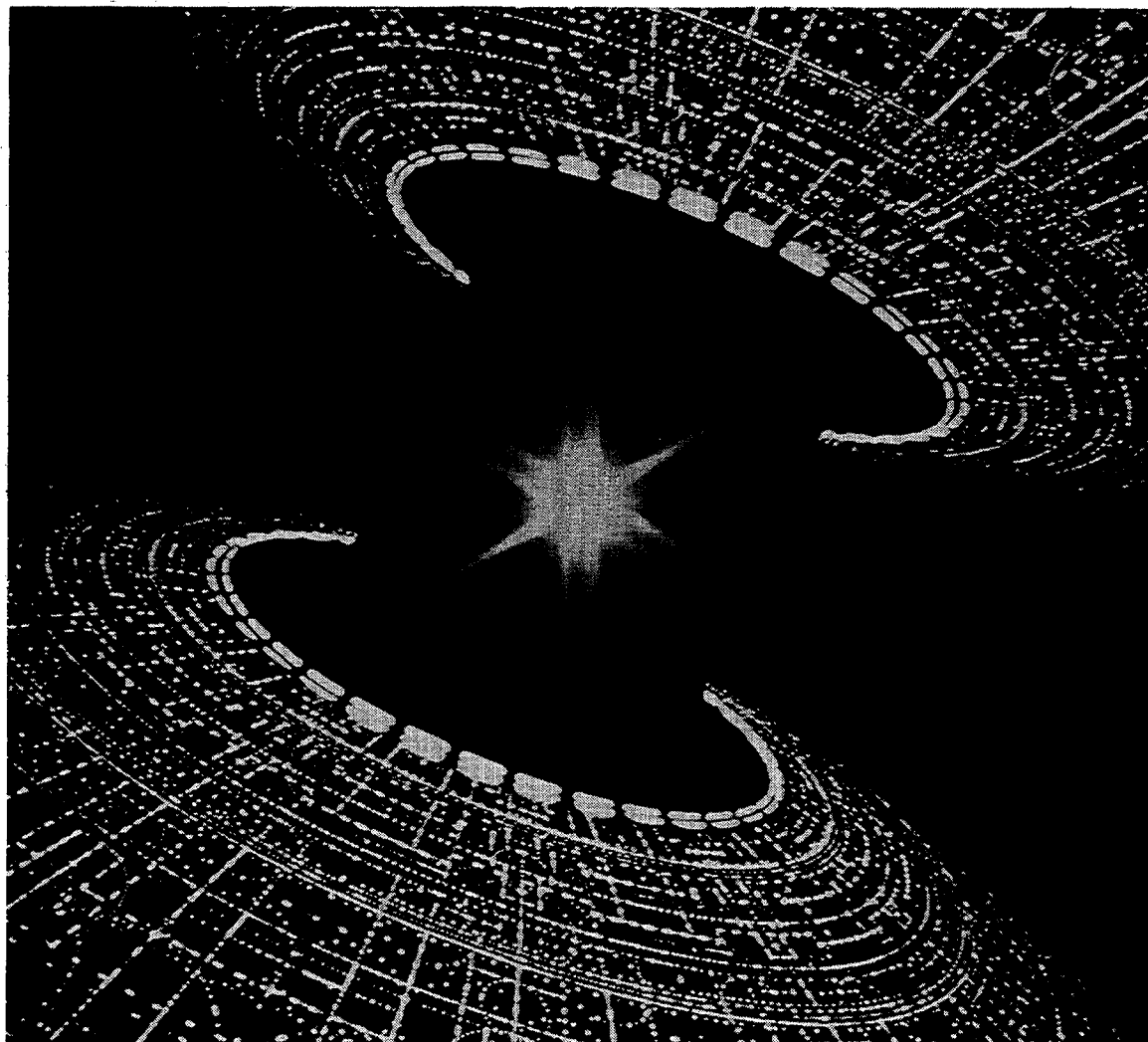


**KOHLER**  
GENERATORS

FAST RESPONSE III



Service Manual



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## Introduction

This manual covers concept, operation, troubleshooting and repair of Kohler Fast-Response II generators and controls. Engine service, and parts information is available separately for particular models and specs.

