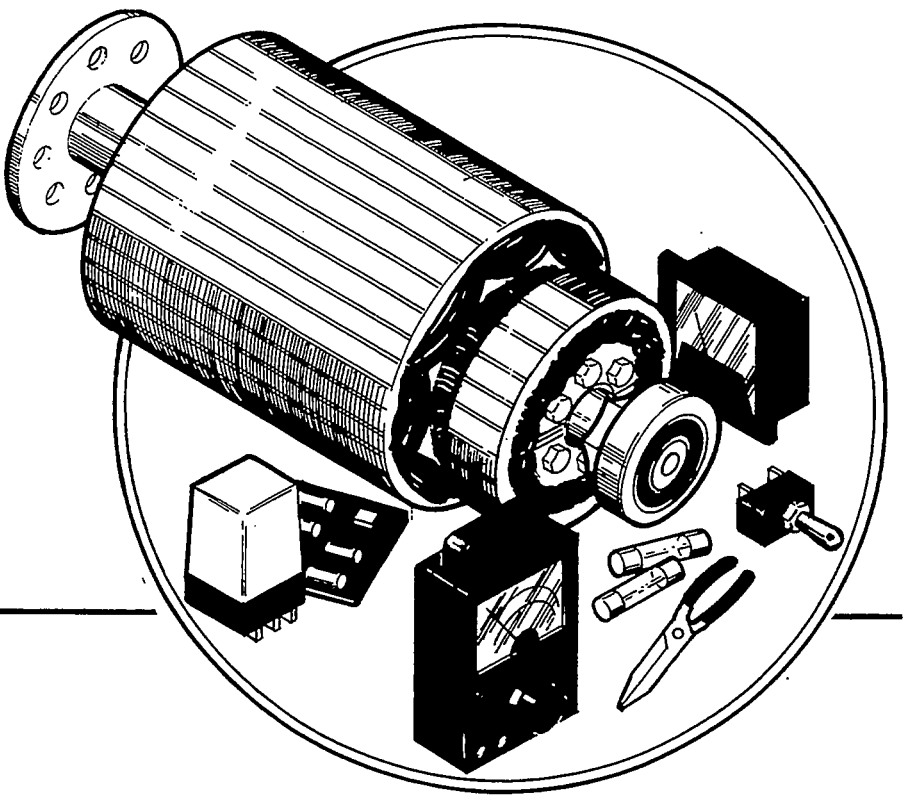
Onan

Service Manual

DL3

Generator and Control



RV Electric Generator Set

934-0501
8-91
Printed in U.S.A.

Safety Precautions

Before operating the generator set, read the Operator's Manual and become familiar with it and the equipment. **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.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

⚠ 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 AND FUMES ARE FLAMMABLE. Fire, explosion, and personal injury can result from improper practices.

- DO NOT fill fuel tanks while engine is running. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT SMOKE OR USE AN OPEN FLAME near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible, non-conductive line. Do not use copper piping on flexible lines as copper will work harden and become brittle.
- Be sure all fuel supplies have a positive shutoff valve.

GASOLINE AND LPG FUEL MAY BE ACCIDENTALLY IGNITED BY ELECTRICAL SPARKS, presenting the hazard of fire or explosion, which can result in severe personal injury or death. When installing the generator set:

- Do not tie electrical wiring to fuel lines.
- Do not run electrical lines and fuel lines through the same compartment openings.
- Keep electrical and fuel lines as far apart as possible.
- Place a physical barrier between fuel lines and electrical lines wherever possible.
- If electrical and fuel lines must pass through the same compartment opening, make certain that they are physically separated by running them through individual channels, or by passing each line through a separate piece of tubing.
- DO NOT SMOKE while servicing batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

EXHAUST GASES ARE DEADLY

- Never sleep in the vehicle with the generator set running unless vehicle is equipped with an operating carbon monoxide detector.
- Provide an adequate exhaust system to properly expel discharged gases. Inspect exhaust system daily for leaks per the maintenance schedule. Ensure that exhaust manifolds are secure and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Before starting work on the generator set, disconnect batteries. This will prevent accidental arcing.
- Keep your hands away from moving parts.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry while working on generator sets. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Disconnect starting battery before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages can cause injury or death.
- Follow all state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved device and after building main switch is open. Consult an electrician in regard to emergency power use.

GENERAL SAFETY PRECAUTIONS

- Have a fire extinguisher nearby. Maintain extinguisher properly and become familiar with its use. Extinguishers rated ABC by the NFPA are appropriate for all applications. Consult the local fire department for the correct type of extinguisher for various applications.
- Hot coolants under pressure can cause severe personal injury. DO NOT open a radiator pressure cap while the engine is running. Stop the engine and carefully bleed the system pressure.
- 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.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage, which presents a potential fire hazard.
- DO NOT store anything in the generator compartment such as oil or gas cans, oily rags, chains, wooden blocks, portable propane cylinders, etc. A fire could result or the generator set operation (cooling, noise and vibration) may be adversely affected. Keep the compartment floor clean and dry.
- 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.

⚠WARNING

EXHAUST GAS IS DEADLY!

Exhaust gases contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:

- ***Dizziness***
- ***Nausea***
- ***Headache***
- ***Weakness and Sleepiness***
- ***Throbbing in Temples***
- ***Muscular Twitching***
- ***Vomiting***
- ***Inability to Think Coherently***

IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Never sleep in vehicle with the generator set running unless the vehicle interior is equipped with an operating carbon monoxide detector. Protection against carbon monoxide inhalation also includes proper exhaust system installation and visual and audible inspection of the complete exhaust system at the start of each generator set operation.

1-RV

Table of Contents

Section 1. General Information

ABOUT THIS MANUAL

This manual covers troubleshooting and repair information for the generator and control. It has separate sections for the generator and voltage regulator, engine control, and wiring diagrams. Refer to the engine service manual (934-0750) when servicing the engine.

Repair information for the solid state printed circuit board is not covered because it lends itself to replacement rather than repair. Application of meters or soldering irons to the printed circuit board by other than qualified personnel can cause unnecessary and expensive damage.

Repair of the printed circuit boards is not recommended except by the factory. A return and exchange service has been initiated whereby faulty printed circuit boards can be returned to the Distributor and exchanged for good units. For more information, contact your Onan Distributor.

⚠CAUTION ***High voltage (Megger) testing or insulation testing of generator windings can cause damage to solid state components. Isolate these components before testing.***

TESTING EQUIPMENT

Many test procedures in this manual can be performed with an AC-DC multimeter (Simpson Model 260 VOM) or a digital VOM. Some other instruments to have available are:

- Megger or Insulation Resistance Meter
- Wheatstone Bridge or Digital Ohmmeter
- Jumper Leads
- Load Test Panel
- Variac
- Frequency Meter
- Tachometer or Strobotach

See Onan Tool Catalog 900-0019.

⚠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/OR MECHANICAL SERVICE.

Section 2. Generator/Voltage Regulator

GENERATOR DESCRIPTION

The YD generator (Figure 2-1) is a four-pole, revolving field, brushless exciter design. The DL3 generator set is available in single phase only.

The generator rotor is directly coupled to the engine flywheel with a flexible drive disc. A centrifugal blower on the drive disc circulates generator cooling air which is drawn in through the end bell and discharged through an outlet at the blower end.

A ball bearing in the end bell supports the outer rotor shaft. The end bell is attached with four studs that thread into the generator adapter casting. The brushless exciter stator mounts in the end bell while the exciter rotor and its rotating diode assemblies mount on the generator rotor shaft.

In addition to the AC output leads (T1-T4), six control leads exit from the generator housing. See Figure 2-2. Lead F1 (+) and F2 (-) from the exciter stator winding and leads S1 and S2 from the main stator go to the voltage regulator circuit. Leads 1 and 2 go to the start/disconnect circuit on the engine monitor PCB, and leads B1 and B2 go to the battery charger circuit.

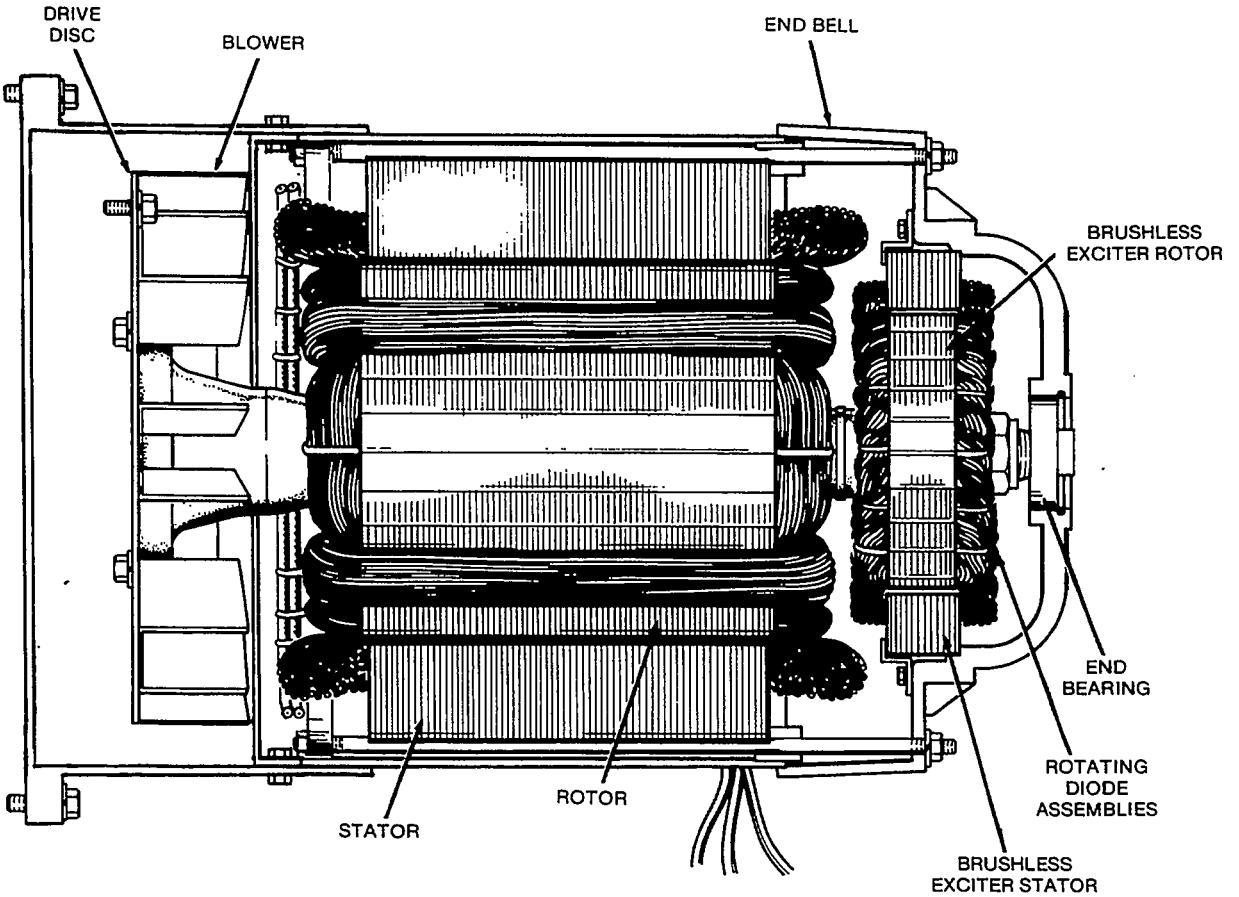


FIGURE 2-1. TYPICAL YD SERIES GENERATOR

GENERATOR OPERATION

Operation of the generator involves the main stator and rotor, exciter stator and rotor, rotating diode assemblies, and the voltage regulator. See Figure 2-3. A permanent magnet embedded in one exciter field pole begins the voltage build-up process as the generator set starts.

The exciter rotor produces three-phase AC voltage that is converted to DC by the rotating diode assemblies. The resultant DC voltage excites the main rotor winding to produce the stator output voltage for the AC load.

Voltage regulation is covered in the next chapter.

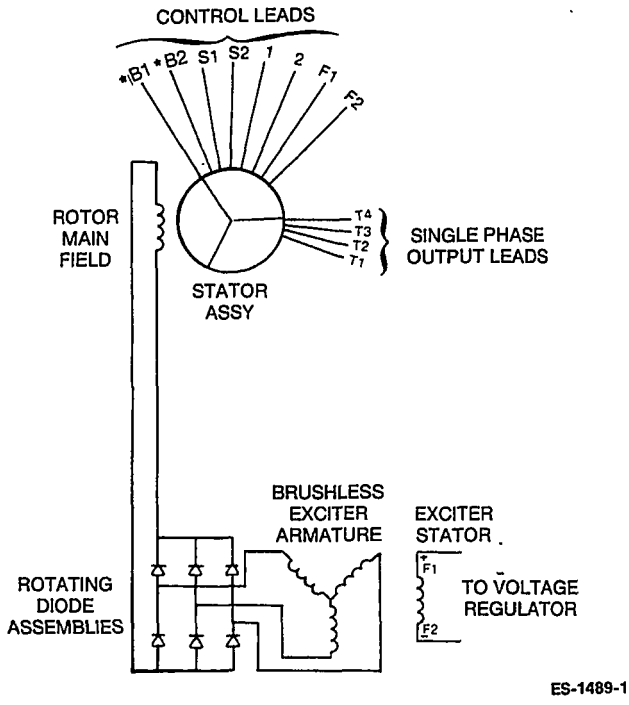


FIGURE 2-2. GENERATOR SCHEMATIC (COMPOSITE)

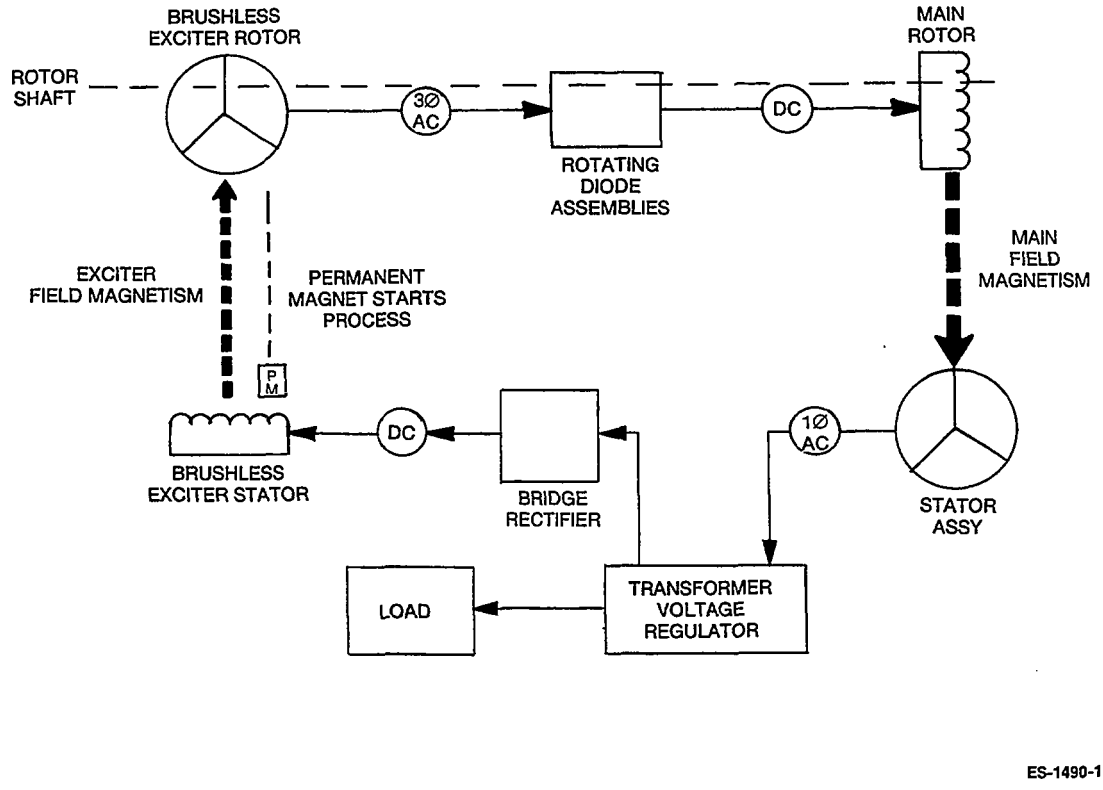


FIGURE 2-3. EXCITATION BLOCK DIAGRAM

VOLTAGE REGULATOR

The voltage regulator controls the output of the generator so that a constant voltage is maintained under varying load conditions. The following is an operational description of the DL3 transformer regulator.

