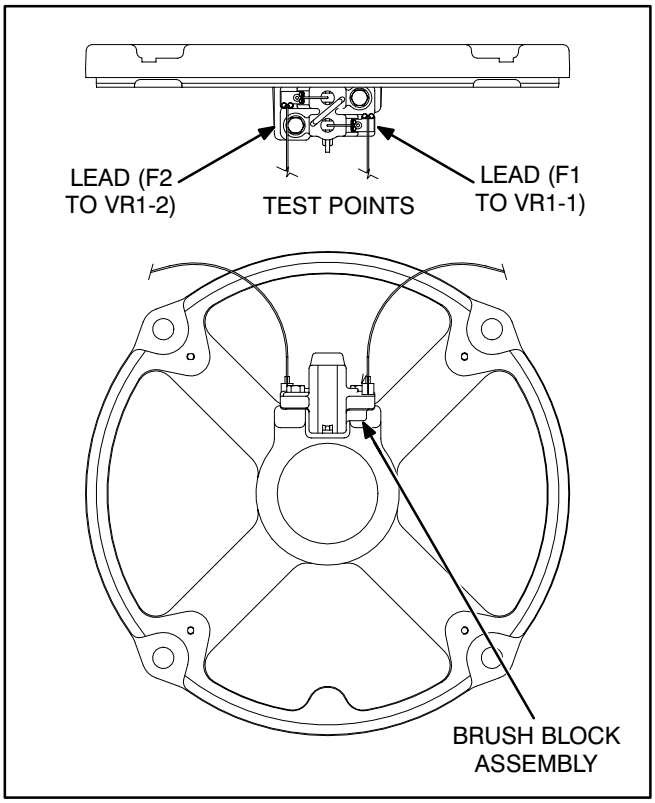



**FIGURE 6-1. FIELD VOLTAGE TEST POINTS**

## [B] TESTING GENERATOR ROTOR

The generator circuits can be tested without having to disassemble the generator. It is recommended that an ohmmeter be used to check for open circuits and an insulation resistance meter for grounded circuits. An ohmmeter can be used to check for grounded circuits, but it may not be able to detect marginal insulation breakdown.

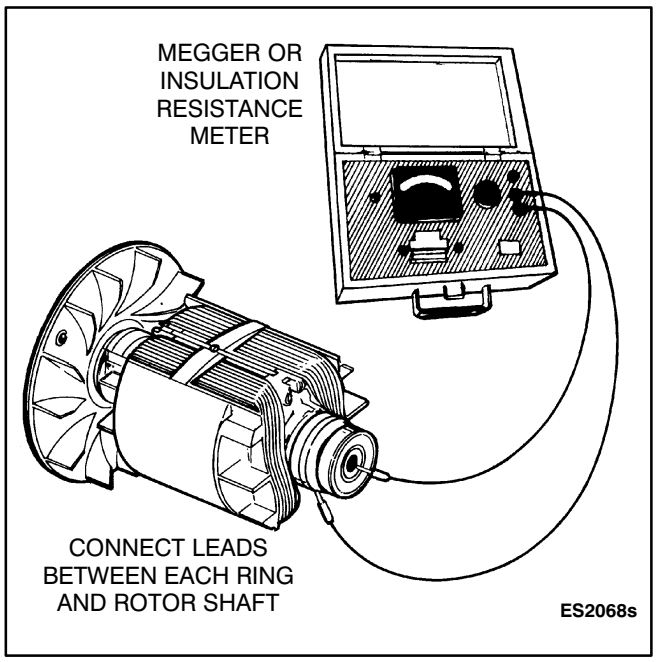



**FIGURE 6-2. TESTING ROTOR FOR GROUNDS**

### Testing for Grounds

Check for grounds between each slip ring and the rotor shaft, Figure 6-2. Use a Megger or insulation resistance meter which applies 500 VDC or more at the test leads. Perform test as follows:

1. Isolate the rotor windings by disconnecting the two leads to the brush holder.
2. Connect test leads between each ring and the rotor shaft in turn. Meter should register 100,000 ohms or greater.
3. If less than 100,000 ohms, rotor is questionable. Thoroughly dry the rotor and retest.
4. Replace a grounded rotor with a new identical part.

### Testing for Open or Shorted Windings

Perform this test with an accurate meter such as a digital ohmmeter.

1. Isolate the rotor windings by disconnecting the two leads to the brush holder.

2. Using ohmmeter, check resistance between F1 and F2 leads, Figure 6-3.

   - MDKUB: 22.1 ohms ± 10%
   - MDKWB: 27.6 ohms ± 10%

   If there is a large difference, replace the defective rotor with new, identical part.

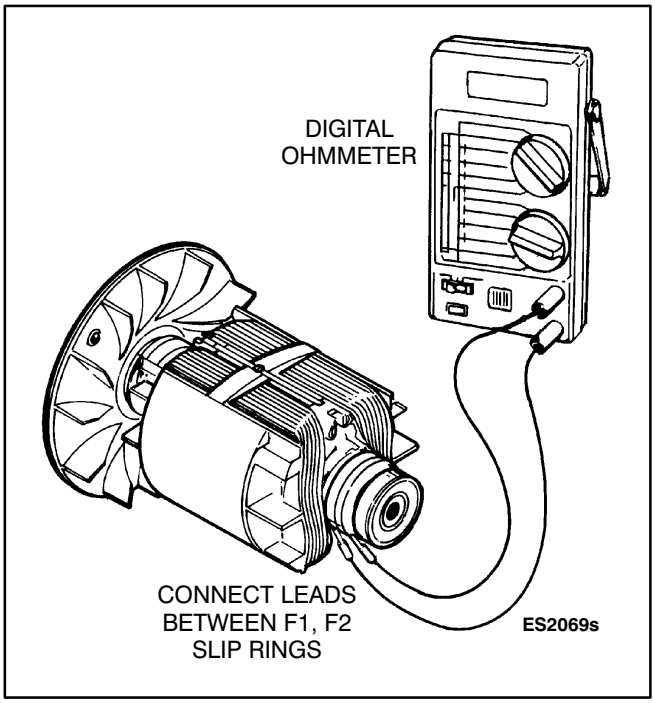



**FIGURE 6-3. TESTING ROTOR FOR AN OPEN CIRCUIT**

## [C] TESTING GENERATOR STATOR

Isolate the stator windings by disconnecting all six stator leads. Test for open circuits between T1-T2, T3-T4 and Q1-Q2, and for grounded circuits between T1, T3 and B1 and the stator laminations or other unpainted grounding point.

Using proper test equipment, check the stator for grounds, opens, and shorts in the windings.

### Testing for Grounds

Some generators have ground connections to the frame. Check wiring diagram. All stator leads must be isolated for testing.

Use a megger or insulation resistance meter which applies not more than 500 VDC to the test leads (Figure 6-4). Test each stator winding for short to laminations. A reading less than 100,000 ohms indicates a questionable stator. Thoroughly dry the stator and retest.

### Testing for Open or Shorted Windings

Test for continuity between coil leads as shown in Figure 6-5; all pairs should have equal resistance. Use an accurate instrument for this test such as a Wheatstone Bridge. Resistance should correspond to the values shown below.

- MDKUB resistance values (± 5%):
  T1-T2: 0.371 ohms
  T3-T4: 0.371 ohms
  Q1-Q2: 2.238 ohms
- MDKWB resistance values (± 5%):
  T1-T2: 0.186 ohms
  T3-T4: 0.186 ohms
  Q1-Q2: 1.88 ohms

If a winding is shorted, open or grounded, replace the stator assembly. Before replacing the assembly, check the leads for broken wires or insulation.