## Service Assistance

Contact your Kohler Generator Distributor to obtain additional service information for particular models. See Yellow page listing under **Generators-Electric**. Order ES-797 and supply Model, Spec, and Serial numbers from generator nameplate for complete engine service manual and generator set parts list.

# Safety Precautions

Read these instructions carefully. Failure to follow instructions and safety rules could result in serious bodily injury and/or damage to the generator or test equipment.

## WARNING

**LETHAL EXHAUST GAS!** The engine powering your generator discharges deadly carbon monoxide as part of the exhaust gas when operating. Carbon monoxide is particularly dangerous in that it is odorless and colorless. Keep in mind that it can cause death if inhaled for even a short period of time. Never operate the generator set inside a building unless the exhaust gas is piped safely outside. Never operate in any area where exhaust gas could accumulate and seep back inside an occupied building. Avoid breathing exhaust fumes when working on or near the generator set.

## WARNING

**DANGEROUS FUELS – MAY CAUSE SERIOUS BURNS OR INJURY!** Use extreme caution when handling, storing, and using fuels – all fuels are highly explosive in a vapor state. Store fuel in a well-ventilated area away from spark producing equipment and out of the reach of children. Never add fuel to the tank while the engine is running to prevent spilled fuel from igniting on contact with hot parts or from ignition spark. Keep fuel lines and connections tight and in good condition – don't replace flexible fuel lines with rigid lines. Flexible sections are used to avoid breakage due to vibration. Additional precautions should be taken when using the following fuels:

**Gasoline** – Store gasoline only in approved red containers clearly marked GASOLINE. Don't store gasoline in any occupied building.

**Propane (LP)** – Adequate ventilation is mandatory. Propane is heavier than air; install gas detectors low in room. Inspect detectors often.

**Natural Gas** – Adequate ventilation is mandatory. Natural gas rises; install gas detectors high in room. Inspect detectors often.

## WARNING

**FLASH FIRE!** A sudden flash fire can cause serious burns. To avoid the possibility of a flash fire, do not smoke or permit flame or spark to occur near carburetor, fuel line, fuel filter, fuel pump or other potential sources of spilled fuel or fuel vapors.

## WARNING

**BACKFIRE!** A sudden backfire can cause serious burns. Keep hands and face away from the carburetor when the air cleaner is removed.

## WARNING

**HIGH VOLTAGE!** Remember that the function of a generator set is to produce electricity and whenever electrical energy is present, there is the potential danger of electrocution. Keep everyone, especially children, away from the set while it is running and take precautions to prevent unqualified personnel from tampering with or attempting to operate your generator set. Have the set and electrical circuits serviced only by qualified technicians. Wiring should be inspected frequently – replace leads that are frayed or in poor condition. Do not operate electrical equipment when standing in water, on wet ground, or when your hands are wet.

## WARNING

**UNITS STARTS WITHOUT NOTICE!** Units with Automatic Transfer Switches start automatically. Potential injury or electrocution can result. Turn Generator Master Switch on controller to OFF position, and remove battery cables (remove ground lead first and reconnect it last) to disable generator set before working on any equipment connected to generator. See Warning – EXPLOSIVE GASES following.

## WARNING

**EXCESSIVE NOISE!** Never operate without adequate muffler or with faulty exhaust system – exposure to excessive noise is not only tiring but can lead to impairment of hearing.

## WARNING

**EXPLOSIVE GASES!** The gases generated by a battery being charged are highly explosive and can result in serious burns if ignited. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is charging. Any room containing charging batteries should be well-ventilated to prevent accumulation of explosive gases. To avoid sparks do not disturb battery charger connections while battery is charging, and always turn charger off before connecting or disconnecting. When operating any test equipment from an auxiliary battery in an enclosed area, auxiliary battery should be located at least 18 inches above the floor to minimize the possibility of igniting fuel vapors.

**⚠ WARNING**

**DANGEROUS ACID!** Avoid contact with battery electrolyte. It contains acid which can eat holes in clothing, burn skin, and cause permanent damage to eyes. Always wear splash-proof safety goggles when working around the battery. If battery electrolyte is splashed in the eyes or on skin, immediately flush the affected area for 15 minutes with large quantities of clean water. In the case of eye contact, seek immediate medical aid. Never add acid to a battery once the battery has been placed in service. Doing so may result in dangerous spattering of electrolyte.