Transformer Voltage Regulator

The transformer voltage regulator is located in the AC control box. The transformer and a schematic showing circuit application is shown in Figure 2-4. The transformer provides a feedback loop from the generator AC output/load to the generator exciter.

The voltage regulator transformer primary is connected in series with the load. The transformer secondary voltage is rectified to DC and connected to the brushless exciter stator. The brushless exciter rotor produces three phase AC voltage that is converted to DC by the rotating diode assemblies. The resultant DC voltage excites the main rotor winding to produce the stator output for the AC load.

The transformer secondary is connected to a diode bridge. The bridge converts AC to DC for the exciter. Thus the exciter DC boost current is dependent upon the primary/load current.

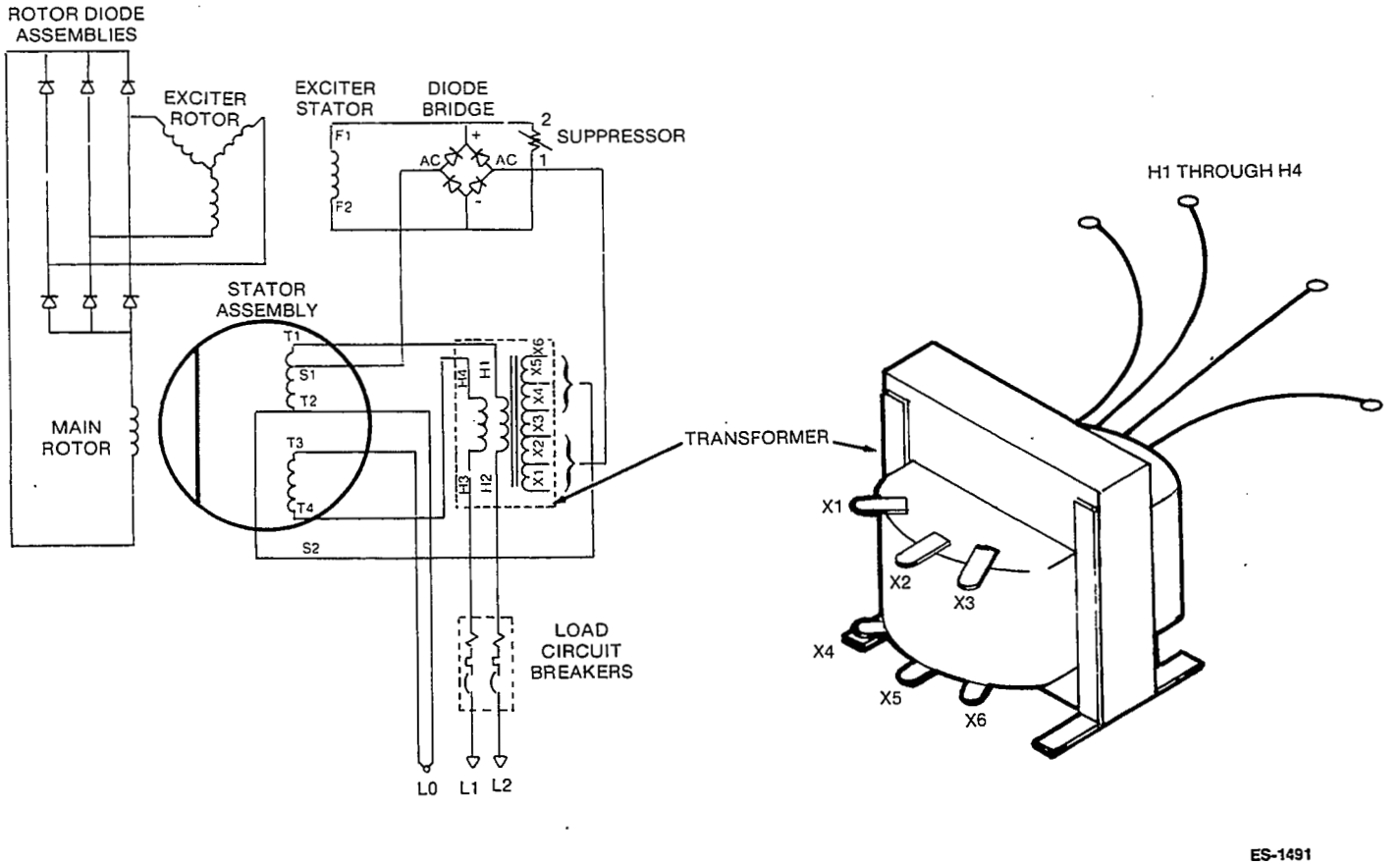


FIGURE 2-4. TRANSFORMER AND CIRCUIT APPLICATION

GENERATOR SERVICE

The following sections describe the disassembly and reassembly procedures for the generator.

Disassembly

1. Disconnect the negative (-) battery cable to prevent accidental starting of the generator set.

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

2. Remove cover from the AC control box. Disconnect main stator leads (T1-T4) and voltage leads (1 and 2).
3. Remove the end bell cover. Disconnect the field leads F1 and F2 from the terminal board; and three leads from the battery charge regulator (mark leads if necessary for reassembly). Some early generator sets have a fixed charge rate and the generator leads are disconnected at a diode and resistor (see Figure 2-8). Remove the regulator (or components) from the end bell.
4. Remove load wires and flexible conduit from the AC control box. Unplug connectors (J1-J3) on rear of the DC control box.
5. Remove capscrews securing the mounting saddle to the stator. The control boxes and saddle are removed as an assembly.
6. Pull stator leads through opening in bottom of the AC control box as the assembly is lifted free from the stator.
7. Remove the stud nuts and slide the end bell/exciter stator assembly off the main stator. It may be necessary to pry or jar the assembly loose from the main stator.
8. Use a hoist and a safe lifting device (stator handling tongs, nylon lifting strap or chain and lift hooks) to support the stator assembly.
9. Remove the stator assembly being careful not to touch or drag it on the rotor. Place stator on its side and block to prevent rolling.

⚠WARNING ***Dropping the stator assembly can cause severe personal injury or death. Be sure the lifting device is securely attached and strong to support the stator.***

10. Remove the two-section air baffle from the generator adapter.
11. Using a hoist and sling to support the rotor, carefully remove the capscrews that attach the drive disk to the engine flywheel (Figure 2-8).
12. Remove the rotor assembly and place upon wood block in the horizontal position. The drive disk and fan should not be resting on anything or distortion may occur.
13. Remove bolts that hold the drive disk and fan to the rotor shaft.
14. Use a gear puller to remove the end bearing from the rotor shaft (Figure 2-7).

⚠CAUTION ***The end bearing will be damaged if pulled on the outer race. If reused, the bearing must be pulled on the inner race.***

15. Clamp the rotor in a fixed position and remove the exciter rotor lock nut.
16. Remove the generator field leads from the exciter rotor and slide the exciter off the rotor shaft.

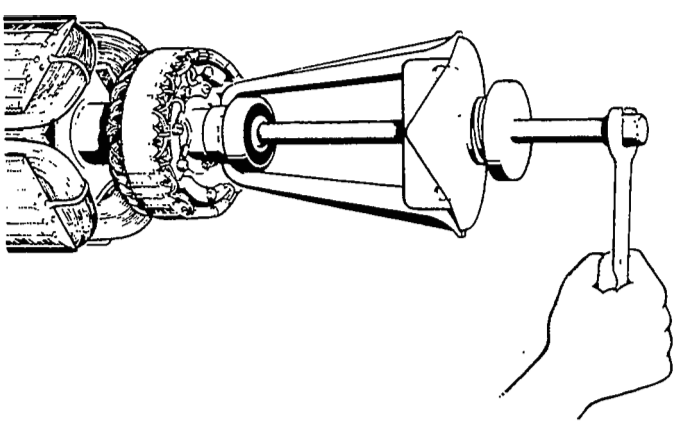


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FIGURE 2-7. END BEARING REMOVAL

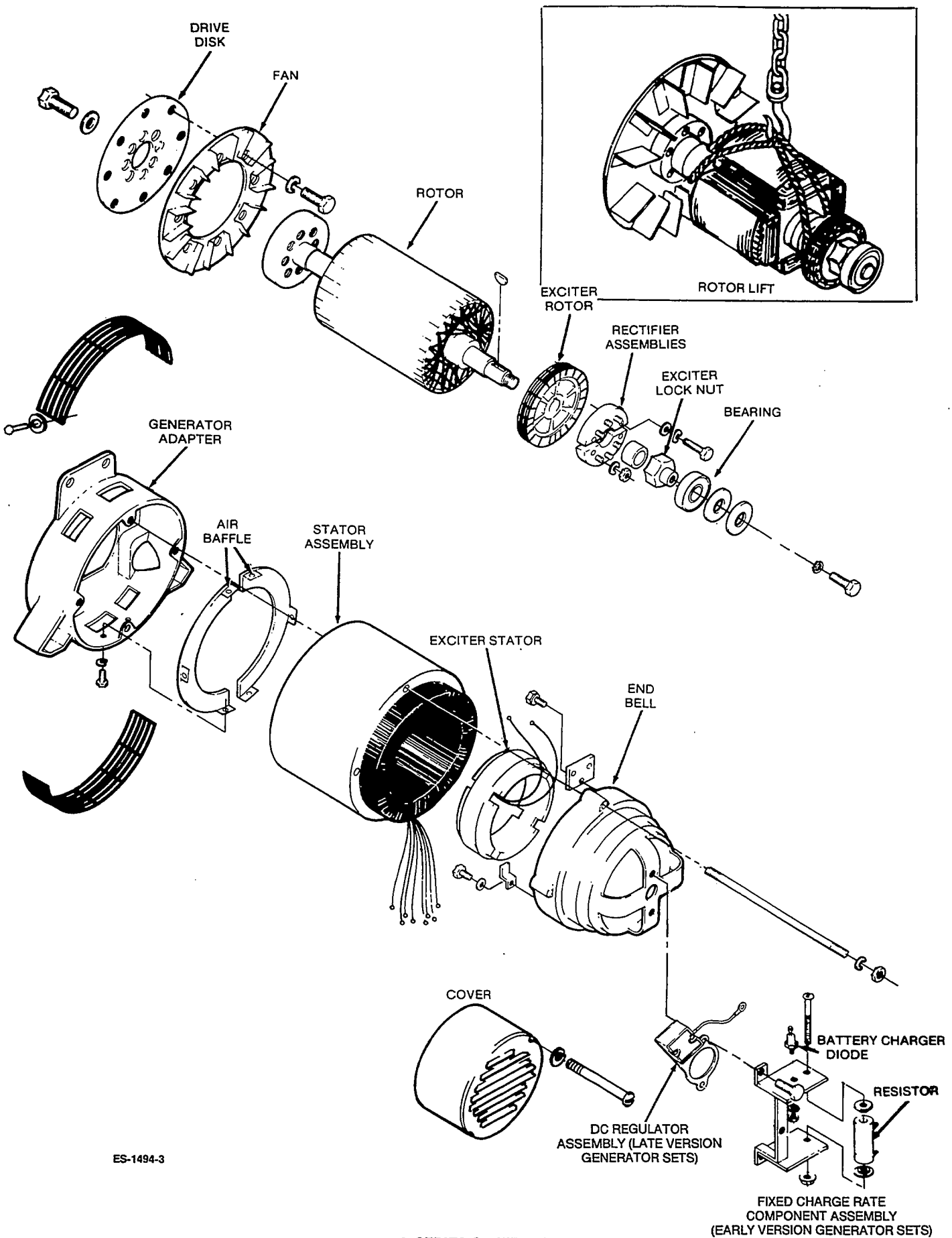


FIGURE 2-8. L-SERIES GENERATOR ASSEMBLY

Reassembly

1. Slide the exciter rotor over the generator shaft and woodruff key. Install the exciter nut and apply torque values shown in Figure 2-9.
2. Connect generator field leads to F1+ and F2- terminals on exciter assembly. Torque to values shown.
3. Press the end bearing onto the rotor shaft.
4. Assemble rotor fan and drive disk to the engine flywheel. Use a hoist and sling to support rotor. Be sure the drive disk is assembled with the chamfer on the flywheel side. Apply torque values shown in Figure 2-9.
5. Install air baffle.
6. Using a hoist and safe lifting device, carefully move the stator into position over the rotor. The leads should exit in the top position.
7. Install the end bell stud bolts through the stator and into the generator adapter.
8. Apply a thin film of Molykote grease to mating surfaces of the end bearing and the end bearing hole. Install end bell assembly on the stator with the generator lead opening at top position.
9. Replace the stud nuts and torque to 20 ft lbs (27 N•m). Install the battery charge regulator bracket (or component assembly) in the upright position. The ground lead terminal is secured under the mounting screw.
10. Using a lead hammer, tap the end bell at the horizontal and vertical plane to relieve stress. Retorque end bell stud nuts.
11. Route generator leads through opening in the AC control box and secure saddle to the generator.
12. Connect control leads and verify that all connections are correct and secure.
13. Connect the field leads F1 and F2 to the terminal board; and the leads to the battery charge regulator (the diode and resistor on some early generator sets). Install the end bell cover.
14. Connect the load wires to their correct terminals.
15. Connect the negative (-) battery cable and test generator operation.