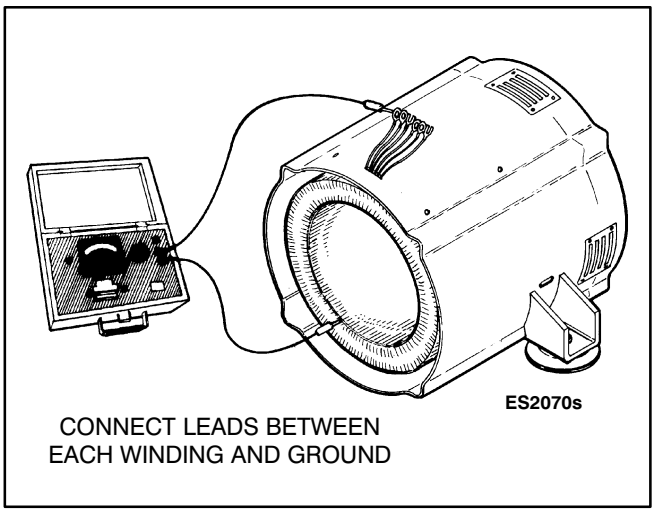



**FIGURE 6-4. TESTING STATOR WINDING FOR GROUNDS**

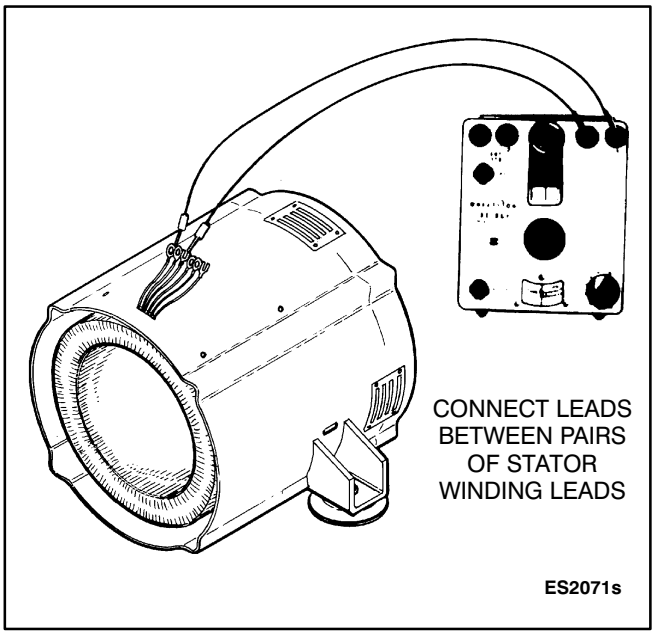



**FIGURE 6-5. TESTING STATOR WINDING RESISTANCE**

## [D] VOLTAGE REGULATOR TEST

The following procedure determines if there is an internal problem with the voltage regulator. If the regulator fails this test, it is faulty and must be replaced; there are no user-serviceable parts on the voltage regulator.

**NOTE: If the regulator checks "good", there is a small chance that it may yet be faulty. Recheck it on a genset if possible. Also check that the terminal lugs are connected to the correct terminals.**

**⚠WARNING** ***Electrical shock can cause severe personal injury or death. Do not touch electrical wiring or components during testing. Disconnect electrical power by removing starting battery negative (-) cable before handling electrical wiring or components.***

1. Stop the generator set and disconnect the starting battery leads, negative (-) lead first.
2. Unscrew the voltage regulator from the control box.
3. Disconnect the voltage regulator from the wiring harness.
4. Set the volt-ohmmeter to "diode check".
5. Place the positive (+) and negative (-) leads firmly on the pairs of terminals listed below in Table 6-1, as shown in Figure 6-6. Test the pairs of terminals listed in the table, note the readings, and compare them with the values shown in the table.

**NOTE: The "good" readings listed below correspond to the voltage drop across a good diode, positively biased. Different brands of meters may read differently for "good" test values. If in doubt, compare these readings with the readings obtained from a voltage regulator that is known to be working correctly.**

**TABLE 6-1. VOLTAGE REGULATOR TEST VALUES**

| POS (+) LEAD | NEG (-) LEAD | BAD | GOOD |
|---|---|---|---|
| TERMINAL | TERMINAL | | |
| 2 | 8 | short | not short |
| 2 | 1 | open or short | 0.3 - 0.6 |
| 3 | 1 | open or short | 0.3 - 0.6 |
| 4 | 1 | open or short | 0.3 - 0.6 |
| 8 | 3 | open or short | 0.3 - 0.6 |
| 8 | 4 | open or short | 0.3 - 0.6 |

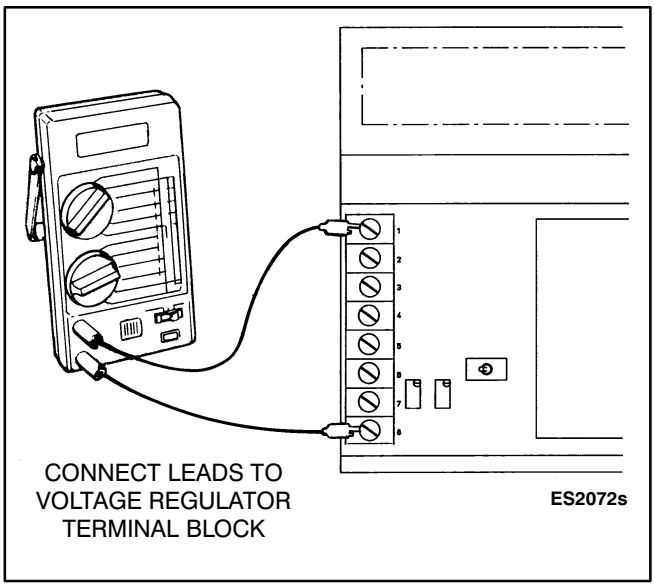



**FIGURE 6-6. VOLTAGE REGULATOR TEST**

## [E] VOLTAGE REGULATOR REPLACEMENT

Use the following procedure for replacing the AC voltage regulator assembly.

1. Stop the generator set and disconnect the starting battery leads, negative (-) lead first.
2. Unscrew the voltage regulator from the control box.
3. Disconnect the regulator from the wiring harness.
4. Remove the mounting screws from the old voltage regulator, then install the new regulator.
5. Reconnect the plug connection to the wiring harness.
6. Set voltage as outlined in [G] Voltage Adjustment.

## [F]

## WIRING HARNESS CHECK

Carefully check the wiring harness as follows:

1. Inspect all wires for breaks, loose connections, and reversed connections. Refer to applicable wiring diagram.
2. Remove wires from terminals at each end and with an ohmmeter, check each wire end to end for continuity or opens.
3. Using an ohmmeter, check each wire to other wires and to ground for possible shorts or insulation breaks under areas covered by wrapping material.
4. Reconnect or replace wires/harness according to applicable wiring diagram.

## [G]

## VOLTAGE ADJUSTMENT

This section describes adjustment of the genset output voltage. When checking output voltage, be sure the generator set has stabilized and is running at the correct speed (frequency). The regulator is adjusted with the set running.

**⚠WARNING** ***Accidental starting of the set can cause severe personal injury or death. Disconnect both battery cables, negative (-) cable first, when repairs are made to the engine, controls, or generator.***

**⚠WARNING** ***Contact with high voltage can cause severe personal injury or death. Do not touch any exposed wiring or components with any part of the body, clothing, tool or jewelry. Do not use non-insulated tools inside the control. Stand on an insulating mat or dry wood platform when the control doors are open.***

Output voltage adjustments are found on the genset faceplate and on the voltage regulator board inside the control box. See Figure 6-9.

1. Attach a voltmeter securely to the L1 and L2 leads.
2. Start the generator set and place a typical load on its output.
3. Loosen the hex locking nut securing the faceplate voltage adjustment pot. Use a flat-blade

screwdriver to set the voltage adjust potentiometer for correct voltage.

For most 60 Hz applications, the ideal setting is 117 VAC at 60-61 hz, measured at L1-L2 terminals. Retighten the locking nut when complete.