**⚠ WARNING**

**HOT COOLANT!** Engine coolant is pressurized and hot enough to cause severe burns. If generator set is equipped with a coolant recovery tank, check coolant level at tank. If necessary to check coolant level at radiator or surge tank (on city-water or remote radiator-cooled sets), place a rag over the cap and turn slowly to release pressure, before removing cap.

**⚠ WARNING**

**MOVING PARTS!** Keep hands, hair, necktie, loose clothing and test leads well away from moving parts, as serious injury could result from entanglement. Never run generator set with guards, covers, or screens removed.

**⚠ WARNING**

**ELECTRICAL SHOCK!** Battery can cause electrical burns and shocks. Exercise reasonable care when working near the battery to avoid electrical connections through tools. Remove wristwatch, rings and any other jewelry.

**⚠ WARNING**

**UNIT STARTS WITHOUT NOTICE!** Units with Automatic Transfer Switches start automatically. Potential injury or electrocution can result. Turn Generator Master Switch on controller to OFF position and remove battery cables (ground lead first) to disable the generator set before working on generator set or any connected equipment. See "Safety Precautions."

**⚠ WARNING**

**DANGER OF ELECTROCUTION!** When the generator is used for standby power, use of an automatic transfer switch is required to prevent inadvertent interconnection of standby and other sources of power. In some states and/or localities it is illegal to operate a

standby generator without an automatic transfer switch. Failure to install an automatic transfer switch will cause "backfeed" into utility transmission lines and can cause serious injury or death.

## Prestart Checklist

The following items should be checked before each start-up of manually controlled generator sets and at regular intervals on sets equipped with automatic transfer switches. See your engine operation/maintenance manual for specific service procedures.

**OIL LEVEL:** Should be at or near FULL mark, not over.

**FUEL LEVEL:** Make sure there is an adequate supply; keep tanks full to allow operation for extended periods.

**BATTERY:** Check connections and level of battery electrolyte.

**COOLANT LEVEL:** Maintain coolant level at one-half to one inch below top of radiator filler neck, or to proper level in recovery tank. If unit is equipped with a coolant recovery tank, level in tank should be between 1/3 full (cold) and 2/3 full (hot). See "Safety Precautions."

### CAUTION

Do not turn on block heater before filling cooling system. Run engine until warm and refill radiator to purge air from the system. Block heater failure could result if not immersed in water.

**AIR CLEANER:** Must be clean and properly installed to prevent unfiltered air from entering engine.

**DRIVE BELTS:** Make visual check of radiator fan, water pump and battery charging alternator belt to make sure it is tight and in good condition.

**OPERATING AREA:** Make sure there are no obstructions that could block the flow of cooling air. Make sure area is clean. Rags, tools or debris must not be left on or near the generator set.

**EXHAUST SYSTEM:** Exhaust outlet must be clear; silencer and piping must be tight and in good condition.

**LAMP TEST:** Press the lamp test button and check to make sure all lamps provided on your controller are operational.



## Section 1

# FAST-RESPONSE II CONCEPTS

### General

A Kohler Fast-Response II set is a rotating-field generator, and a smaller rotating armature generator turned by a common shaft. The main, rotating field generator supplies to load circuits, while the rotating armature (exciter) generator supplies DC to excite the main generator's field. See Figure 1-1.

### System

The Fast-Response II excitation system uses a permanent magnet exciter with an FR Activator (SCR Bridge) which controls the amount of the DC current fed to the generator field. This type of system uses a voltage regulator, which signals the FR Activator through an optical coupling. The voltage regulator senses the output voltage of the generator and turns a stationary LED (light emitting diode) on or off, depending upon the level of the output voltage. The LED is mounted on the end bracket opposite a photo transistor, which rotates on the shaft. The photo transistor picks up the signal from the LED and tells the SCR rotating bridge to turn on or off, depending upon the need, as dictated by the voltage regulator. This type generator has a voltage recovery time several times faster than the

conventional wound field brushless generator, because it does not have the inductance of the exciter field to contend with. It also has better recovery characteristics than the static excited machine, because it is not dependent upon the generator output voltage for excitation power. Possibly the greatest advantage of this type machine is its inherent ability to support short circuit current and allow system coordination for tripping downstream branch circuit breakers.