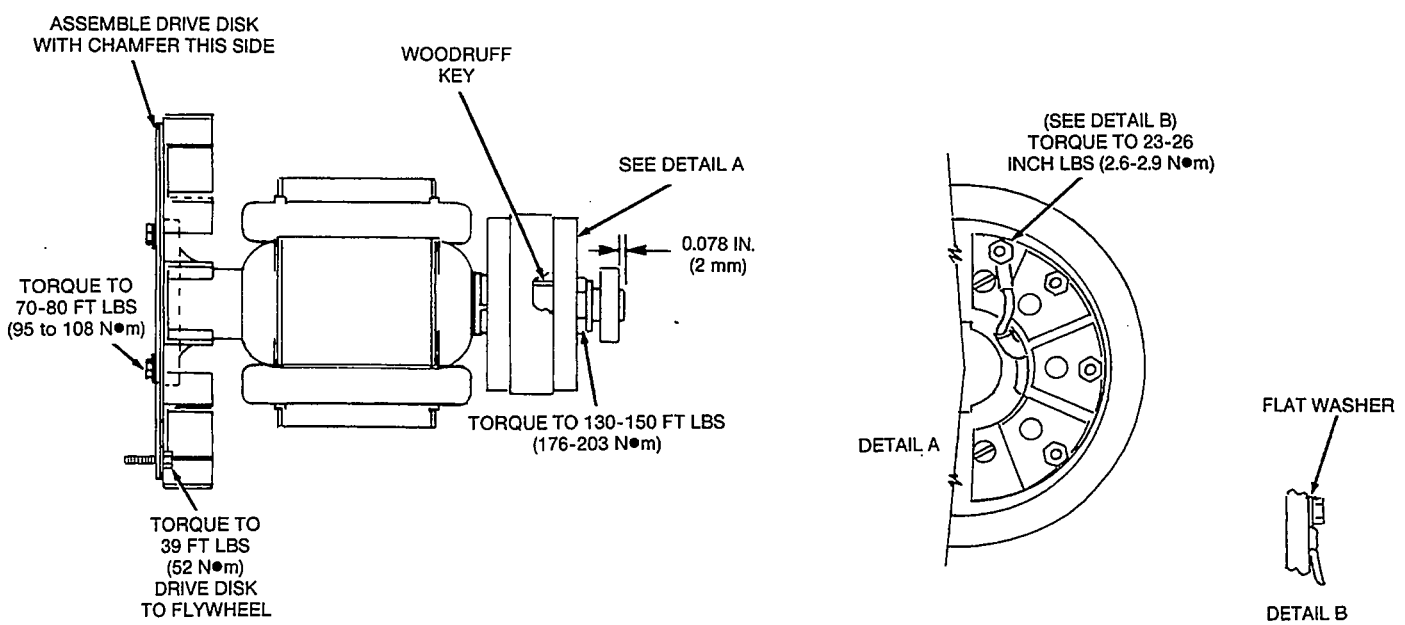


FIGURE 2-9. ROTOR ASSEMBLY AND TORQUE VALUES

Section 3.
Generator/Regulator Troubleshooting

PREPARATION

A few simple checks and a proper troubleshooting procedure can locate the probable source of trouble and reduce down time.

- Check all modifications, repairs, and replacements performed since last satisfactory operation of set to ensure that connection of generator leads are correct. A loose wire connection overlooked when installing a replacement part could cause problems. An incorrect connection, an opened circuit breaker, or a loose connection on printed circuit board are all potential malfunction areas to be eliminated by a visual check.

TROUBLESHOOTING PROCEDURES

This section contains service information for the generator and transformer regulator. Determine the problem and then refer to the appropriate flow chart (A, B or C) listed below for troubleshooting procedures.

A. NO AC OUTPUT VOLTAGE AT RATED ENGINE RPM
B. UNSTABLE OUTPUT VOLTAGE, ENGINE SPEED STABLE
C. UNBALANCED GENERATOR OUTPUT VOLTAGE

To troubleshoot a problem, start at upper-left corner of the chart related to problem, and answer all questions either YES or NO. Follow the chart until the problem is found, performing referenced Adjustment and Test procedures following the Flow Charts.

Referenced components in the Flow Charts and Adjustment and Test procedures can be found on the electrical schematic (Figure 3-1) and on assembly drawings and wiring diagrams.

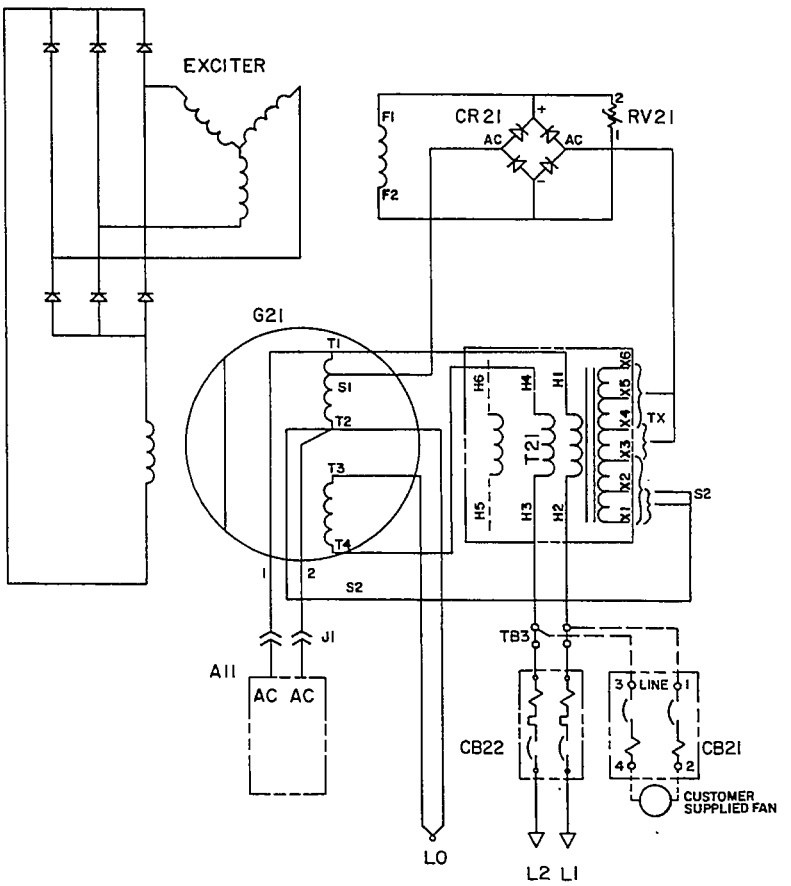
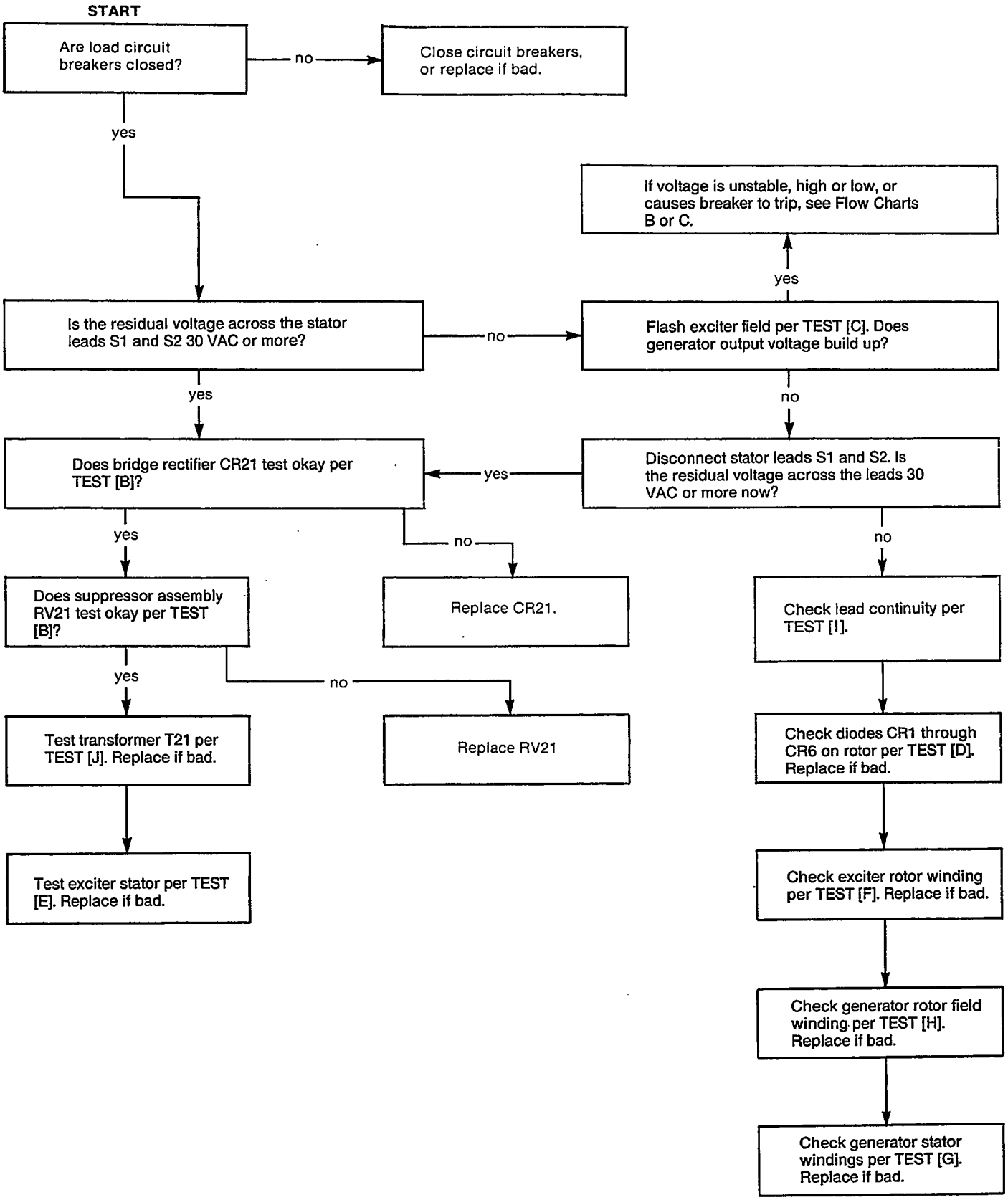


FIGURE 3-1. TRANSFORMER REGULATOR SCHEMATIC

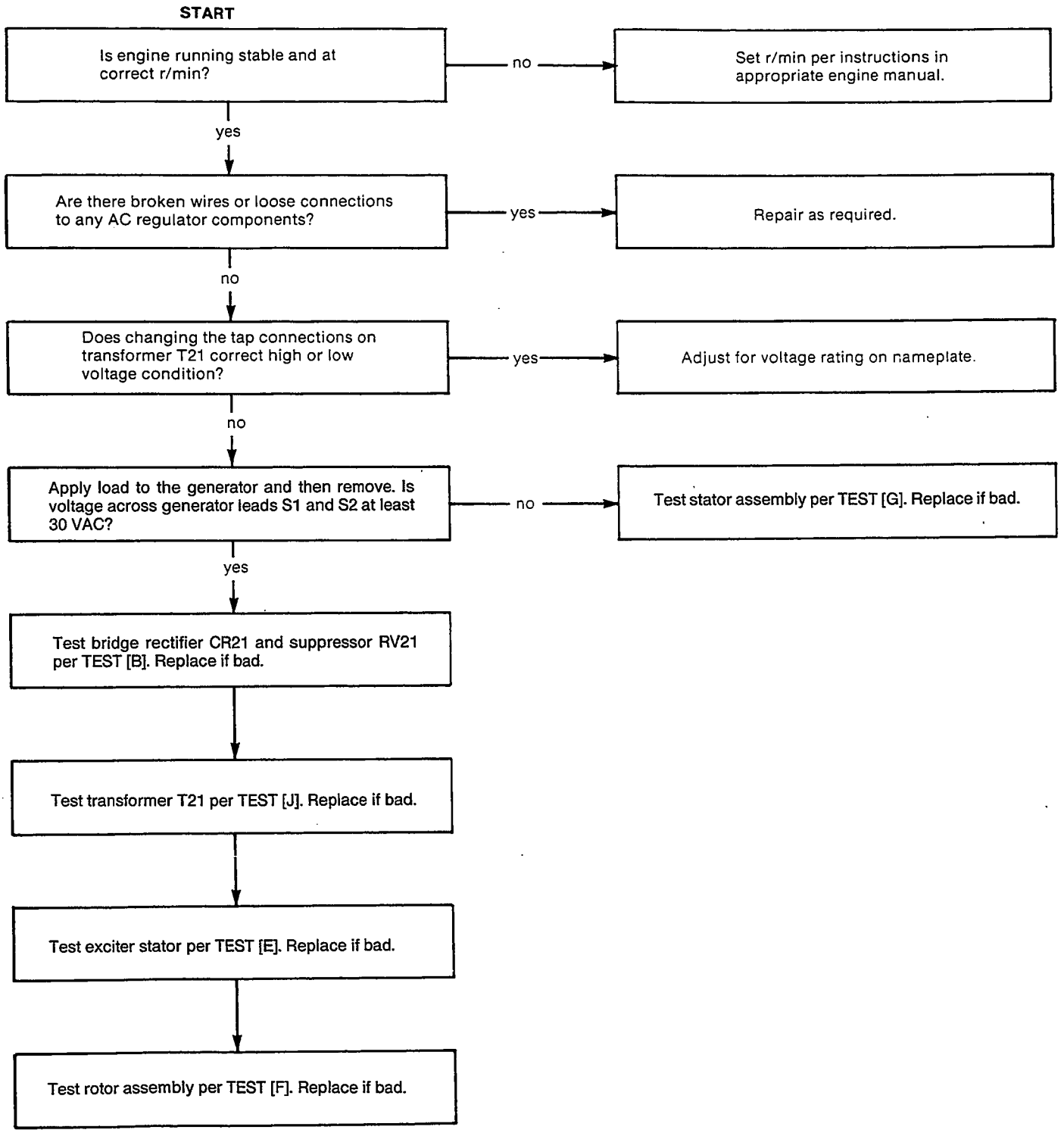
⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