4. If satisfactory adjustment cannot be made at the faceplate, adjust output voltage using the pot on the voltage regulator board. Set the faceplate voltage adjustment pot to midrange, then adjust the output voltage as closely as possible using the pot on the voltage regulator board. Then make a final adjustment by means of the pot on the faceplate.

**Note that the voltage adjustment pot on the voltage regulator board is a 10-turn potentiometer: it may take several turns to change the voltage noticeably.**

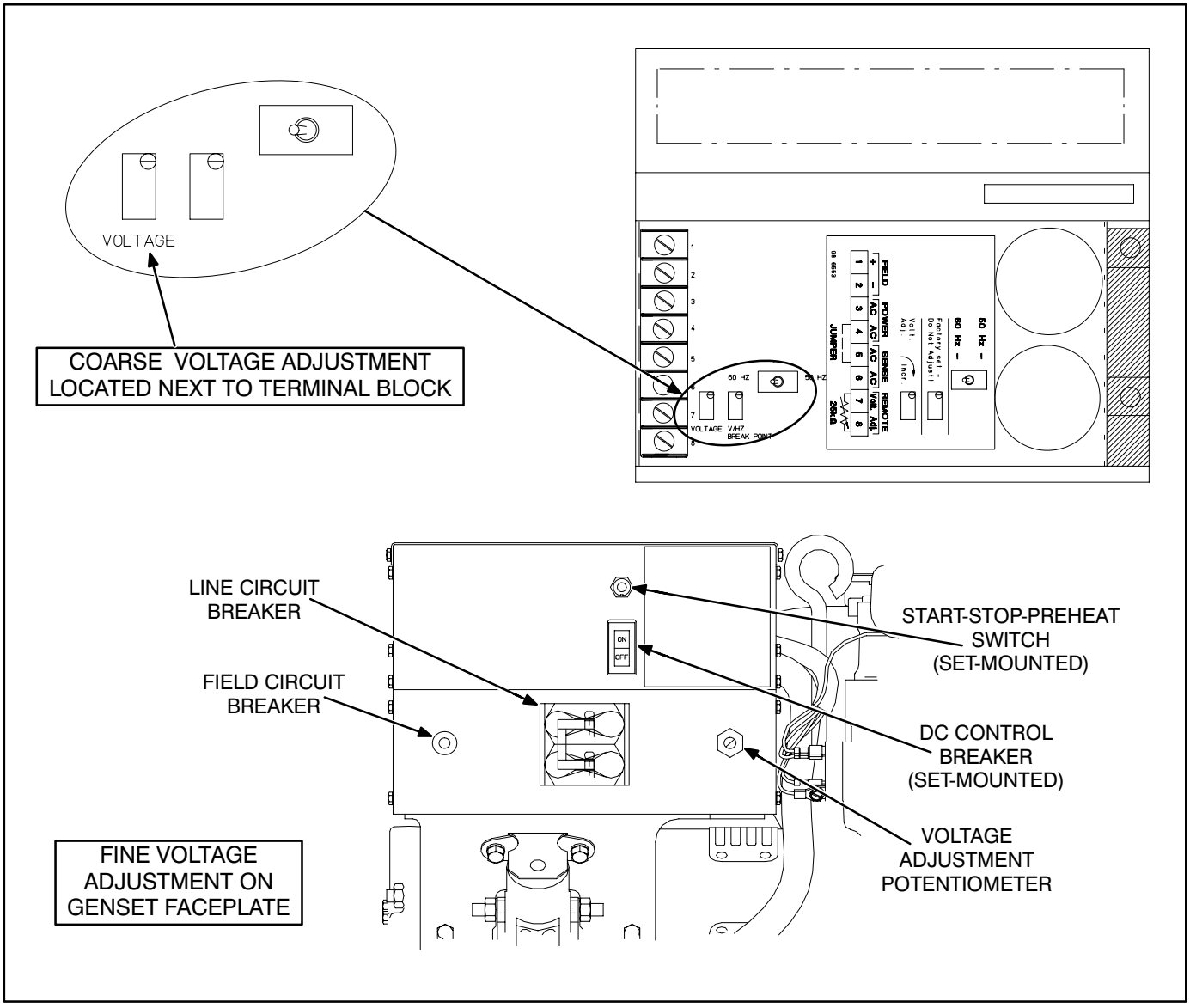



**FIGURE 6-9. LOCATION, OUTPUT VOLTAGE ADJUSTMENTS**

## [H]

## RECONNECTION

Generator reconnection is dependent upon the nameplate code. Diagram 612-6621, reproduced in Section 9 of this manual, shows reconnection possibilities.

# Section 7. Exhaust System

## GENERAL

The MDKUB/MDKWB generator sets are designed for installation with a hydrodynamic muffler. The exhaust manifold is water-jacketed, and the full flow of raw water (from the outside of the vessel) for engine cooling is discharged into the exhaust gas stream through ports at the exhaust outlet of the engine. Exhaust pressure is used to expel the water out the through-the-hull exhaust fitting. Figure 7-1 illustrates a typical exhaust/cooling installation. Refer to the Installation Manual (#981-0602) for important installation requirements.