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



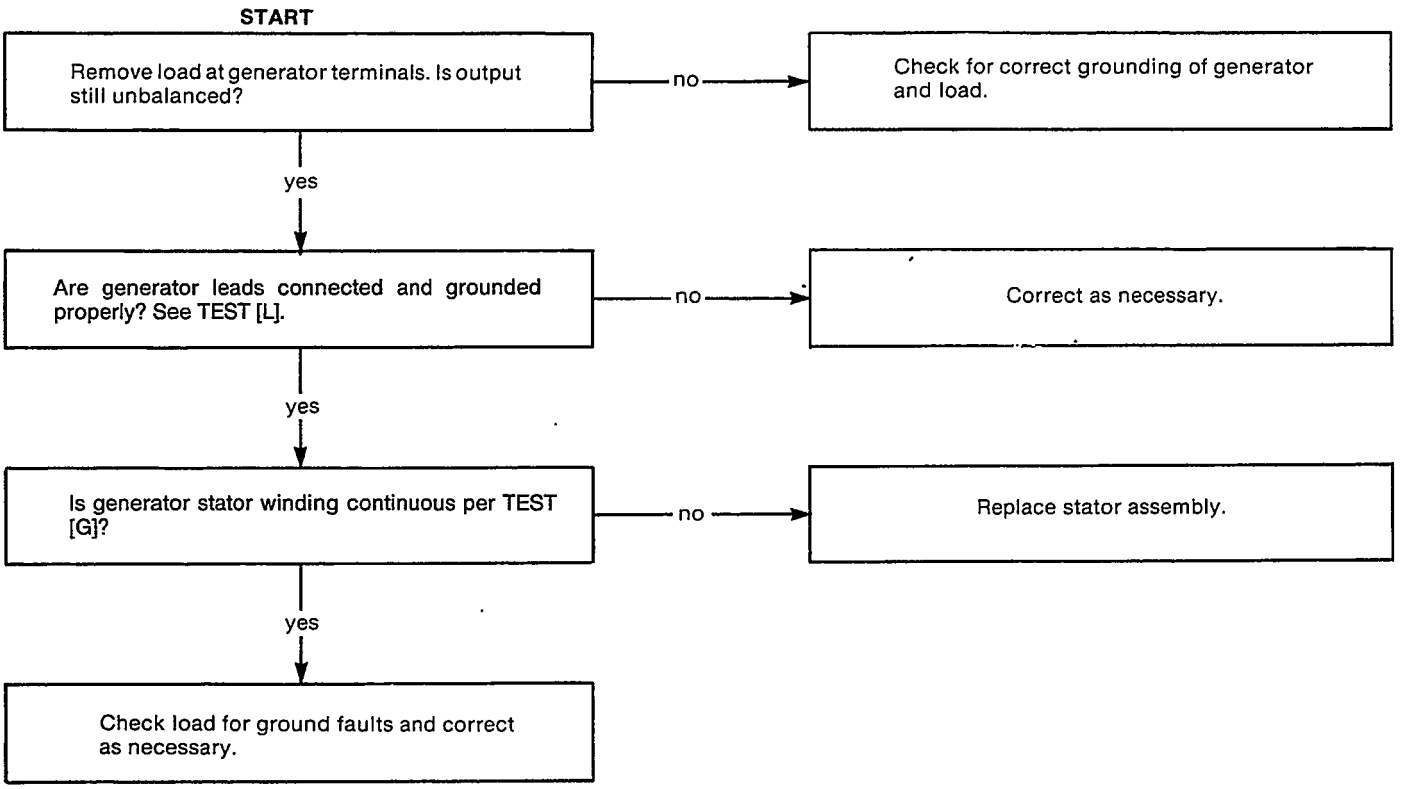
⚠WARNING ***Many troubleshooting procedures present hazards which can result in personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

FLOW CHART B. OUTPUT VOLTAGE TOO HIGH, TOO LOW, OR UNSTABLE



⚠WARNING ***Many troubleshooting procedures present hazards which can result in 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. UNBALANCED GENERATOR OUTPUT VOLTAGE



Section 4. Generator/Regulator Tests

GENERAL

All of the following Adjustments and Tests can be performed without disassembly of the generator. They should be used for testing generator regulator components in conjunction with the troubleshooting flow charts in Section 3.

[A]

TESTING AC RESIDUAL VOLTAGE

Test for residual AC voltage if there is no AC output power from the generator. Check between generator leads S1 and S2 with the generator set running. See Figure 3-1. Residual voltage should be at least 30 VAC or more. The actual voltage varies and is dependent upon when load was last applied to the generator.

[B]

TESTING RECTIFIER BRIDGE CR21 AND SUPPRESSOR RV21

The rectifier bridge and suppressor are located within the control box of transformer regulated sets. The bridge contains four diodes as shown in Figure 4-1. They are encapsulated within a hermetically sealed block, and failure of any diode means replacement of the entire bridge.

Disconnect wires from the bridge prior to testing. Check forward resistance with an ohmmeter on the R x 1 scale; reverse resistance on the R x 10K scale. Forward resistance should be 6 to 50 ohms, and reverse resistance infinity.

If CR21 is defective, the suppressor RV21 should also be replaced. RV21 should have infinite ohmmeter readings in both directions (R x 10K scale).

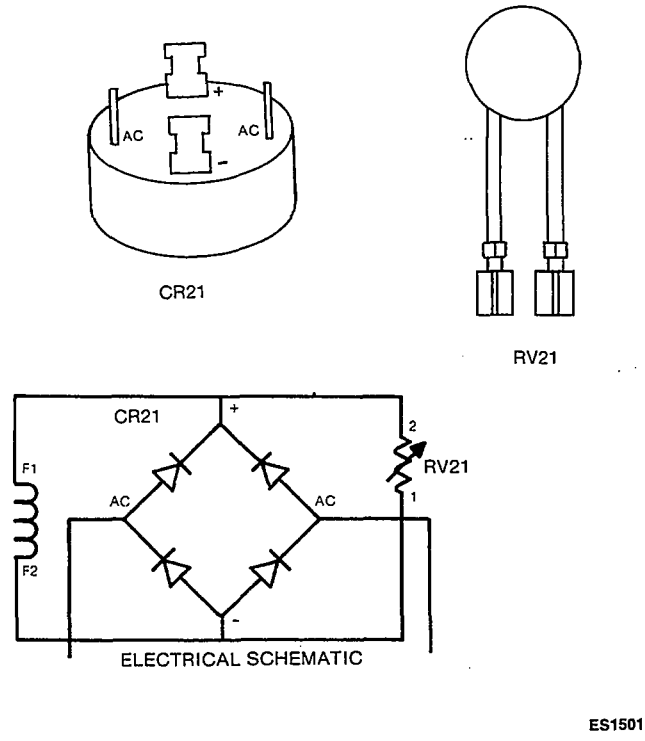


FIGURE 4-1. RECTIFIER BRIDGE AND SUPPRESSOR

[C]

FLASHING THE FIELD

If output voltage does not build up it may be necessary to restore residual magnetism by flashing the field. Assemble a 12-volt storage battery, 10-amp fuse, momentary-on switch, and diode as shown in Figure 4-2.

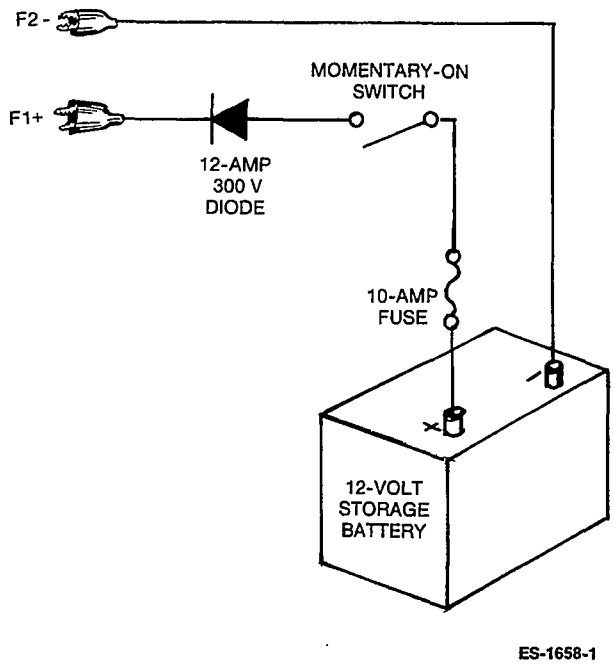


FIGURE 4-2. FIELD FLASHING CIRCUIT

Remove the generator end bell cover. Connect the positive (+) battery lead to the F1+ terminal, and the negative (-) battery lead to the F1- terminal. Terminals F1+ and F1- are located on a terminal board attached to the end bell.

Start the generator set and operate at normal speed. Close the momentary switch just long enough for the generator output voltage to build up, but no longer than 5 seconds.

⚠CAUTION ***Incorrect flashing procedure can damage the generator or regulator components. Do not keep excitation circuit connected longer than 5 seconds.***

⚠WARNING ***Contact with rotating parts can cause severe personal injury or death. Be sure to keep hands and clothing away from the generator.***

⚠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.***

[D]

TESTING ROTATING RECTIFIERS

Two different rectifier assemblies make up the rotating rectifier bridge assembly, Figure 4-3. Test each CR rectifier by applying negative and positive polarities with an ohmmeter as follows:

1. Disconnect all leads from assembly to be tested.
2. Connect one test lead to F1+ stud and connect other lead to CR1, CR2, and CR3 in turn; record resistance value of each rectifier.
3. Connect one lead to F2- stud and connect other lead to CR4, CR5, and CR6 in turn; record resistance valve of each rectifier.
4. Reverse ohmmeter leads from steps 2 and 3 and record resistance value of each rectifier F1+ to CR1, CR2, and CR3 and F2- to CR4, CR5, and CR6.
5. All the resistance readings should be high in one test and low in the other test. If any reading is high or low in both tests, rectifier assembly is defective.
6. Replace defective rectifier assembly with new identical part.

Use 23 to 26 inch lbs (2.6 to 2.9 N•m) torque when replacing nuts of F1+ and F2-, CR1, CR2, CR3, CR4, CR5, and CR6.

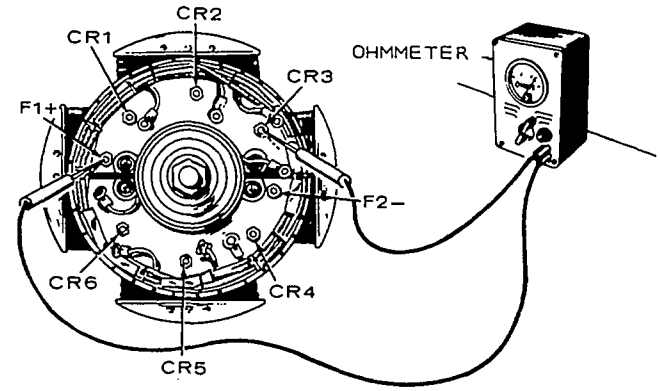


FIGURE 4-3. TESTING ROTATING RECTIFIERS

[E]

TESTING EXCITER STATOR

Test the exciter stator (Figure 4-4) for open or shorted windings and grounds as follows:

Testing for Open or Shorted Windings

Disconnect F1+ and F2- exciter field leads from terminal block in the generator end bell. The resistance between field leads should be 11 to 14 ohms at 77°F (25°C).

Testing for Grounds

Connect a megger or insulation resistance meter that applies 500 VDC or more between the exciter stator leads and ground. Readings should be 100,000 ohms or greater.

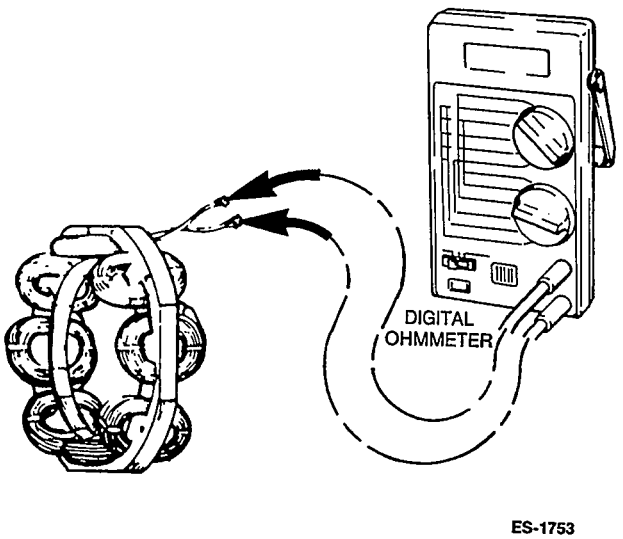


FIGURE 4-4. MEASURING EXCITER STATOR RESISTANCE

[F]

TESTING EXCITER ROTOR

Test the exciter rotor (Figure 4-5) for open or shorted windings or grounds as follows:

Testing for Open or Shorted Windings

Use a Wheatstone Bridge or digital ohmmeter for this test. Disconnect the main rotor field leads which connect to the rotating rectifier assemblies at F1+ and F2-. Disconnect lead wires from diodes CR1, CR2, CR3, CR4, CR5 and CR6. Test between exciter lead pairs T1-T2, T2-T3, and T1-T3. Resistance should be 0.486 to 0.594 ohms at 77°F (25°C).

Testing for Grounds

Connect a megger or insulation resistance meter that applies 500 VDC or more between any CR- lead and the exicter rotor lamination. Be sure all exciter leads are disconnected from the diodes. Readings should be 100,000 ohms or greater.

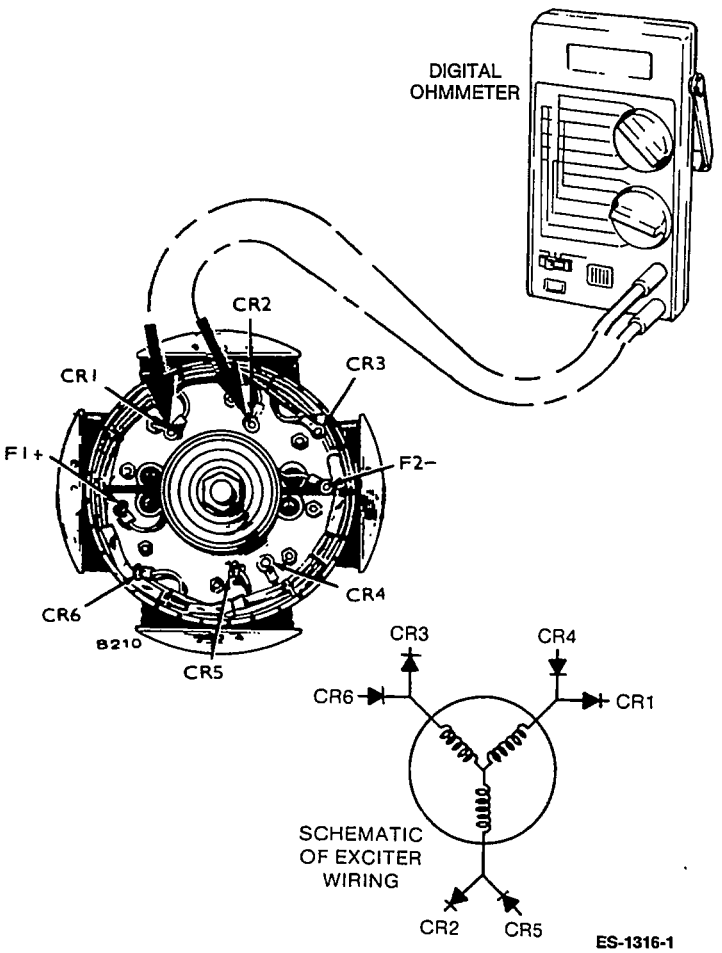


FIGURE 4-5. TESTING EXCITER ROTOR

[G]

TESTING GENERATOR STATOR

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 500 VDC or more to the test leads. Test each stator winding for short to laminations. A reading less than 100,000 ohms indicates a questionable stator. Oven dry the stator and retest.

Testing for Open or Shorted Windings

Test for continuity between coil leads shown in Figure 4-6. The wire pairs should have equal resistance. Use an accurate instrument for this test such as a Kelvin Bridge or digital ohmmeter. Resistance values at 77°F (25°C) should be 0.08 ohms ± 10%. Resistance of the battery charge winding B1-B2 should be 0.1 ohms ±20%.

If any windings are shorted, open or grounded, replace the stator assembly. Before replacing the assembly, check the leads for broken wires or insulation.

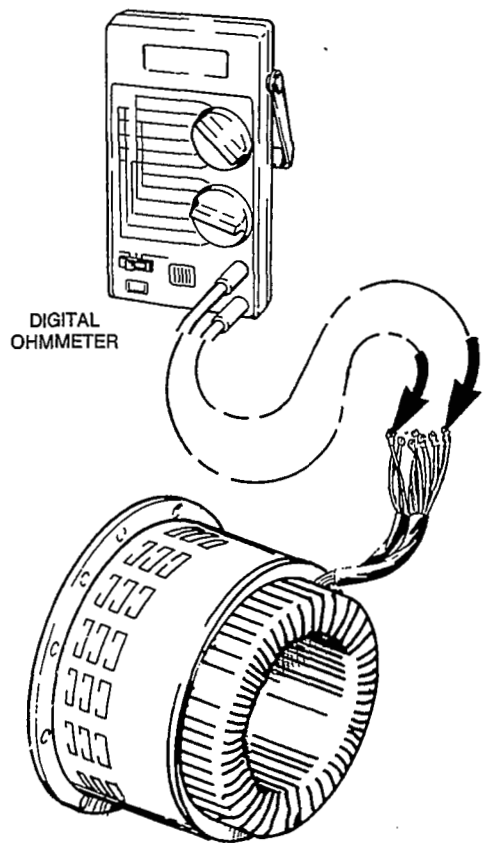


FIGURE 4-6. TESTING STATOR WINDINGS

[H]

TESTING GENERATOR ROTOR

For these tests, use a Megger or insulation resistance meter which applies 500 VDC or more to the test leads.

Testing for Grounds

Check for grounds between each rotor lead and the rotor shaft, Figure 4-7. Perform tests as follows:

1. Remove rotor leads F1+ and F2- from the rotating rectifier assemblies.
2. Connect test leads between F1+ and rotor shaft. Meter should register 100,000 ohms or greater.
3. If less than 100,000 ohms, rotor is questionable. Oven dry the rotor and retest.
4. Replace a grounded rotor with a new identical part.

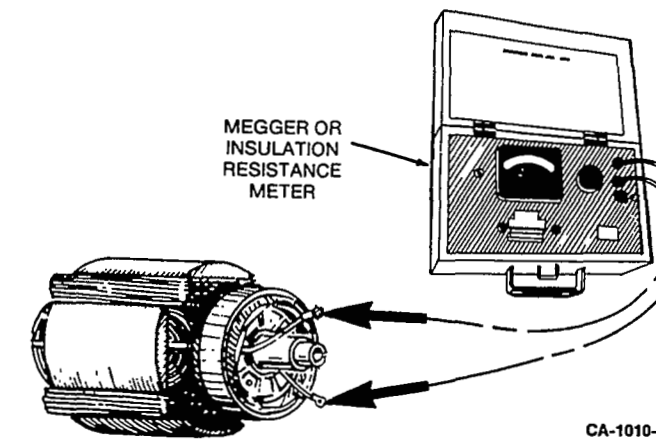


FIGURE 4-7. TESTING ROTOR FOR GROUNDS

Testing for Open or Shorted Windings

Perform tests as follows:

1. Remove rotor leads F1+ and F2- from rotating rectifier assemblies.
2. Using a digital ohmmeter, check resistance between F1 and F2 leads, Figure 4-8. Resistance at 77°F (25°C) should be 2.4 ohms ±10%. If not, replace defective rotor with a new, identical part.

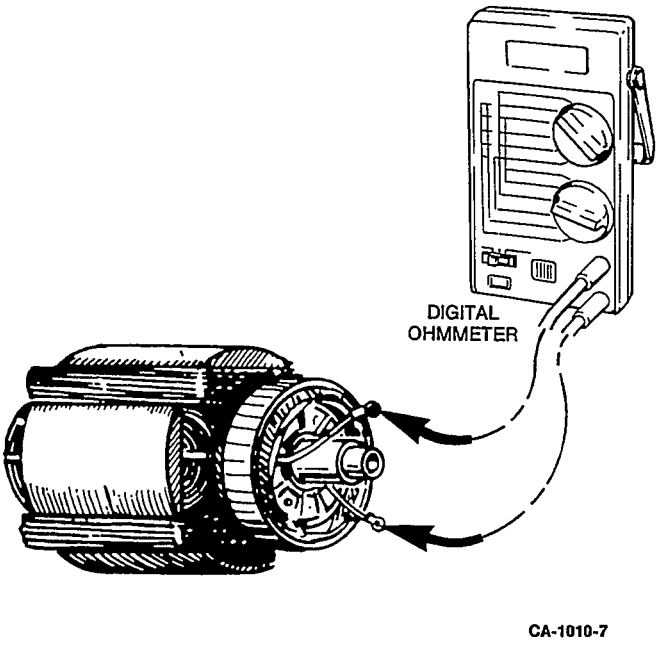


FIGURE 4-8. TESTING ROTOR FOR AN OPEN CIRCUIT

[I]

WIRING HARNESS CHECK

Carefully check wiring harnesses 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 using an ohmmeter, check each wire end to end for continuity or opens.
3. Using an ohmmeter, check each wire against each of the other wires and to ground for possible shorts or insulation breaks under areas covered by wrapping material.
4. Reconnect or replace wires following the applicable wiring diagram.

[J]

TESTING REGULATING TRANSFORMER T21

Regulating transformer T21 consists of a multi-coil primary and multi-tapped secondary (Figure 4-9). DC resistance of windings at 77°F (25°) are shown in Table 4-1. Resistance between primary and secondary and the transformer frame should be over 100,000 ohms when measured with a Megger or insulation resistance meter.

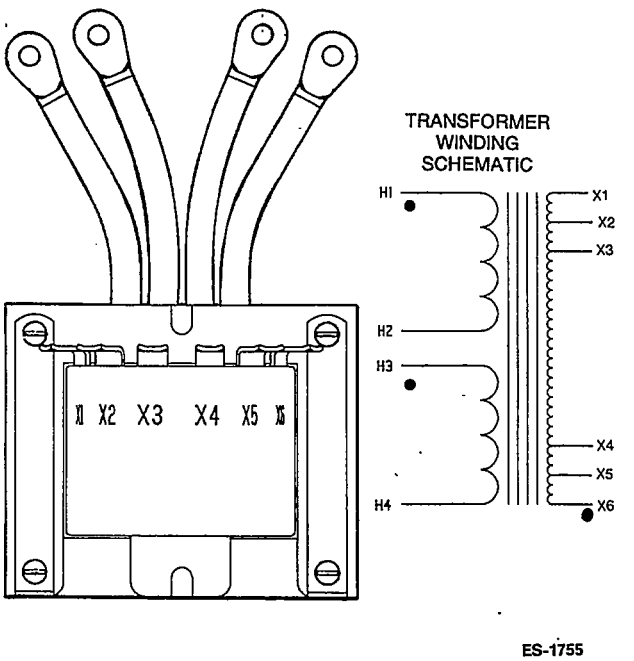


FIGURE 4-9. REGULATING TRANSFORMER

TABLE 4-1. TRANSFORMER RESISTANCE

WINDING	OHMS RESISTANCE
Primary H1-H2	.0015 ± .0002
H3-H4	.0015 ± .0002
Secondary X1-X6	1.45 ± .01
X1-X5	1.34 ± .01
X1-X4	1.22 ± .01
X1-X3	.102 ± .01
X1-X2	.052 ± .01

N.A. (Not Applicable)

[K]

VOLTAGE REGULATOR ADJUSTMENT

Before checking the output voltage, be sure the generator set has stabilized and is running at the correct speed (frequency). The transformer regulator circuit supplies a feedback voltage (dependent on load) to the exciter stator.

Voltage adjustment is made by changing tap connections on the transformer. To change voltage, refer to the generator reconnection diagram under TEST [L].

Adjustment to the transformer regulator must be done with the generator set stopped and disabled.

⚠WARNING ***Accidental starting of the generator set can create a shock hazard resulting in severe personal injury or death. Disconnect the negative (-) starting battery cable before adjusting the regulator.***

[L]

RECONNECTION

Figure 4-10 shows reconnection possibilities. Data is also found on the AC wiring diagram in Section 7 of this manual.

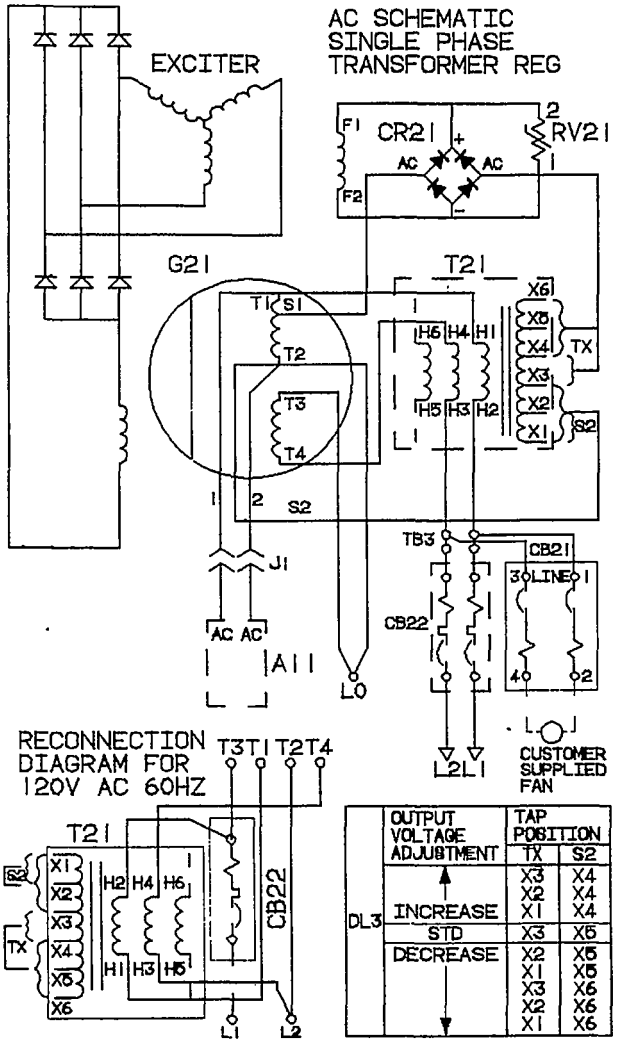


FIGURE 4-10. GENERATOR RECONNECTION DIAGRAM

Section 5. Engine Control

GENERAL

The engine control system covers the functions that relate to engine operation. This includes starting and stopping, instrumentation, monitoring for fault conditions, and battery charging.

DL3 CONTROL

The following is a description of the DC control box as found on the DL3 RV generator set. See Figure 5-1. The DC control box does not contain meters and is designed for remote mounting within limits of the wire harness [approximately 32 inches (813 mm)]. An optional remote control panel with meters is available in a kit from Onan.

Switches

Start-Stop/Preheat Switch S11: Starts and stops the unit locally. Preheat function occurs when the switch is held in the Stop position. The unit may also be operated from a remote switch wired to receptacle J3 on the rear panel.

Circuit Breakers

DC Control Breaker CB11: A 15 ampere DC breaker providing protection to the control box wiring and remote wiring from short circuits or overload. Also serves as an emergency stop switch.

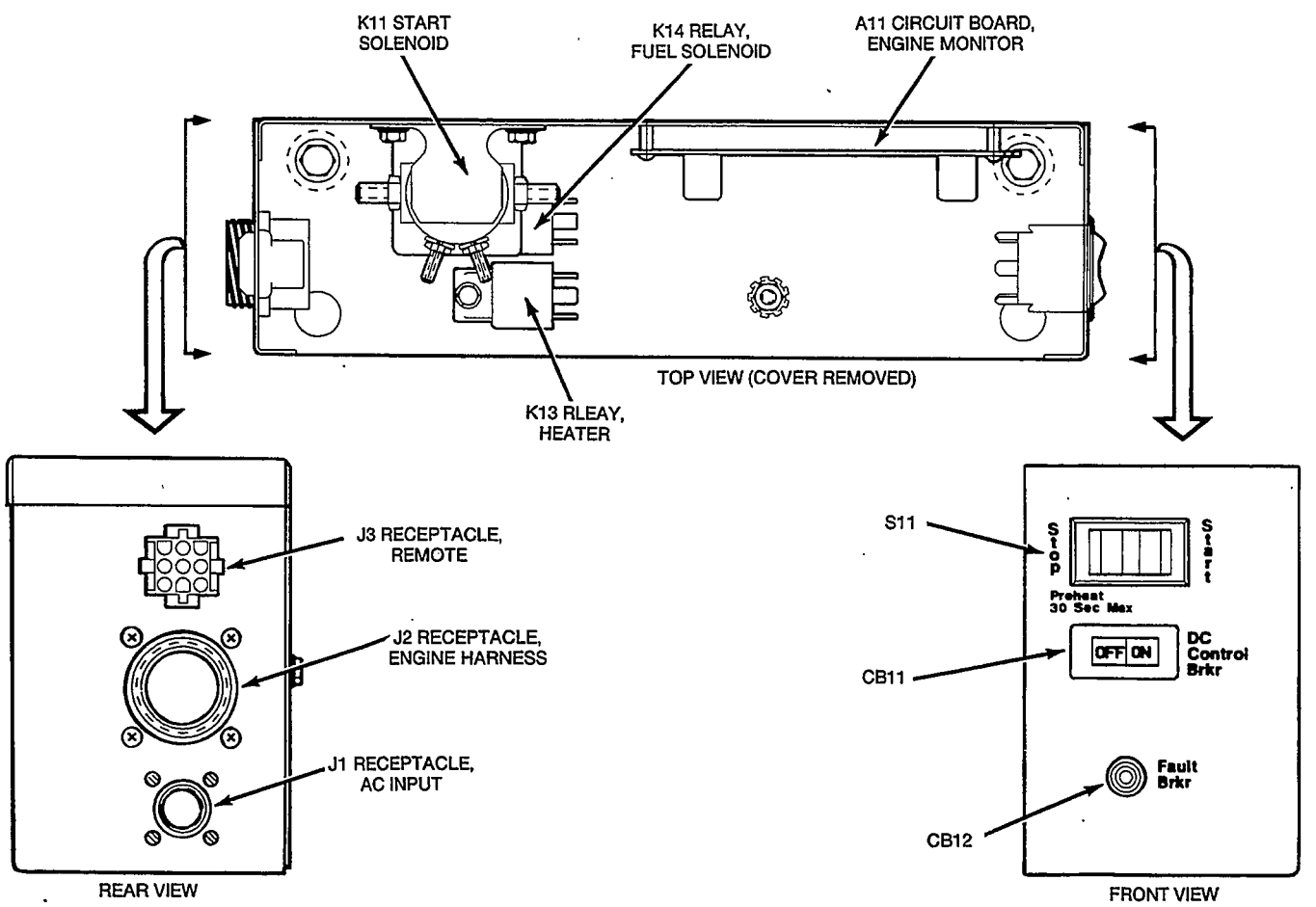


FIGURE 5-1. ENGINE DC CONTROL BOX

Fault Breaker CB12: A manual reset breaker that shuts down the engine for low oil pressure and high coolant temperatures.