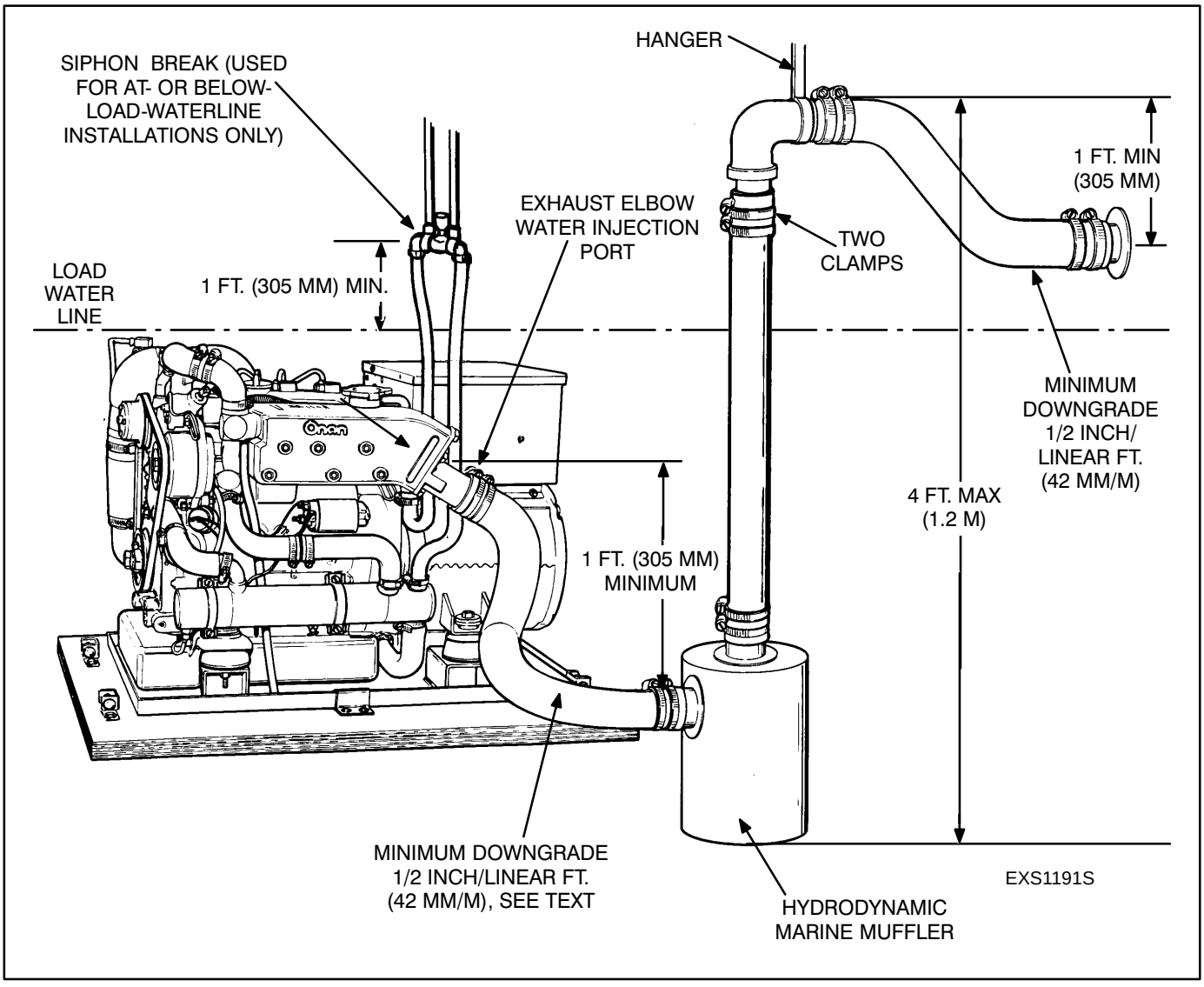



**FIGURE 7-1. TYPICAL EXHAUST/COOLING INSTALLATION**

**⚠WARNING** ***Improper installation, careless connection of hoses or failure to check for water and exhaust leaks can lead to flooding of the engine and boat or to severe sickness or death from exhaust gas (carbon monoxide).***

## FAILURE MODES

The full flow of engine cooling water is necessary to keep the exhaust gases cool enough for the exhaust system to handle. The high exhaust temperature switch closes at 222° F (105.5° C), shutting down the engine to protect the exhaust system from high exhaust temperatures if the flow of cooling water fails. Failure could be the result of the following circumstances:

- Closed sea water cock
- Clogged water filter
- Defective water pump
- Broken hoses or clogged heat exchanger passages

## SERVICE

Service involves checking the exhaust and cooling systems for water and exhaust leaks, and tightening clamps or replacing defective fittings or hose sections. The siphon break (if part of the system) should be checked for free movement of the valve by removing the screw-on cap, and replacing it if the valve is sticky.

If the high exhaust temperature switch has shut down the engine at any time, examine the exhaust hose and fittings and replace any sections that have been damaged by heat.

See the Installation Manual (#981-0602) for more information and diagrams of the exhaust system.

# Section 8. Cooling System

## DESCRIPTION

This marine generator set uses flotation water for heat exchanger and exhaust cooling. The term “raw water” is used in this manual to describe flotation water that is drawn into the boat for cooling purposes.

Figure 8-1 illustrates the heat exchanger cooling system.

A pump circulates coolant between the engine and the coolant/raw water heat exchanger. A thermostat regulates the engine operating temperature by controlling the flow of coolant. As the engine warms and cools, the coolant expands and contracts, pressurizing and depressurizing the system. The pressure cap limits coolant pressure by releasing coolant to the recovery tank. As the coolant volume contracts, the pressure cap allows the coolant in the recovery tank to siphon back into the engine. The coolant system is thereby kept full of coolant and free of air.

Raw water is pushed through the heat exchanger and water injection ports at the engine exhaust outlet by a directly driven pump with a neoprene impeller. To prevent flooding of the engine and the hull with sea water, a siphon break must be provided upstream of the water injection ports if they are below the load water line.

The boat installation must include a sea cock to allow service of the cooling system and a water filter to prevent abrasion of the pump and clogging of passages with dirt.

**⚠ CAUTION** ***The neoprene sea water pump impeller disintegrates in a matter of seconds if the pump is run dry. Do not run the set in dry dock or shop without connecting the pump to an ample reservoir of water at a level that will keep the pump flooded.***

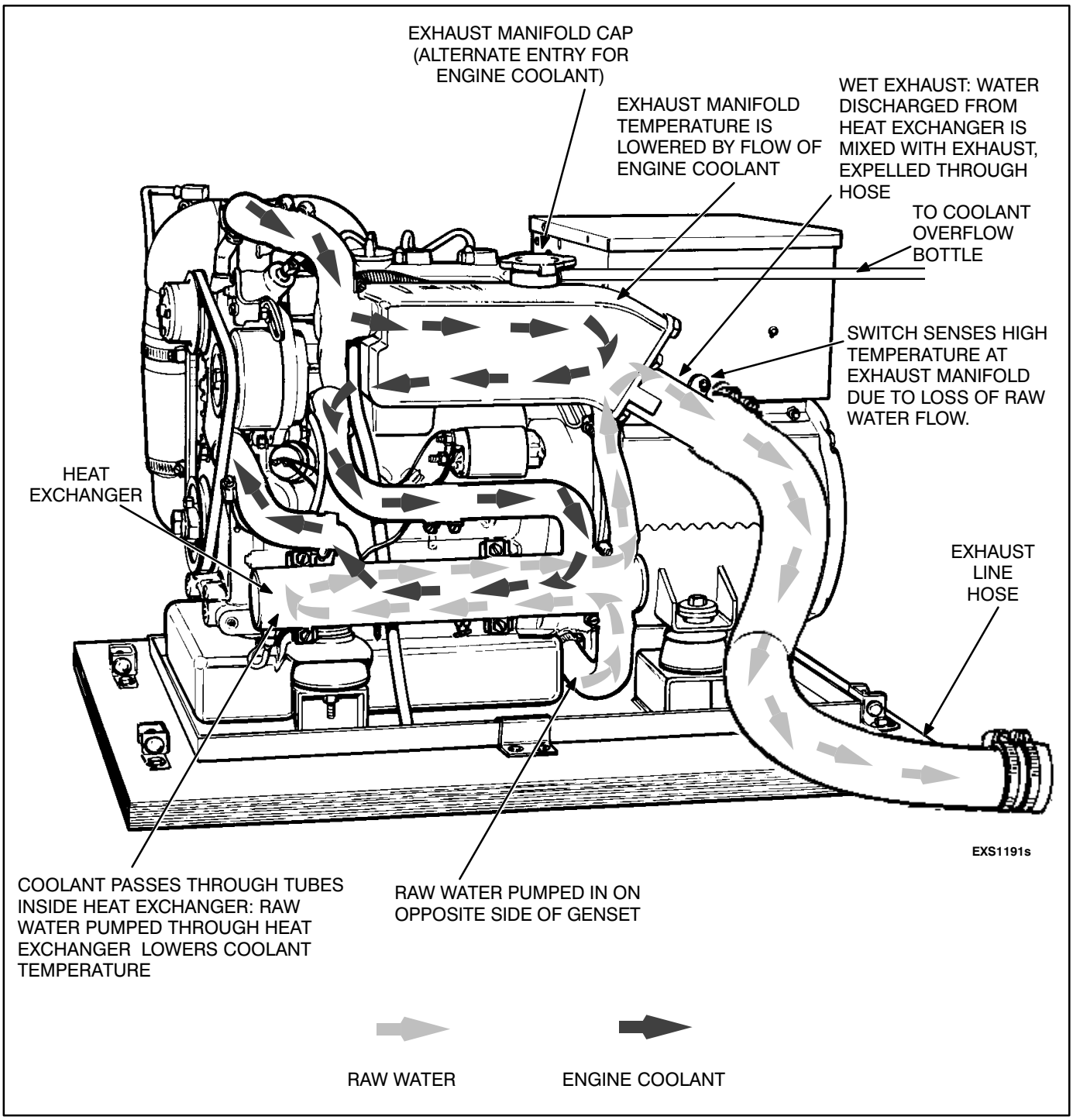



**FIGURE 8-1. COOLANT FLOW, HEAT EXCHANGER COOLING SYSTEM**

## COOLANT

Fill the engine coolant system with a 50/50 solution of ethylene glycol antifreeze and clean water. The antifreeze should include a rust inhibitor but not a stop-leak. A greater portion of antifreeze only degrades the heat transfer properties of the coolant and raises the freezing point.

Fill the recovery tank half way between the high and low marks. The coolant level in the tank will rise and fall as the engine runs.

Change coolant every year. To drain the coolant, let the engine cool, remove the pressure cap, disconnect the hoses to the coolant pump outlet and heat exchanger and remove the coolant plug in the heat exchanger.

Remove the thermostat and back flush the system with clean water. If there is scale and rust, use a cleaning compound according to its manufacturer's instructions. Refill with new coolant. Repair any coolant leaks before placing the set in service.

**⚠WARNING** ***Hot coolant is under pressure and can cause burns if allowed to escape. Let the engine cool before removing the pressure cap.***

## COMPONENTS

### Pressure Cap

Closed cooling systems make use of a pressurized cap to increase the boiling point of the coolant and allow higher operating temperatures. The cap is rated at 13 psi (88 kPa). Replace the pressure cap every two years for optimum performance.

### Thermostat

The thermostat maintains the coolant at the correct temperature. At temperatures lower than 160° F (71° C), coolant circulates in the engine without running to the exhaust manifold. At temperatures higher than 160° F (71° C), coolant is sent to the exhaust manifold. Further information on the engine thermostat may be found in the Engine Manual, Onan part # 981-0514.

### High Engine Temperature Sensor

The high engine temperature sensor senses coolant temperature and shuts down the engine when coolant temperature reaches the calibrated setting of the sensor, 222° F (106° C).

### Coolant Temperature Gauge Sender

The optional coolant temperature sender senses coolant temperature and is connected to indicate the coolant temperature on the remote control panel gauge.

### Coolant Pump

The coolant pump circulates the coolant between the engine and the coolant/sea water heat exchanger. Coolant pump information is found in the Engine Manual, Onan part # 981-0514.

### Heat Exchanger

The heat exchanger cools the engine coolant with raw water while keeping coolant and raw water apart. Coolant flows inside the shell, around the tubes. Sea water flows through one pass of tubes and returns by the other.

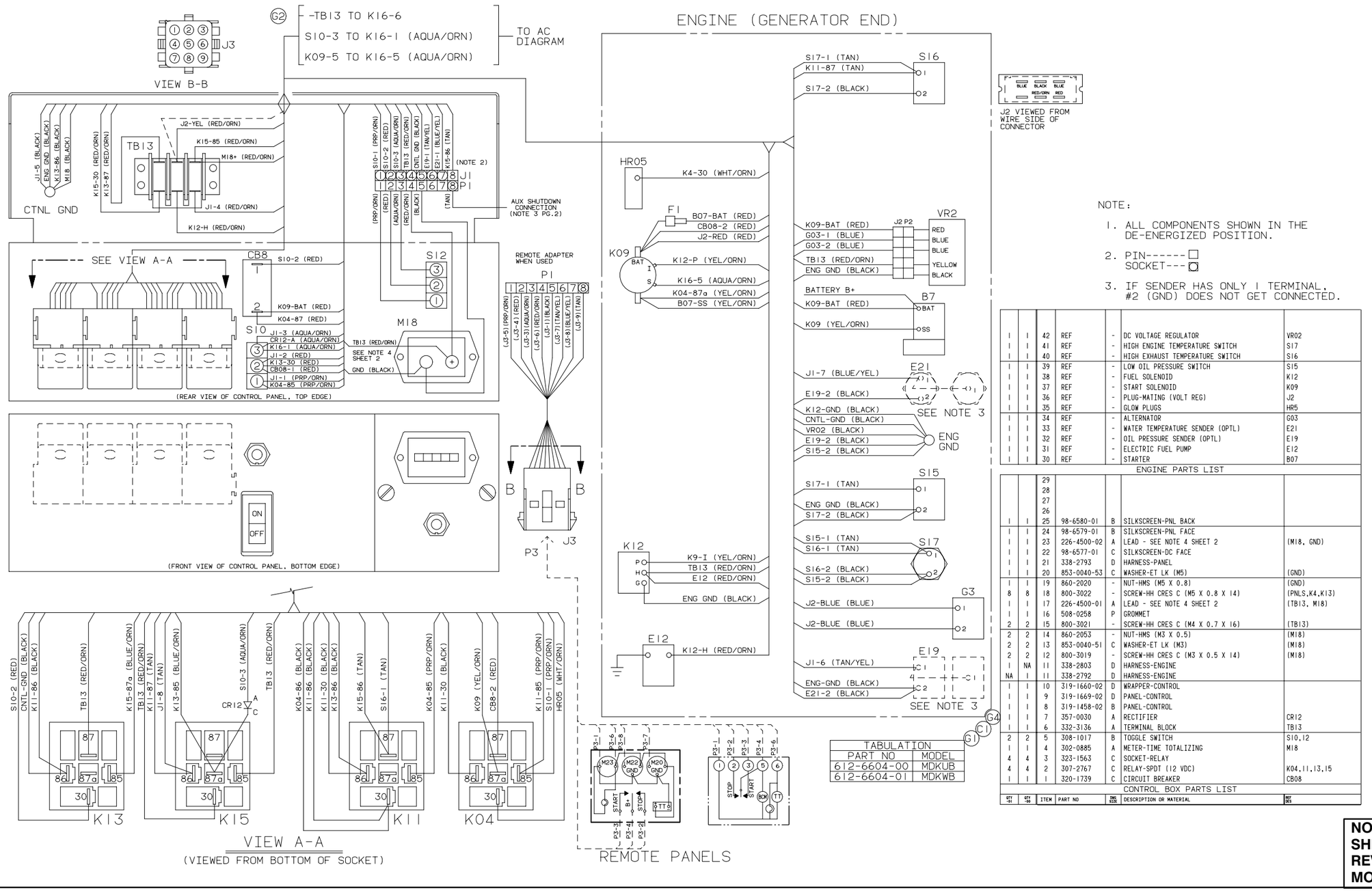
Remove the end cap and drain plug to clean the heat exchanger. Also remove the end cap to check for impeller debris if the raw water pump has accidentally been run dry.

### Raw Water Pump

The raw water pump is of the positive displacement type with a neoprene impeller (Figure 8-2). Short impeller life is usually caused by abrasion from dirt in the raw water. There should always be a water filter ahead of the pump. The raw water pump is powered by the power takeoff at the fuel injector pump.

# Section 9. Wiring Diagrams

The electrical schematics and wiring diagrams that apply to the generator set covered in this manual are listed below.




| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 1 | 42 | REF | - | DC VOLTAGE REGULATOR | VR02 |
| 1 | 1 | 41 | REF | - | HIGH ENGINE TEMPERATURE SWITCH | S17 |
| 1 | 1 | 40 | REF | - | HIGH EXHAUST TEMPERATURE SWITCH | S16 |
| 1 | 1 | 39 | REF | - | LOW OIL PRESSURE SWITCH | S15 |
| 1 | 1 | 38 | REF | - | FUEL SOLENOID | K12 |
| 1 | 1 | 37 | REF | - | START SOLENOID | K09 |
| 1 | 1 | 36 | REF | - | PLUG-MATING (VOLT REG) | J2 |
| 1 | 1 | 35 | REF | - | GLOW PLUGS | HR5 |
| 1 | 1 | 34 | REF | - | ALTERNATOR | G03 |
| 1 | 1 | 33 | REF | - | WATER TEMPERATURE SENDER (OPTL) | E21 |
| 1 | 1 | 32 | REF | - | OIL PRESSURE SENDER (OPTL) | E19 |
| 1 | 1 | 31 | REF | - | ELECTRIC FUEL PUMP | E12 |
| 1 | 1 | 30 | REF | - | STARTER | B07 |