Control Components

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

A11 Engine Monitor Circuit Board: A circuit board that monitors the engine control system functions. This includes starting, stopping, and fault system operation. Terminals are included for making remote connections. See Figure 5-1.

Two relays soldered into the engine monitor board are not serviceable. They function as follows:

- Power relay K12 connects and maintains battery B+ to the control meters and fuel solenoid during operation.
- Starter protection relay K15 is AC operated. When the Start switch is pressed, B+ is connected to K11 start solenoid through the K15 NC contacts until the generator output reaches about 90 volts AC. At this voltage K15 activates and disconnects the starter circuit.

K1 Fuel Solenoid: An integral part of the fuel injection pump. It opens the fuel control valve when the start/stop switch is placed in the Start position.

K11 Start Solenoid: Located over the engine monitor circuit board (above K13 glow plug heater solenoid). It connects battery B+ to the start solenoid, K13 heater solenoid, fuel solenoid and meters during cranking.

K13 Glow Plug Heater Solenoid: Located directly above the monitor circuit board. Connects B+ to the engine glow plugs during cranking. It is energized by K11 start solenoid.

Engine Monitors

The following briefly describes the engine sensors (switches) and optional gauge senders. The sensors protect the engine from unfavorable operating conditions; the senders are used with the optional remote panel. 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 safety sensors (switches) close the fault circuit to ground if abnormal operating conditions exist, tripping the fault breaker CB12 to stop the engine. See Figure 5-2 and the schematic drawing Figure 5-3.

Engine Oil Pressure Monitors

Refer to Figure 5-2 for the location of the oil pressure monitors.

Oil Pressure Sender E1: The sender resistance changes with oil pressure and results in a reading on the oil pressure meter. The at-rest resistance reading should be about 240 ohms, tolerance range 227 to 257 ohms.

Low Oil Pressure Switch S1: This switch closes if oil pressure drops to 14 psi (97 kPa), activating the fault breaker and stopping the engine.

Control Power Latch (S6): This oil pressure switch closes at 5 psi (34 kPa) and provides a latch function for the control circuits. When closed, the switch supplies a ground path for relay K12 on the engine monitor board.

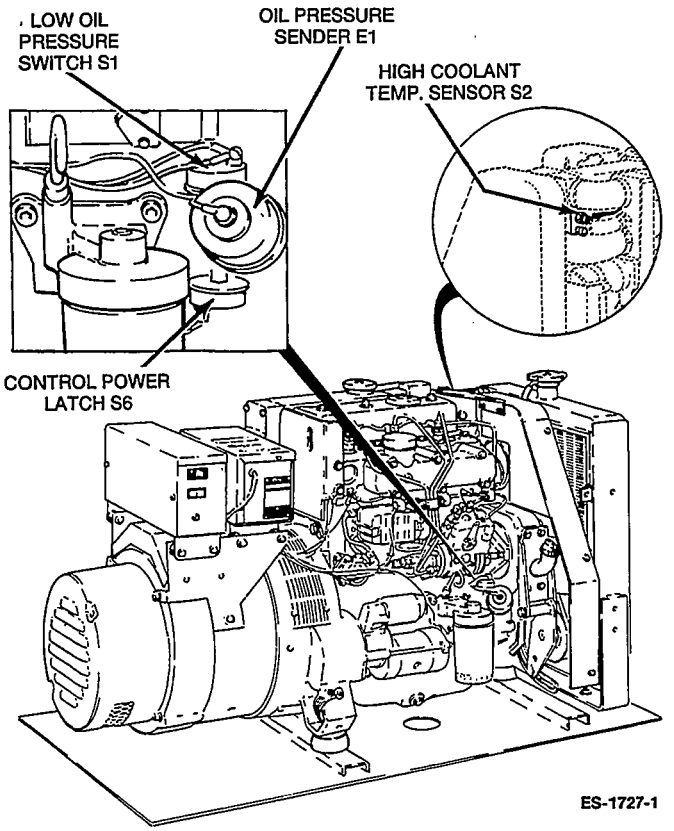


FIGURE 5-2. ENGINE MONITORS

Engine Temperature Monitors

See Figure 5-2 for the location of the engine coolant temperature monitors.

Temperature Sender E2: The resistance of the sender changes with the engine coolant temperature and causes a reading on the coolant temperature meter. The resistance of the sender at 200°F (93°C) should be 64.3 ohms ±10%.

High Coolant Temperature Sensor S2: This sensor grounds the fault circuit if the coolant temperature rises to 222°F (106°C). This activates the Fault Breaker CB12 and stops the engine.

Control Operation

To understand control operation, refer to the following text and the schematic diagram (Figure 5-3).

Starting Sequence: When start/stop switch S11 is held in the *Stop* position, battery B+ is connected to the coil of heater relay K13. The relay contacts close and connect B+ to heaters HR1 - HR3.

Immediately after preheat time interval, S11 is held in the *Start* position. This connects B+ to K14 fuel solenoid relay and K11 start solenoid relay. These relays actuate K1 fuel solenoid, B1 solenoid/starter motor and heaters HR1 - HR3 (via K13 NC contacts).

The running circuit is completed by A11-K12 relay contacts when it is actuated. The ground return for this relay is delayed until the control power latch switch S6 closes. It is closed by rising oil pressure at 5 psi (34 kPa) and assures engine lubrication before operation.

Start-Disconnect Sequence: As the generator gains speed and output voltage, K15 starter protection relay energizes at about 90 VAC. The K15 NC contact opens and de-energizes start solenoid K11. K11 then disconnects B+ from the starter solenoid (to stop the cranking motor) and from the glow plug heaters. If the generator fails to develop voltage, the engine will attempt to start but will stop as soon as the *Start* switch is released.

COMPONENT REFERENCE

A11	Engine Monitor PCB	E1	Sender, Oil Pressure
A11-K12	Relay, Power	E2	Sender, Coolant Temp
A11-K15	Relay, Starter Prot.	HR1-3	Heater, Glow Plug
A11-R1	Resistor (R12)	K1	Fuel Solenoid
A11-R2	Resistor (LOP Timing)	K11	Start Relay
B1	Starter & Solenoid	K13	Heater Relay
BT1	Battery, 12-Volt	K14	Relay, Fuel Solenoid
CB11	Breaker, Control	*R1	Charge Resistor
CB12	Breaker, Fault	S1	Switch, Low Oil Press.
CB13	Breaker, Charging	S2	Switch, High Cool Temp.
*CR1	Rectifier, Batt Charge	S4	Switch, Cont Pwr Latch
CR2	Rectifier, Stop	S11	Switch, Start/Stop
CW1	Charge Winding, Batt	VR1	Battery Charge Regulator

*When Used (Early Version GenSets)

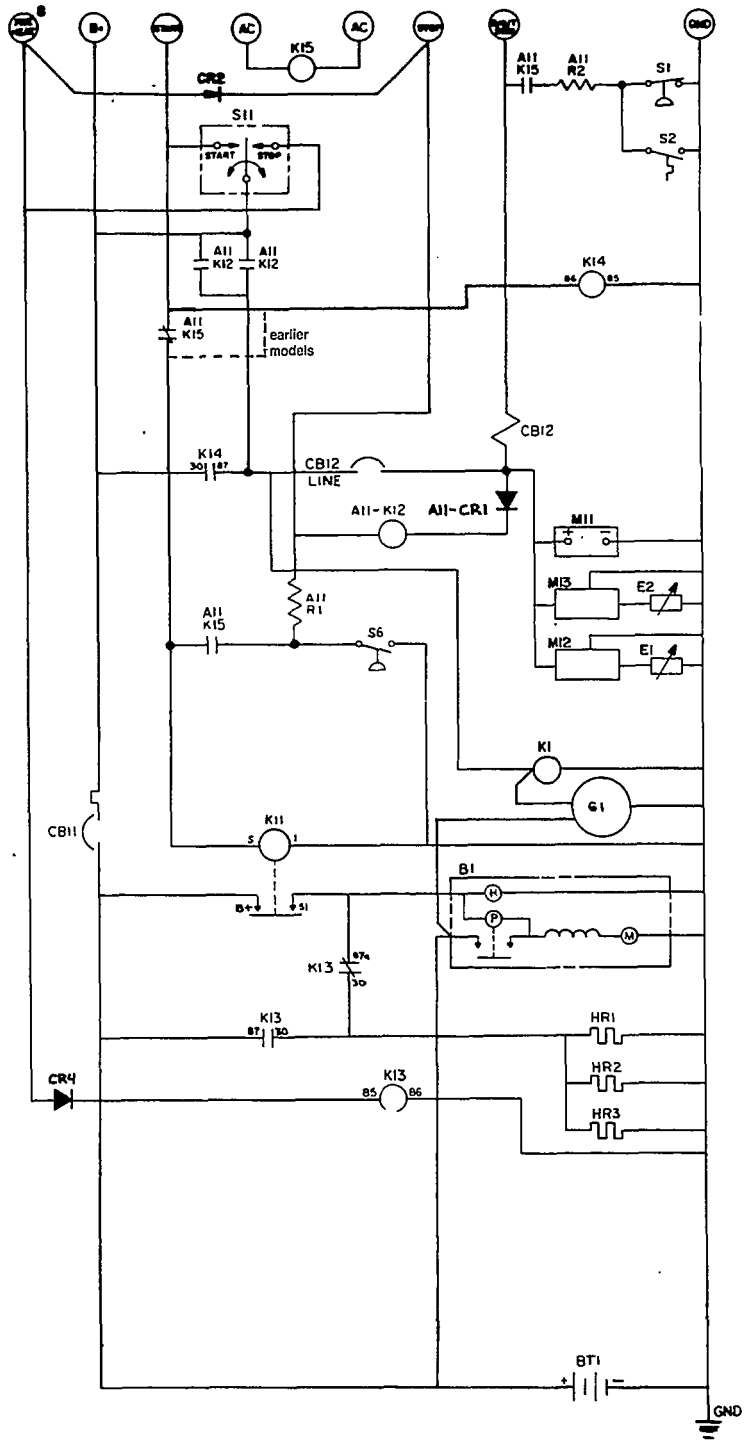


FIGURE 5-3. SCHEMATIC DIAGRAM

The two K15 NO (normally open) contacts close and function as follows:

- Closes circuit for S1 and S2 (low oil pressure and high coolant temperature switches respectively.
- Provides another ground path for K12 coil (through K11 coil) similar to S6.

Battery Charge Circuit: The generator charge winding CW1 (leads B1 and B2) provide AC voltage for this function. Other components include the voltage regulator VR1, and harness circuit breaker CB13. Some early generator sets had a diode CR1, fixed resistor R1, and circuit breaker CB13.

Stopping Sequence: Placing S11 in the *Stop* position puts B+ (through diode CR2) on the ground side of the A11-K12 power relay. This causes K12 to de-energize and disconnect B+ from CB12 and K1 fuel solenoid. De-energizing K1 shuts off the fuel flow to stop the engine.

Fault Shutdown: Fault breaker CB12 opens to stop the engine anytime a fault sensor closes the circuit to ground. The fault sensors as shown in Figure 5-2 are:

- S1 low oil pressure
- S2 high coolant temperature

Remote Control Operation (Optional): The generator set may be operated from a remote switch connected to the control receptacle J3. Installation instructions are furnished with the kit available from Onan. See Figure 5-4.

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.

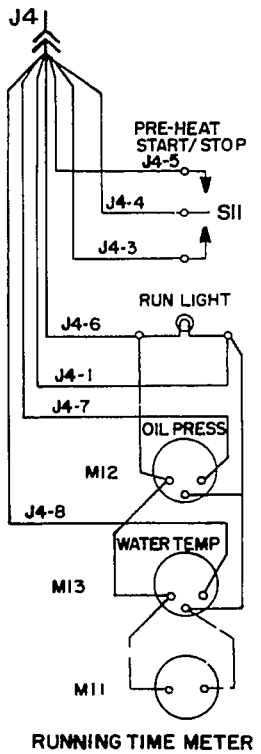


FIGURE 5-4. REMOTE CONTROL WIRING DIAGRAM

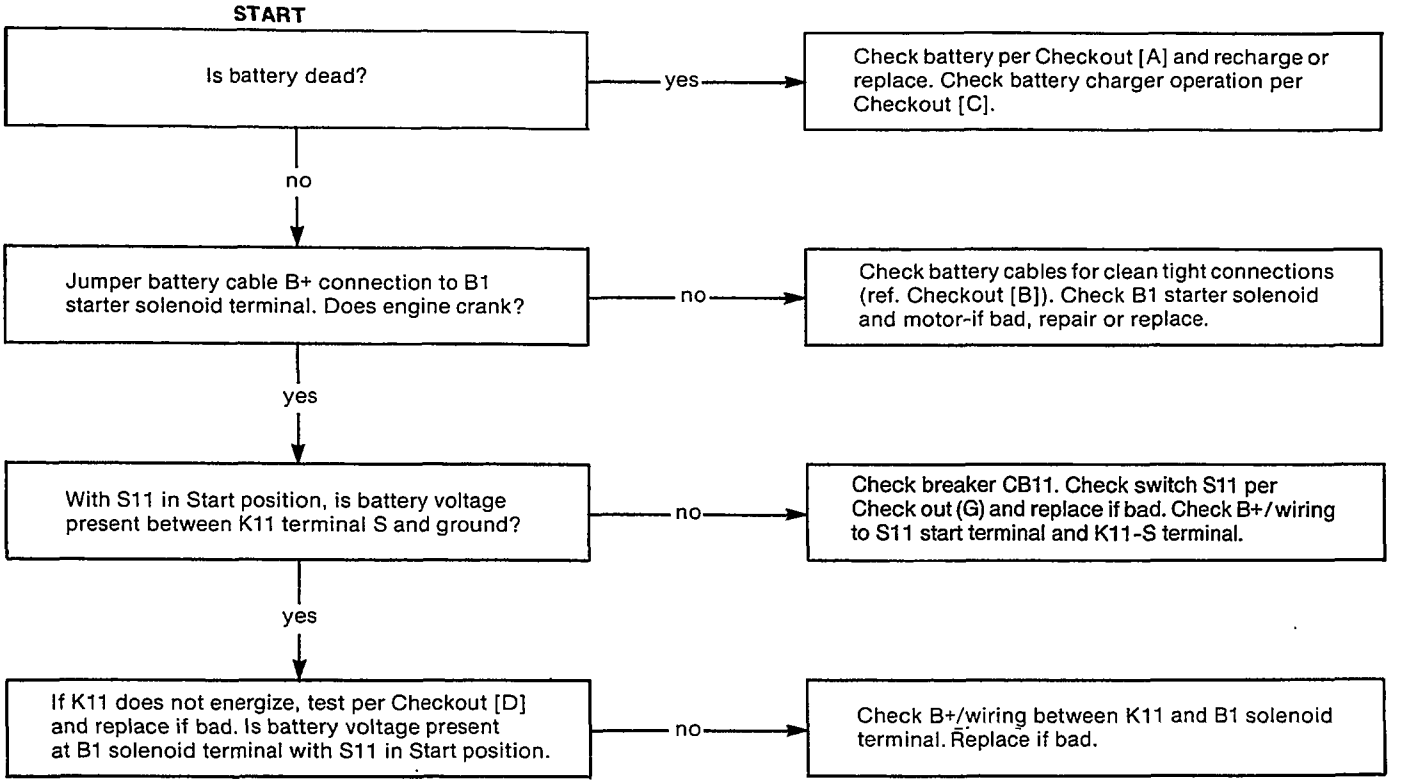
Before starting a troubleshooting procedure, make a few simple checks that may expose the problem and cut down on troubleshooting time.