ENGINE PARTS LIST

| | | | | | |
|---|---|---|---|---|---|
| | | 29 | | | |
| | | 28 | | | |
| | | 27 | | | |
| | | 26 | | | |
| 1 | 1 | 25 | 98-6580-01 | B | SILKSCREEN-PNL BACK |
| 1 | 1 | 24 | 98-6579-01 | B | SILKSCREEN-PNL FACE |
| 1 | 1 | 23 | 226-4500-02 | A | LEAD - SEE NOTE 4 SHEET 2 (M18, GND) |
| 1 | 1 | 22 | 98-6577-01 | C | SILKSCREEN-DC FACE |
| 1 | 1 | 21 | 338-2793 | D | HARNESS-PANEL |
| 1 | 1 | 20 | 853-0040-53 | C | WASHER-ET LK (M5) (GND) |
| 1 | 1 | 19 | 860-2020 | - | NUT-HMS (M5 X 0.8) (GND) |
| 8 | 8 | 18 | 800-3022 | - | SCREW-HH CRES C (M5 X 0.8 X 14) (PNLS,K4,K13) |
| 1 | 1 | 17 | 226-4500-01 | A | LEAD - SEE NOTE 4 SHEET 2 (TB13, M18) |
| 1 | 1 | 16 | 508-0258 | P | GROMMET |
| 2 | 2 | 15 | 800-3021 | - | SCREW-HH CRES C (M4 X 0.7 X 16) (TB13) |
| 2 | 2 | 14 | 860-2053 | - | NUT-HMS (M3 X 0.5) (M18) |
| 2 | 2 | 13 | 853-0040-51 | C | WASHER-ET LK (M3) (M18) |
| 2 | 2 | 12 | 800-3019 | - | SCREW-HH CRES C (M3 X 0.5 X 14) (M18) |
| 1 | NA | 11 | 338-2803 | D | HARNESS-ENGINE |
| NA | 1 | 11 | 338-2792 | D | HARNESS-ENGINE |
| 1 | 1 | 10 | 319-1660-02 | D | WRAPPER-CONTROL |
| 1 | 1 | 9 | 319-1669-02 | D | PANEL-CONTROL |
| 1 | 1 | 8 | 319-1458-02 | B | PANEL-CONTROL |
| 1 | 1 | 7 | 357-0030 | A | RECTIFIER CR12 |
| 1 | 1 | 6 | 332-3136 | A | TERMINAL BLOCK TB13 |
| 2 | 2 | 5 | 308-1017 | B | TOGGLE SWITCH S10,12 |
| 1 | 1 | 4 | 302-0885 | A | METER-TIME TOTALIZING M18 |
| 4 | 4 | 3 | 323-1563 | C | SOCKET-RELAY |
| 4 | 4 | 2 | 307-2767 | C | RELAY-SPDT (12 VDC) K04,11,13,15 |
| 1 | 1 | 1 | 320-1739 | C | CIRCUIT BREAKER CB08 |