- 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.
- Unless absolutely sure that panel instruments are accurate, use portable test meters for troubleshooting.

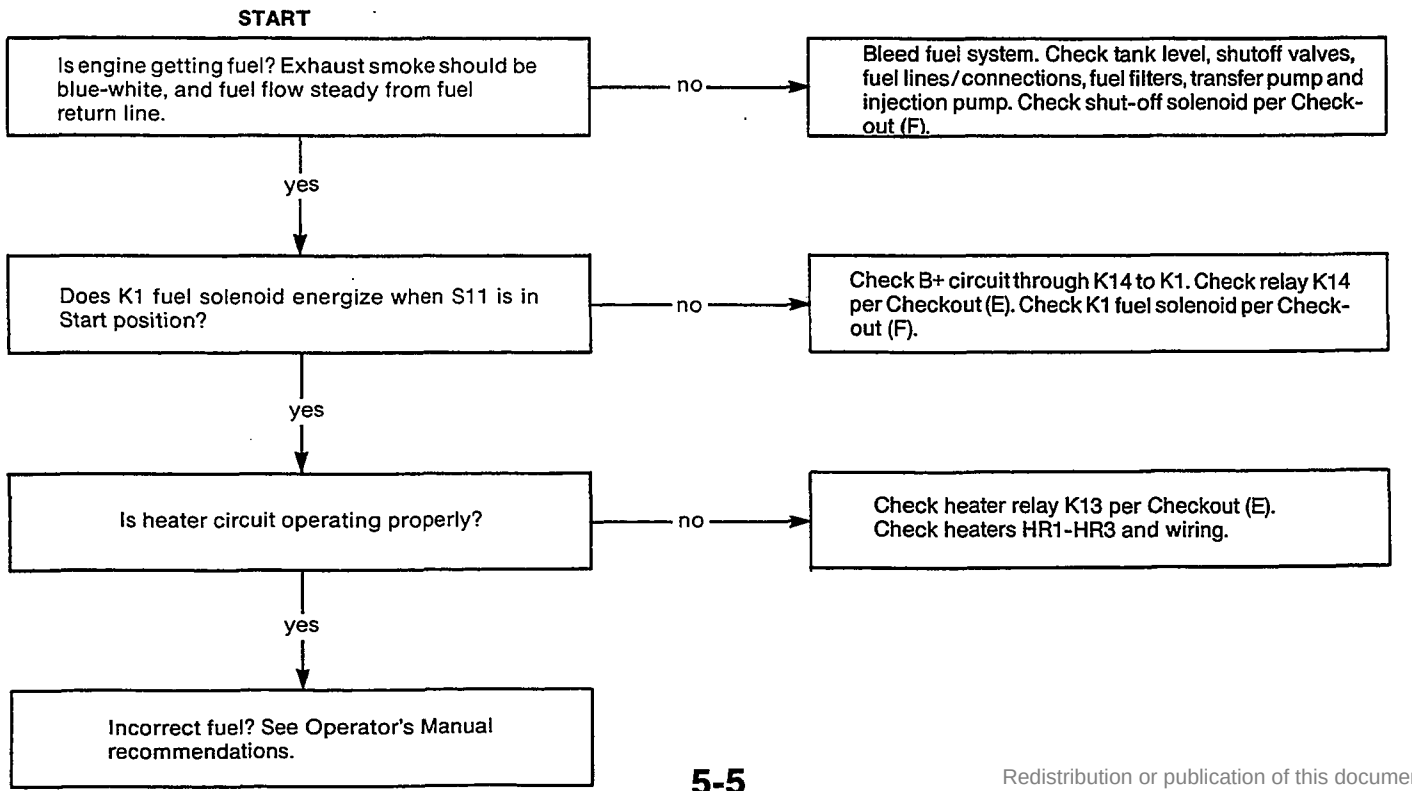
To troubleshoot a problem, start at the upper-left corner of chart and answer all questions either YES or NO. Follow the chart until the problem is found, performing referenced adjustment or test procedures. Refer to Figures 5-1 through 5-4 for locating control components, leads, terminals and other check points.

⚠WARNING ***Many troubleshooting procedures present hazards which 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 A. ENGINE DOES NOT CRANK

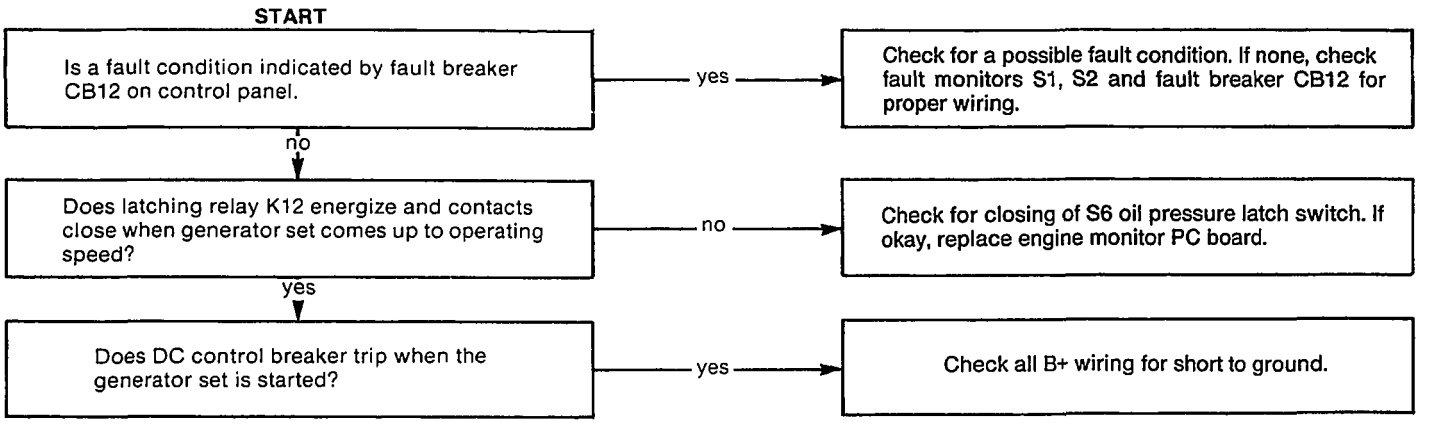


FLOW CHART B. ENGINE CRANKS BUT DOES NOT START



⚠WARNING ***Many troubleshooting procedures present hazards which 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



Section 6
Engine Control Adjustments/Tests

GENERAL

The following component checkouts are referenced in the Control Troubleshooting flow charts. They are an aid to isolating circuit problems caused by faulty engine control components. Disconnect leads before testing components.

[A]

BATTERY CHECKOUT

Check charge condition of the battery with a hydrometer. The 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 and recharge the battery. If battery will not recharge, replace it.

If the battery state-of-charge is not maintained, the charge rate may be too low. See *Checkout [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 CHECKOUT

With the starter motor operating, check the 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, each of these should be less than 0.3 volt. 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 CHECKOUT

With the engine running, connect a voltmeter across the battery terminals. The meter should read 13.5 to 15 volts. The charge rate/voltage is determined by the battery state-of-charge and circuit resistance.

The power source is a winding CW1 on the main stator assembly (Figure 6-1). If the battery charging voltage is incorrect or missing, check the wiring and circuit components as shown in the diagrams. Improper operation may be caused by poor terminal connections, broken wires, or a defective battery. The VR1 voltage regulator is potted and not repairable.

Improper operation may be caused by poor terminal connections, defective battery, or broken wires.

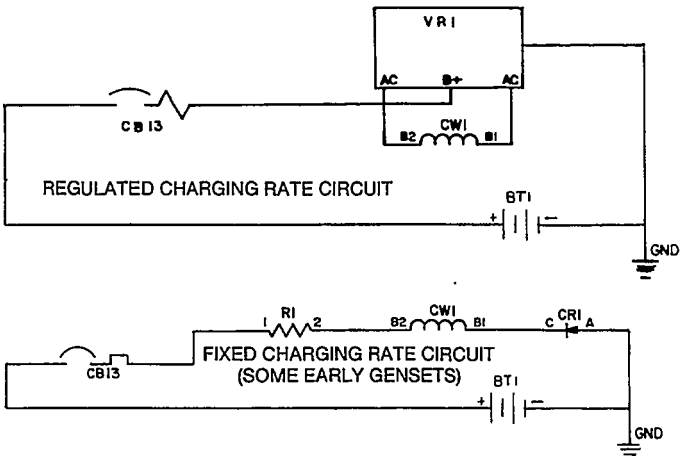
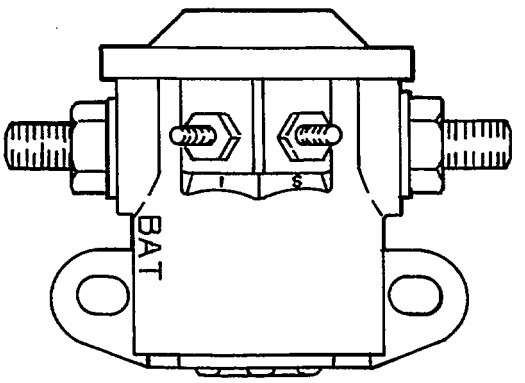


FIGURE 6-1. BATTERY CHARGING CIRCUIT

[D]

START SOLENOID CHECKOUT

1. Apply 12-volt battery positive (+) to the K11 coil terminal S. See Figure 6-2.
2. Connect a wire from the battery negative (-) to the coil terminal I. The solenoid should activate.
3. If the contacts are good, zero resistance should be read across the large terminals when the coil is activated. The voltage drop across the contacts should never exceed one volt when in circuit application.



ES-1754

FIGURE 6-2. SOLENOID TERMINALS

[E]

RELAY CHECKOUT

1. Determine coil and contact terminals from the schematic diagram. Numbers/letters shown on the schematic are stamped on the relay.
2. Apply rated voltage across the relay coil terminals. Relay should activate if coil is okay.
3. Connect voltage source to one side of relay contacts.
4. Connect a voltmeter to other side of relay contact and to the voltage source. If voltage appears when relay energizes, contact is okay. The voltage reading appears in reverse order when checking normally closed (NC) contacts.

[F]

FUEL SOLENOID CHECKOUT

If there is fuel to the injection pump, but no fuel at the injection nozzle, the fuel solenoid may be defective. The solenoid is located in the governor control cover on top of the fuel injection pump.

To check for solenoid operation, listen for solenoid actuation when B+ is applied (start switch in *Start* position). If there is no click sound when B+ is applied and again when removed, the fuel solenoid must be replaced. See the *Fuel System* section of the L Series Diesel Engine Service Manual (934-0750) for the replacement procedure.

⚠WARNING ***Ignition of fuel can cause serious personal injury or death by fire or explosion. Do not permit any flame, cigarette, or other igniter near the fuel system.***

[G]

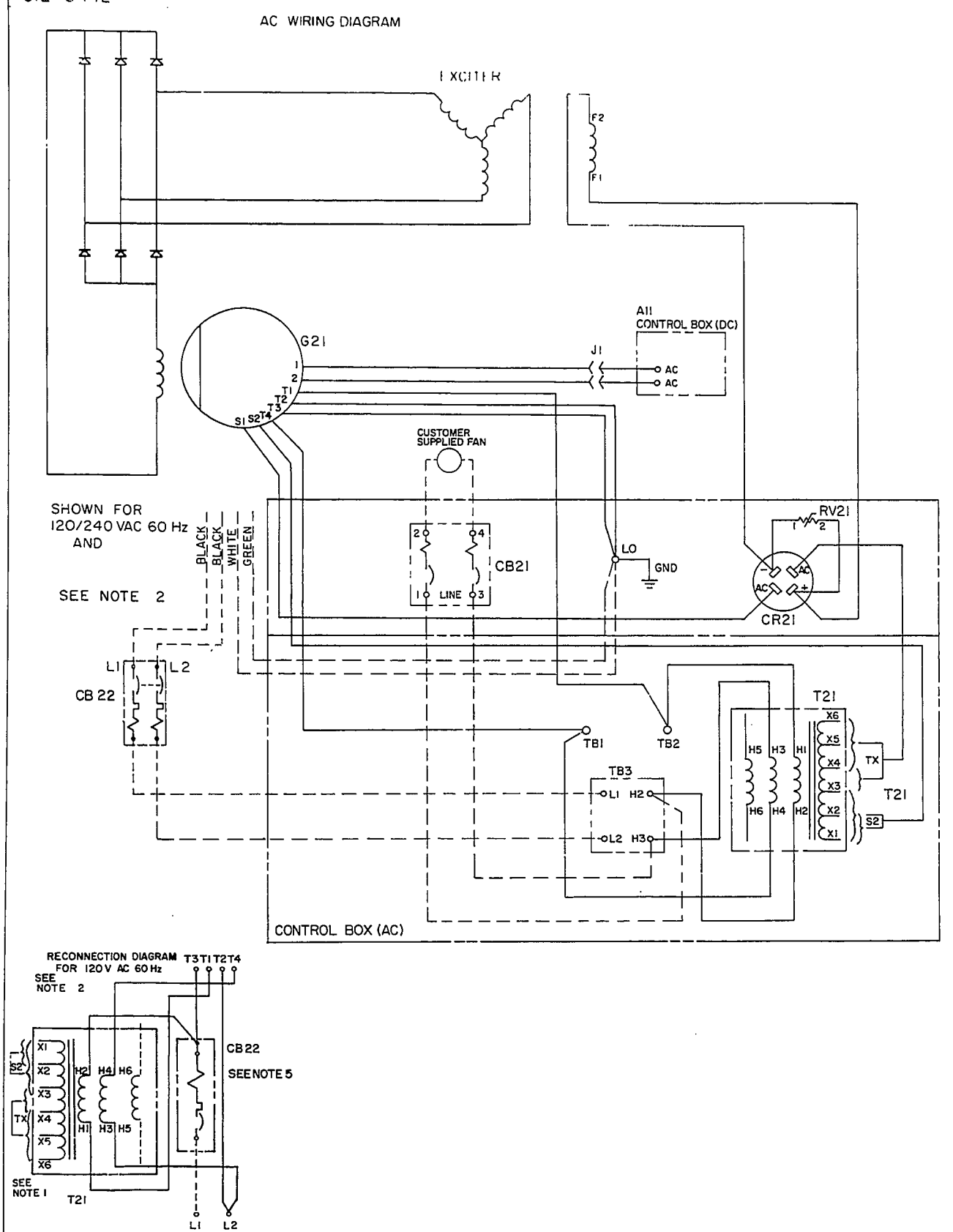
SWITCH CHECKOUT

1. Disconnect the starting battery cables, the negative (-) cable first.
2. Connect an ohmmeter across the switch terminals.
3. Open and close the switch while observing the ohmmeter. Note operation of normally open (NO) and normally closed (NC) contacts.
4. Replace the switch if defective.