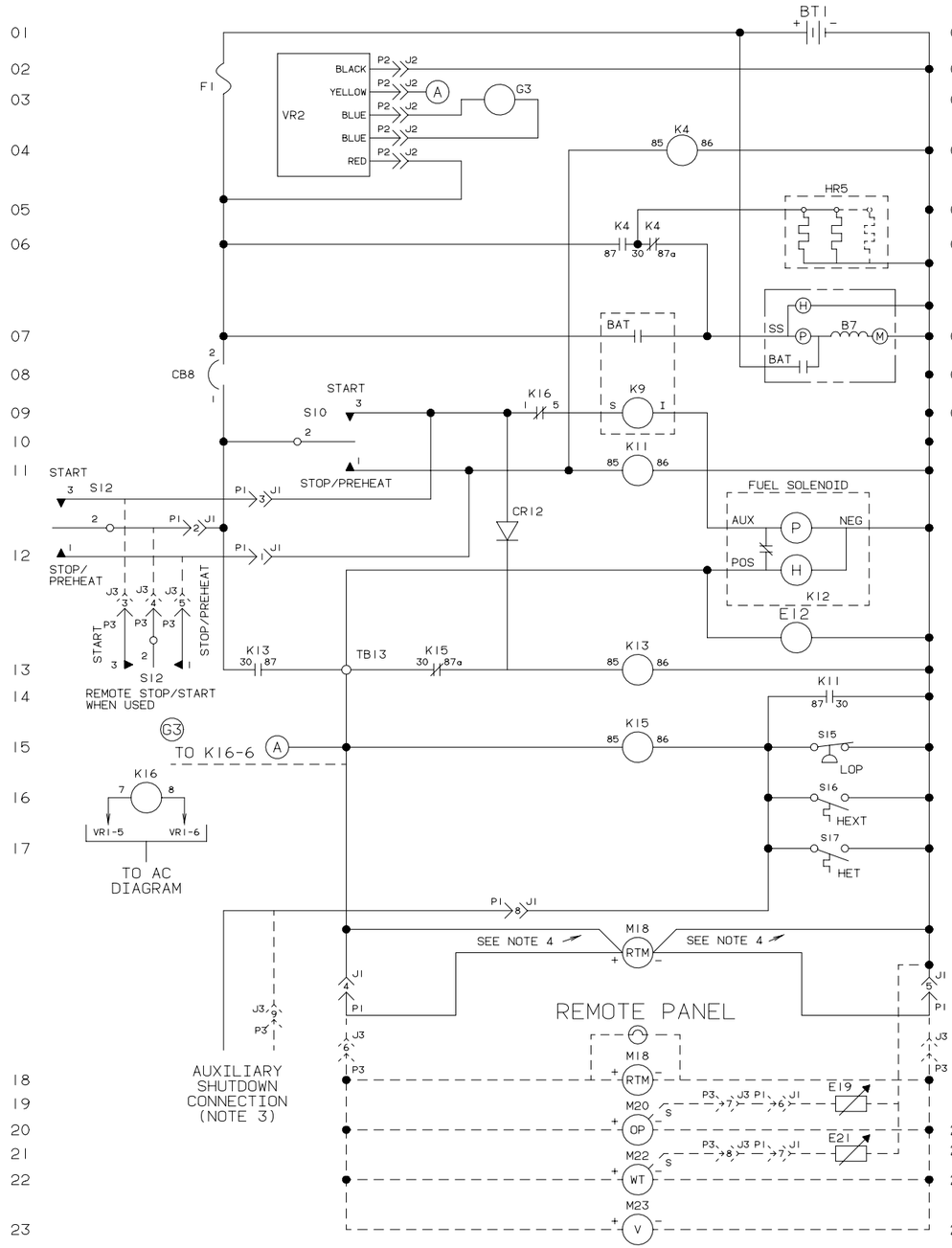
CONTROL BOX PARTS LIST

| QTY -01 | QTY -02 | ITEM | PART NO | DWG SIZE | DESCRIPTION OR MATERIAL | REF DES |
|---|---|---|---|---|---|---|

TABULATION

| PART NO | MODEL |
|---|---|
| 612-6604-00 | MDKUB |
| 612-6604-01 | MDKWB |

**NO. 612-6604**
**SHEET 1 OF 2**
**REV. G**
**MODIFIED**




01 BT01-BATTERY

02 VR02-DC VOLTAGE REGULATOR

03 G03-ALTERNATOR

04 K04-PREHEAT RELAY-06,06

05 HR05-GLOW PLUGS

06

07 B07-STARTER

08 CB08-CONTROL-CIRCUIT BREAKER

09 K09-START SOLENOID

10 S10-START-STOP/PREHEAT SWITCH

11 K11-STOP RELAY-14

12 S12-REMOTE START-STOP/PREHEAT SWITCH
CR12-DIODE
K12-FUEL SOLENOID
E12-FUEL PUMP

13 K13-RUN RELAY-13
TB13-TERMINAL BLOCK

14

15 K15-SHUTDOWN RELAY-13
S15-LOW OIL PRESSURE SWITCH

16 S16-HIGH EXHAUST TEMPERATURE SWITCH
K16-START DISCONNECT RELAY 09

17 S17-HIGH ENGINE TEMPERATURE SWITCH

18 M18-RUNNING TIME METER

19 E19-OIL PRESSURE SENDER

20 M20-OIL PRESSURE GAUGE

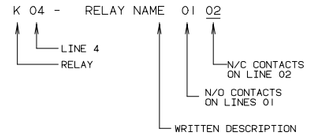
21 E21-WATER TEMPERATURE SENDER

22 M22-WATER TEMPERATURE GAUGE

23 M23-D.C. VOLTMETER

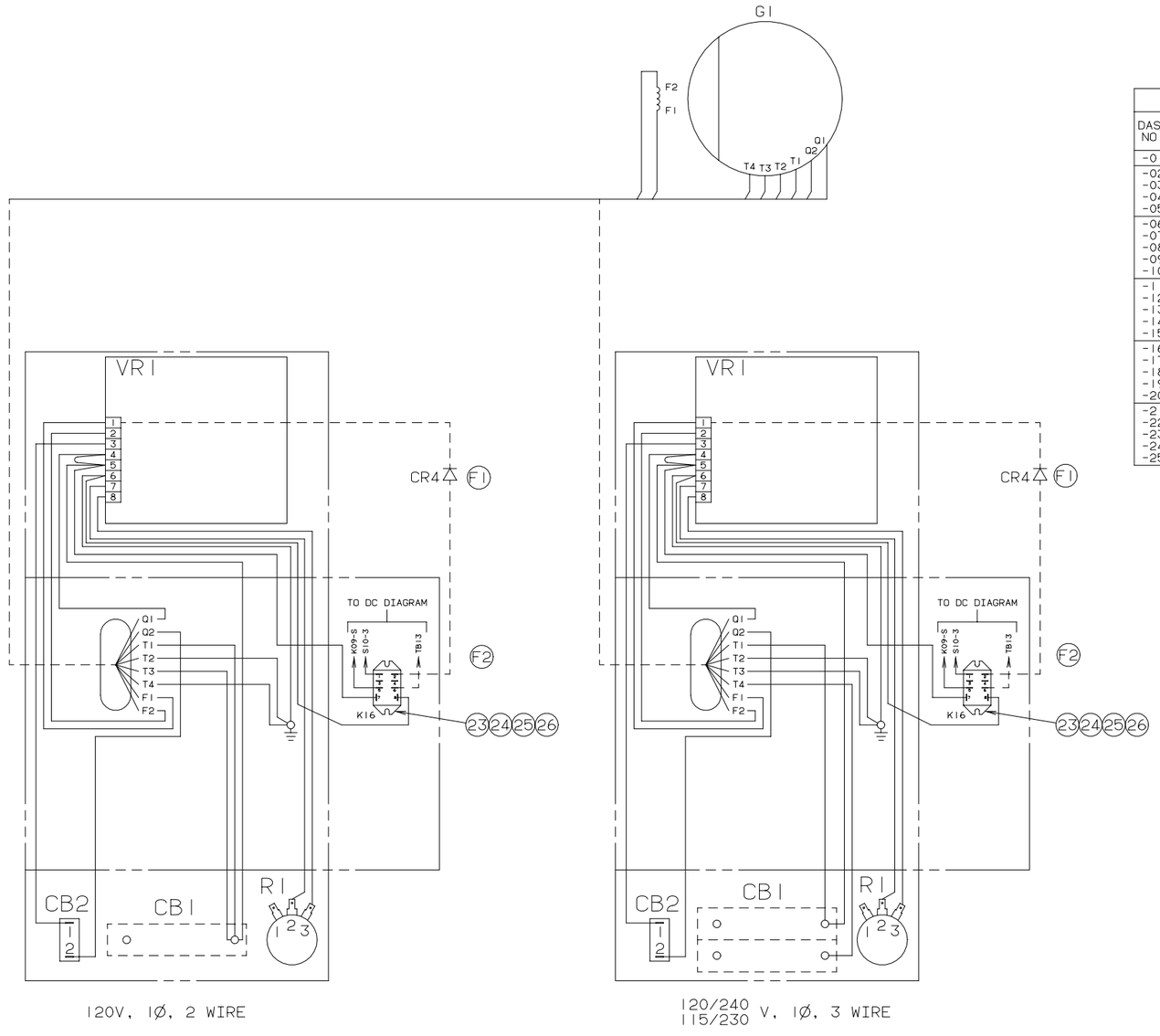
NOTES:

1. SCHEMATIC KEY:
   EACH COMPONENT IS LOCATED BY ITS DESIGNATION. ITS DESCRIPTION AND ITS COMPONANTS ARE LISTED TO THE RIGHT OF THE SCHEMATIC.




2. DASHED COMPONENTS ARE OPTIONS AND ARE SHOWN FOR IDENTIFICATION AND LOCATION.
3. AUXILIARY SHUTDOWN: CONNECT TO GROUND TO SHUTOFF GENSET.
4. DISCONNECT THESE TWO LEADS AND DISCARD THEM ONLY WHEN MI8 IS USED IN A REMOTE LOCATION

**NO. 612-6604**
**SHEET 2 OF 2**
**REV. G**
**MODIFIED**




TABULATION

| DASH NO. | VOLTAGE CONNECTION | MAIN LINE BREAKER | MAX. BREAKER VOLTAGE | NO. OF POLES | AMPS | ITEM 1 BREAKER NO. | ITEM 7 SCREW NO.(QTY) | ITEM 8 WASHER-LK NO.(QTY) | ITEM 29 COVER PLT NO. |
|---|---|---|---|---|---|---|---|---|---|
| -01 | RECONNECTABLE | NO | --- | --- | --- | --- | --- | --- | 320-1813-02 |
| -02 | 110 OR 120 VAC | YES | 240 | 1 | 35 | 320-1690-01 | 812-0061 (4) | 850-0020 (4) | 320-1813-02 |
| -03 | | YES | 240 | 1 | 40 | 320-1690-02 | 812-0061 (4) | 850-0020 (4) | 320-1813-02 |
| -04 | | YES | 240 | 1 | 45 | 320-1690-09 | 812-0061 (4) | 850-0020 (4) | 320-1813-02 |
| -05 | | YES | 240 | 1 | 50 | 320-1690-08 | 812-0061 (4) | 850-0020 (4) | 320-1813-02 |
| -06 | | YES | 240 | 1 | 55 | 320-1690-10 | 812-0061 (4) | 850-0020 (4) | 320-1813-02 |
| -07 | | YES | 240 | 1 | 60 | 320-1690-03 | 812-0061 (4) | 850-0020 (4) | 320-1813-02 |
| -08 | | YES | 240 | 1 | 65 | 320-1690-11 | 812-0061 (4) | 850-0020 (4) | 320-1813-02 |
| -09 | | YES | 240 | 1 | 70 | 320-1690-04 | 812-0061 (4) | 850-0020 (4) | 320-1813-02 |
| -10 | | YES | 240 | 1 | 75 | 320-1690-12 | 812-0061 (4) | 850-0020 (4) | 320-1813-02 |
| -11 | | YES | 240 | 1 | 80 | 320-1690-05 | 812-0061 (4) | 850-0020 (4) | 320-1813-02 |
| -12 | 220 THRU 240 VAC | YES | 240 | 1 | 25 | 320-1690-16 | 812-0061 (4) | 850-0020 (4) | 320-1813-02 |
| -13 | | | | | | | | | |
| -14 | | | | | | | | | |
| -15 | | | | | | | | | |
| -16 | 110/220 VAC | YES | 240 | 2 | 18 | 320-1689-01 | 812-0061 (4) | 850-0020 (4) | |
| -17 | OR | YES | 240 | 2 | 20 | 320-1689-02 | 812-0061 (4) | 850-0020 (4) | |
| -18 | 120/240 VAC | YES | 240 | 2 | 25 | 320-1689-03 | 812-0061 (4) | 850-0020 (4) | |
| -19 | | YES | 240 | 2 | 30 | 320-1689-04 | 812-0061 (4) | 850-0020 (4) | |
| -20 | | YES | 240 | 2 | 35 | 320-1689-05 | 812-0061 (4) | 850-0020 (4) | |
| -21 | | 240 | 240 | 2 | 40 | 320-1689-06 | 812-0061 (4) | 850-0020 (4) | |
| -22 | | 240 | 240 | 2 | 45 | 320-1689-07 | 812-0061 (4) | 850-0020 (4) | |
| -23 | | | | | | | | | |
| -24 | | | | | | | | | |
| -25 | | | | | | | | | |

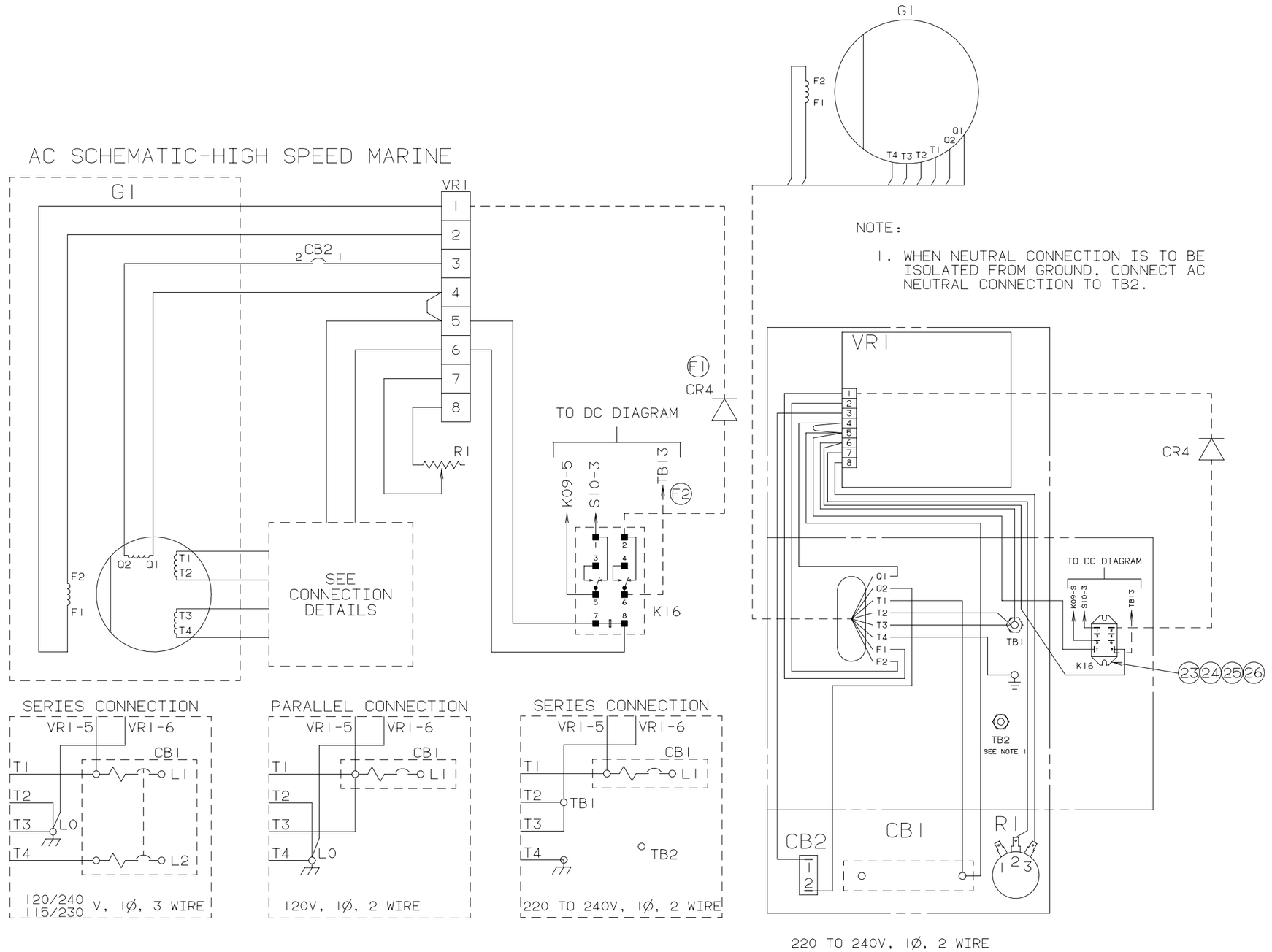
D1,2

| REF DES | ITEM | PART NO *BULK | DWG SIZE | QTY | DESCRIPTION OR MATERIAL |
|---|---|---|---|---|---|
| | 30 | 821-0009 | - | 2 | SCREW - 1/4-20 X .38 (TO MT ITEM 27) |
| | 29 | SEE TAB | B | 1 | PLATE - COVER |
| | 28 | 821-0008 | - | 2 | SCREW - 1/4-20 X .31 (TO MT ITEM 27) |
| | 27 | 332-2370 | P | 2 | STANDOFF - INSULATING |
| | 26 | 860-2053 | - | 2 | NUT-HMS (M3 X 0.5) |
| | 25 | 853-0001 | - | 2 | WASHER-ET LK (.12) |
| | 24 | 800-3019 | - | 2 | SCREW- CRES C (M3 X 0.5 X 14) |
| K16 | 23 | 307-2594 | B | 1 | RELAY (START DISC) |
| W7 | 22 | 226-4398-08 | A | 1 | LEAD (VR1-6,K16-8) |
| W6 | 21 | 226-4398-07 | A | 1 | LEAD (VR1-5,K16-7) |
| | 20 | 98-6582-01 | C | 1 | SILKSCREEN-AC BACK |
| | 19 | 98-6581-01 | C | 1 | SILKSCREEN-AC FACE |
| | 18 | 853-0040-05 | - | 1 | WASHER-ET LK (1/4)(GND STUD) |
| | 17 | 862-0013 | - | 1 | NUT-HEX (1/4-20) (GND STUD) |
| | 16 | 226-4398-06 | A | 1 | JUMPER (VR1-4,VR1-5) |
| W5 | 15 | 226-4398-05 | A | 1 | LEAD (VR1-3,CB2-1) |
| W4 | 14 | 226-4398-04 | A | 1 | LEAD (VR1-8,R1-3) |
| W3 | 13 | 226-4398-03 | A | 1 | LEAD (VR1-7,R1-2) |
| W2 | 12 | 226-4398-02 | A | 1 | LEAD (VR1-6,L0) |
| W1 | 11 | 226-4398-01 | A | 1 | LEAD (VR1-5,L1) |
| | 10 | 319-1665-02 | D | 1 | PANEL-CONTROL |
| | 9 | 800-3022 | A | 7 | SCREW-HH CRES C (M5 X 0.8 X 14)(PNL,VR1) |
| | 8 | SEE TAB | - | TAB | WASHER-LK .250Dx.042ID (BREAKER MTG) |
| | 7 | SEE TAB | - | TAB | SCREW-RHM 6-32x3/8 (BREAKER MTG) |
| CR4 | 6 | REF | A | 1 | RECTIFIER |
| VR1 | 5 | REF | A | 1 | REGULATOR-VOLTAGE |
| R1 | 4 | 303-0285 | A | 1 | POTENTIOMETER |
| G1 | 3 | REF | D | 1 | GENERATOR (AC) |
| CB2 | 2 | 320-1769 | C | 1 | CIRCUIT BREAKER (FIELD) |
| CB1 | 1 | SEE TAB | C | 1 | CIRCUIT BREAKER (MAIN LINE) |

F1

**NO. 612-6621**
**SHEET 1 OF 2**
**REV. F**
**MODIFIED**

# AC SCHEMATIC-HIGH SPEED MARINE




**NO. 612-6621**
**SHEET 2 OF 2**
**REV. F**
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