Section 7. Wiring Diagrams

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

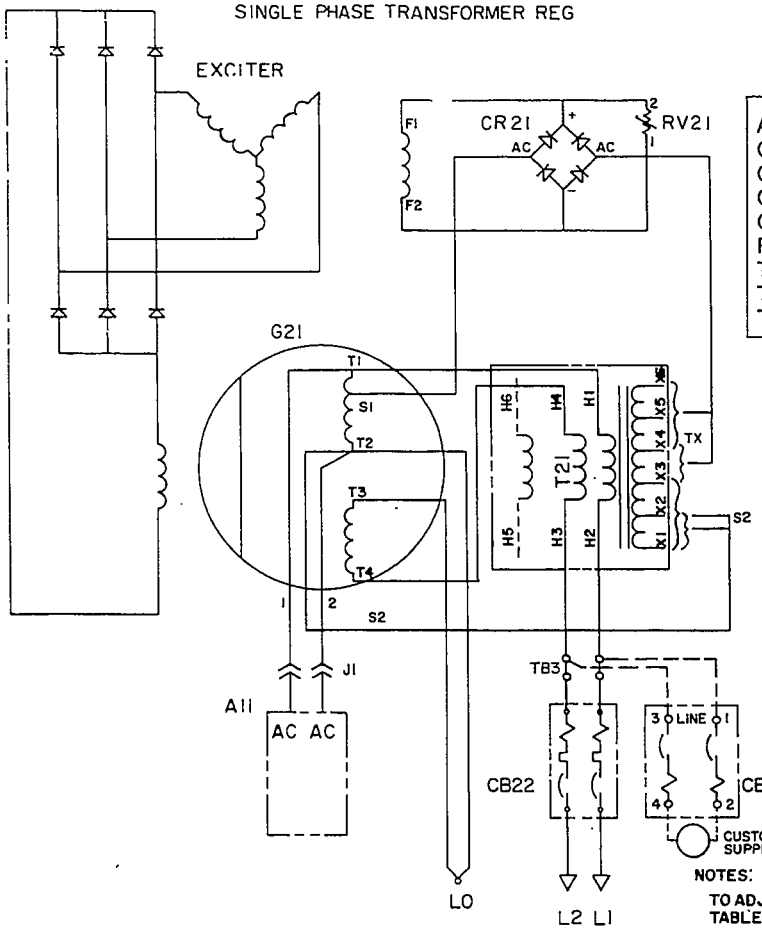
612-6442



SEE SCHEMATIC DIAGRAM FOR COMPONENT REFERENCE

DL3 SINGLE PHASE AC CONTROL

AC SCHEMATIC
SINGLE PHASE TRANSFORMER REG



COMPONENT REFERENCE

A11	Engine Monitor PCB
CB21	Circuit Breaker, Fan
CB22	Circuit Breaker, Load
CR21	Bridge Rectifier
G21	Generator
RV21	Suppressor Assy.
T21	Transformer Assy.
TB1,2	Standoff Insulator
TB3	Terminal Block

NOTES:

TO ADJUST OUTPUT VOLTAGE, MOVE TAPS ON T21 ACCORDING TO TABLES.

1. IN ALL VOLTAGE CONNECTIONS LEAVE T1 AND T4 CONNECTED TO H1 AND H4 RESPECTIVELY.
2. FOR 60Hz: USE S2 LEAD (FROM GEN) ON TAPS X1-2 (4 TAPS) USE TX LEAD ON TAPS X3-4
3. UNLESS OTHERWISE NOTED, ALL COMPONENTS ARE SHOWN IN THE DE-ENERGIZED POSITION.
4. DASHED LINES INDICATE WHEN USED.
5. IF CB22 IS NOT USED CONNECT LEADS DIRECTLY TO THE LOAD

DKD

OUTPUT VOLTAGE ADJUSTMENT	60Hz (-01) 120,120/240V TAP POSITION S2	TX
↑		
INCREASE	X2	X3
	X1	X3
STD	X2	X4
DECREASE	X1	X4
↓		

DKC

OUTPUT VOLTAGE ADJUSTMENT	60Hz (-02) 120,120/240V TAP POSITION S2	TX
↑		
INCREASE	X2	X3
STD	X1	X3
DECREASE	X2	X4
	X1	X4
↓		

DL3

OUTPUT VOLTAGE ADJUSTMENT	60Hz (-03) 120,120/240V TAP POSITION TX	S2
↑		
INCREASE	X3	X4
	X2	X4
	X1	X4
STD	X3	X5
DECREASE	X2	X5
	X1	X5
	X3	X6
	X2	X6
	X1	X6
↓		

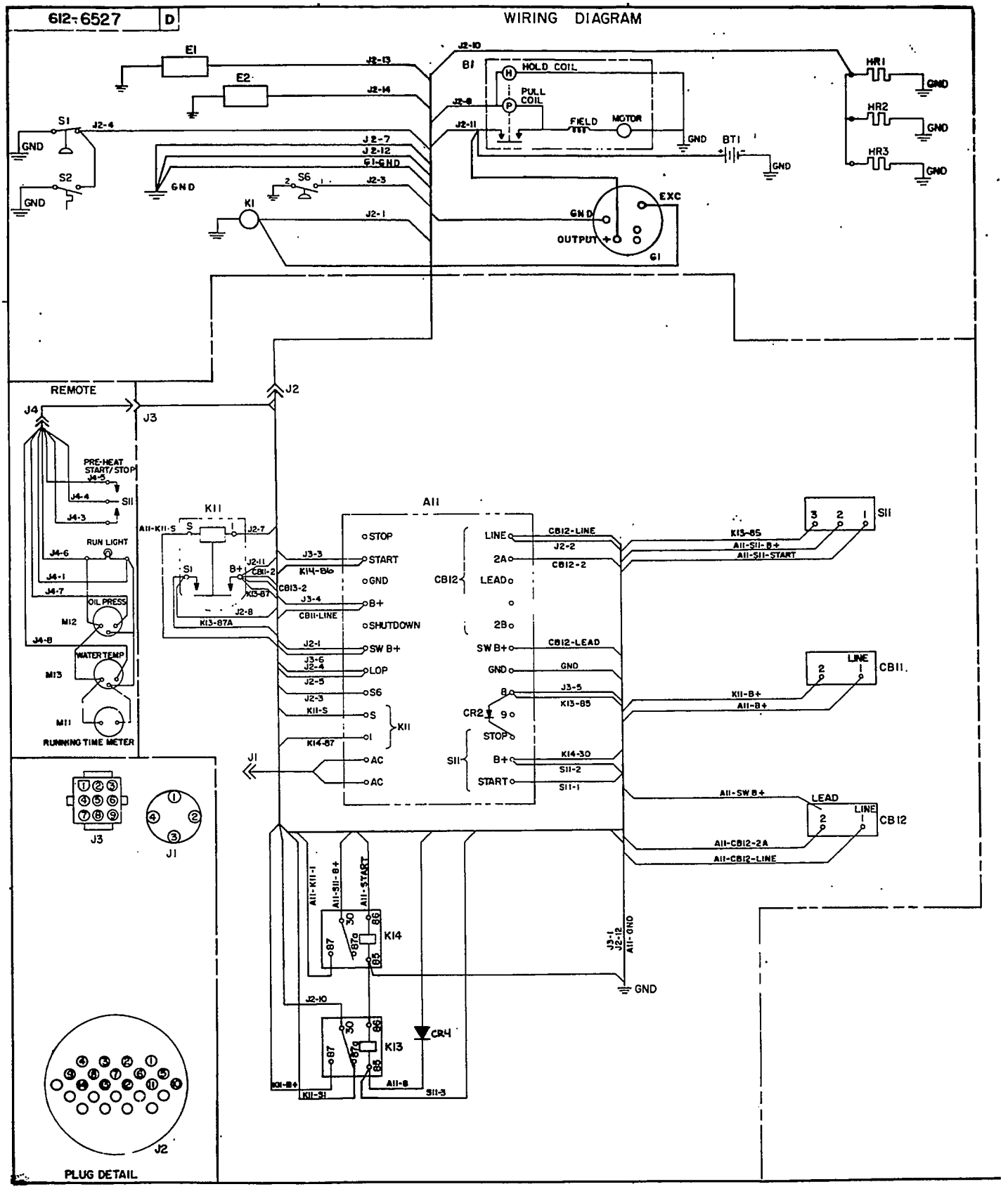
ER NO.	LTR	NO.	REVISION	ZONE	ENG	CKR	DATE
30325	D	1	CHANGED PICTORIAL	—			7-14-87
29140	C	1	ADD -03	2D		P.	12-30-86
29059	B	1	ADD -02	2D		QA	12-30-86
28383	A	1	RLSE FOR PROD				7-15-86

60Hz		
8.0 DKD	-01	
4.0 DKC	-02	
15.0 DL3	-03	

Onan — DATE 7-15-85 RLW

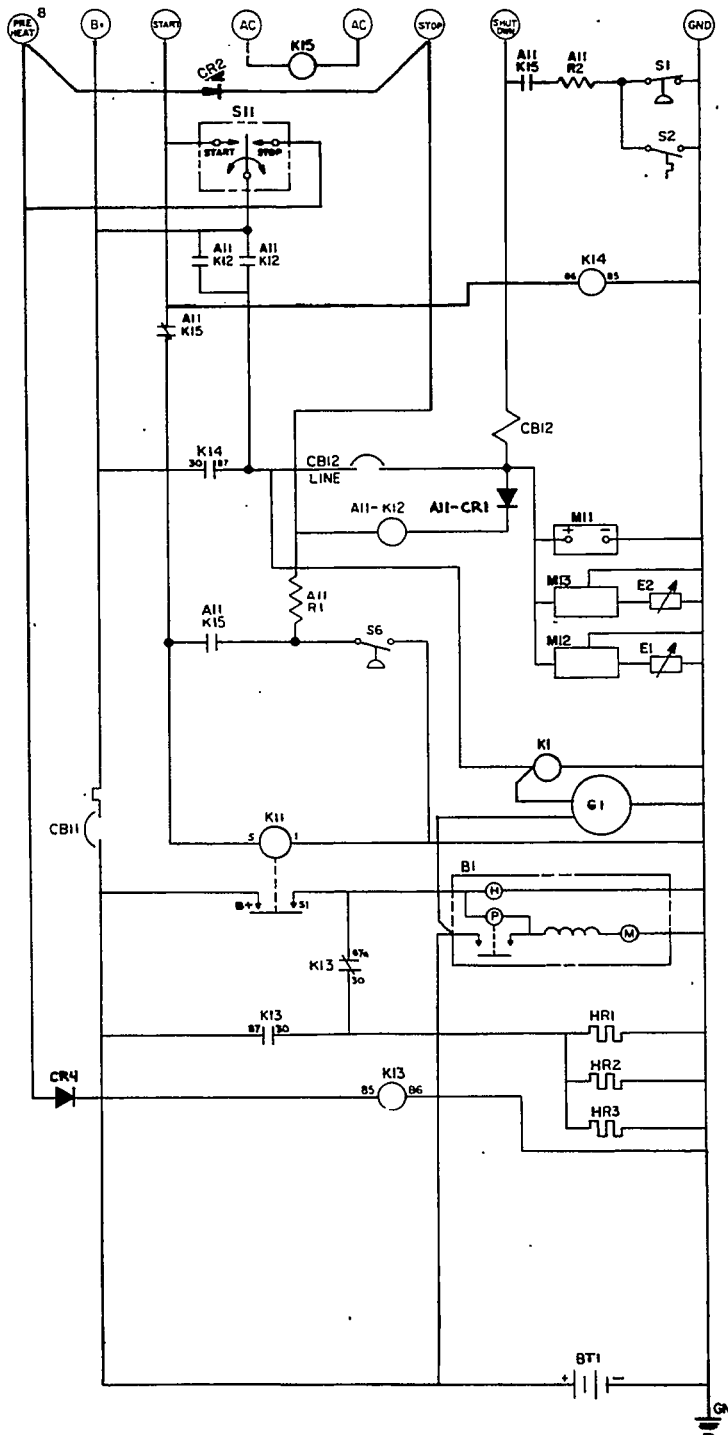
CONTROL-GEN SET AC(1PH)

612-6184 612-6442



DL3 12-VOLT DC CONTROL

SCHEMATIC



COMPONENT REFERENCE

A11	Engine Monitor PCB
A11-K12	Relay, Power
A11-K15	Relay, Starter Protection
A11-R1	Resistor, (R12)
A11-R2	Resistor (LOP Timing)
B1	Starter and Solenoid
BT1	Battery, 12-Volt
CB11	Breaker, Control
CB12	Breaker, Fault
CB13	Breaker, Charging
CR2	Rectifier, Stop
CW1	Charge Winding, Battery
E1	Sender, Oil Pressure
E2	Sender, Coolant Temp
HR1-3	Heater, Glow Plug
K1	Fuel Solenoid
K11	Start Relay
K13	Heater, Relay
K14	Relay, Fuel Solenoid
S1	Switch, Low Oil Pressure
S2	Switch, High Coolant Temp.
S6	Switch, Control Power Latch
S11	Switch, Start/Stop
VR1	Voltage Regulator, DC

ER NO	LET	NO.	REVISION	ZONE	DR	EN	CK	DATE
36330	D	1	SEE ER	–	GH	WA	RW	5-11-90
34398	C	1	SEE ER	–	GS	WA	JC	4-25-89
33226	B	1	REMOVE CB13	DS	AS	TS	WA	RW	11-9-88
32158	A	1	PROD RLSE	–	GS	WA	JC	6-6-88

Onan Corporation
Minneapolis, Minnesota

Title: CONTROL- GEN SET DC(WD

Dwg No. 612-6527 Dwg Size D

Bkn to
Copied from
Third Angle Projection

Dr G. SALMONSON 6-6-88
Chkr JIM CAMERON 6-16-88
Approved 6-14-88

Model first used on DL3

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DL3 SINGLE PHASE AC CONTROL

Onan

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