Fast-Response II systems deliver proper exciter current to the main field within 0.05 seconds of a change in load demand.

### Short Circuit Performance

When a short circuit occurs in the load circuit(s) being served, output voltage drops to a low level until the short is removed, and amperage momentarily rises to 600-1000% of the generator's rated current. The FR activator sends full exciter power to the main field. The generator then sustains up to 300% of its rated amperage. Sustained high current will cause properly rated load circuit fuses/breakers to open, or generator safeguard breaker to trip. The Safeguard breaker serves to collapse the generator's main field in the event of a sustained heavy overload or short circuit.

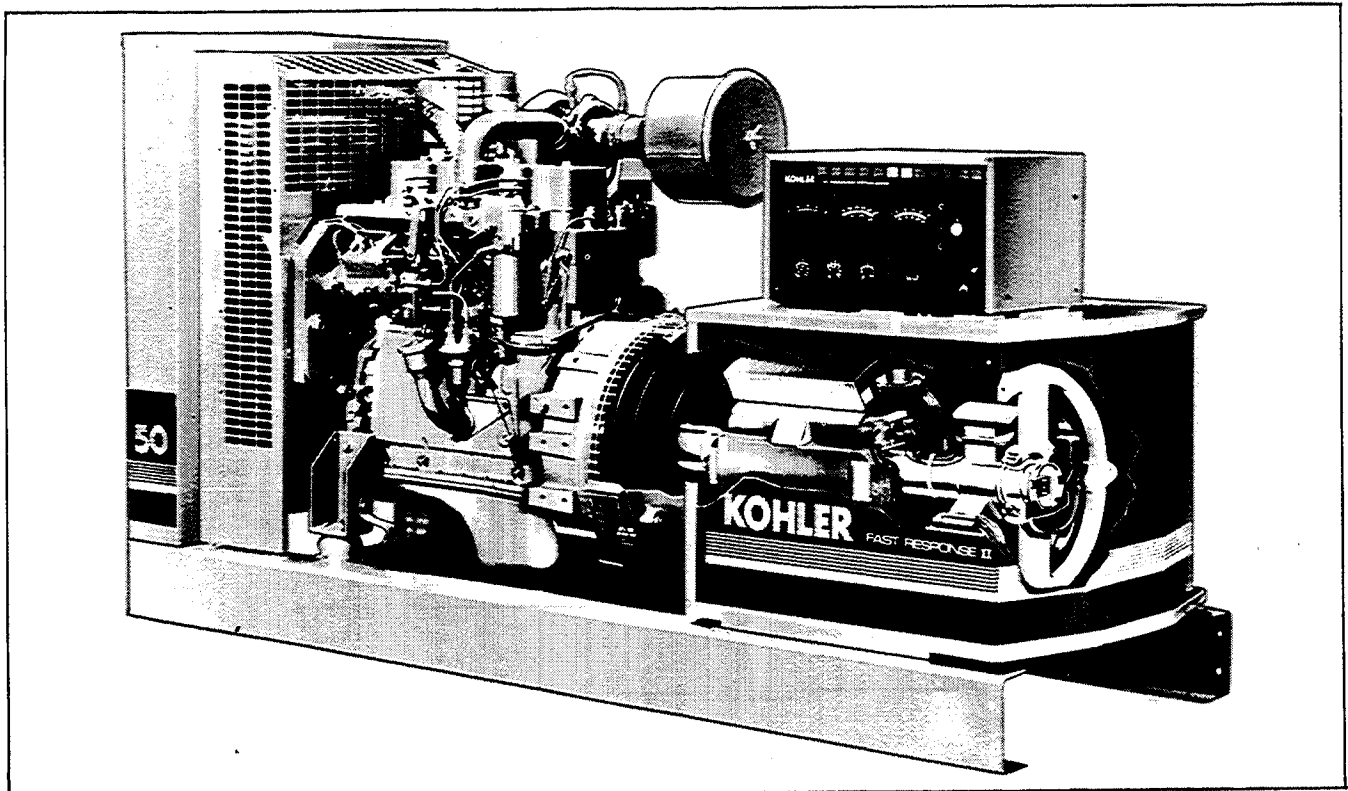


Figure 1-1. Generator Cutaway

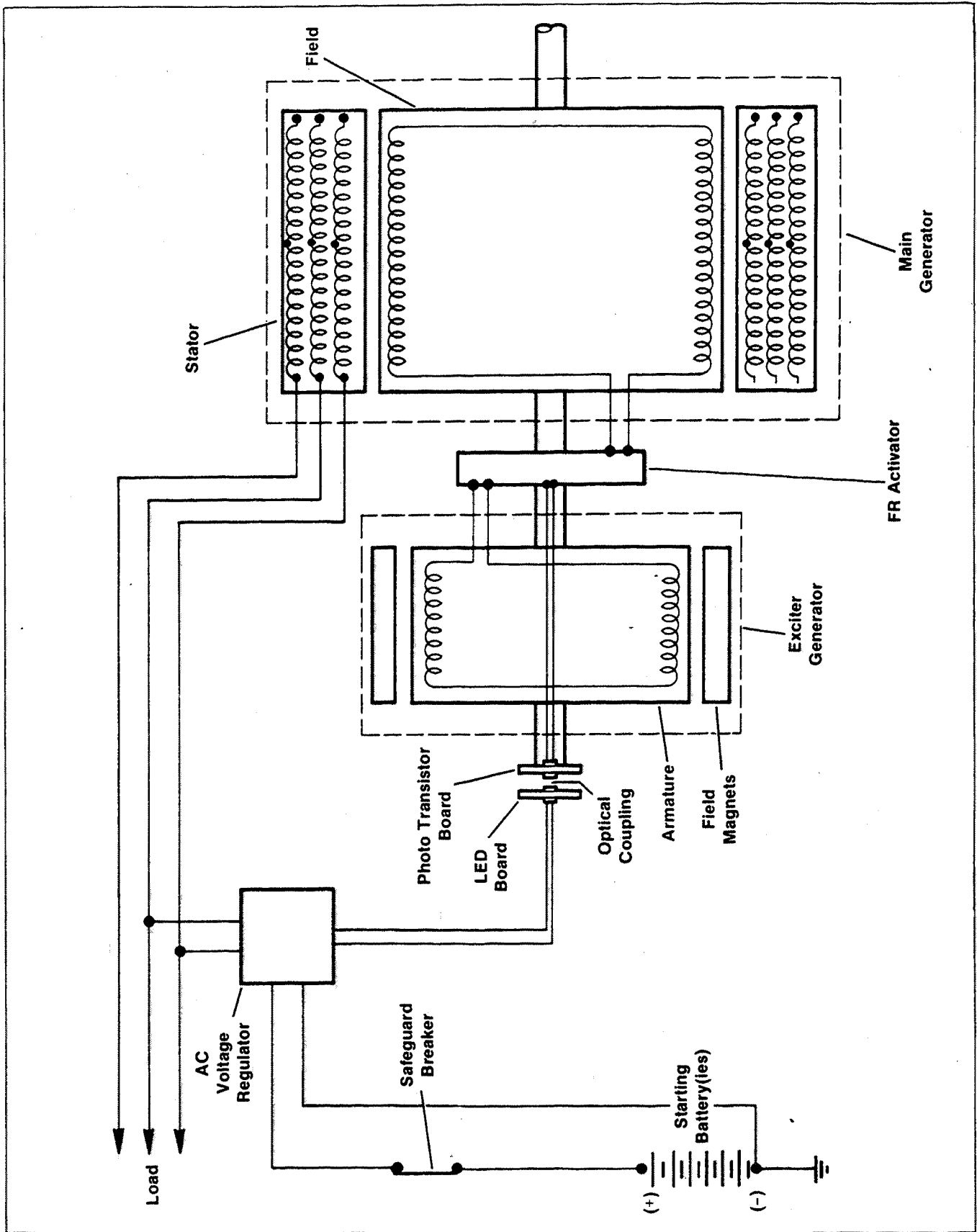


Figure 1-2. Fast Response II Schematic

# OPERATION

## Relay Controller Operation

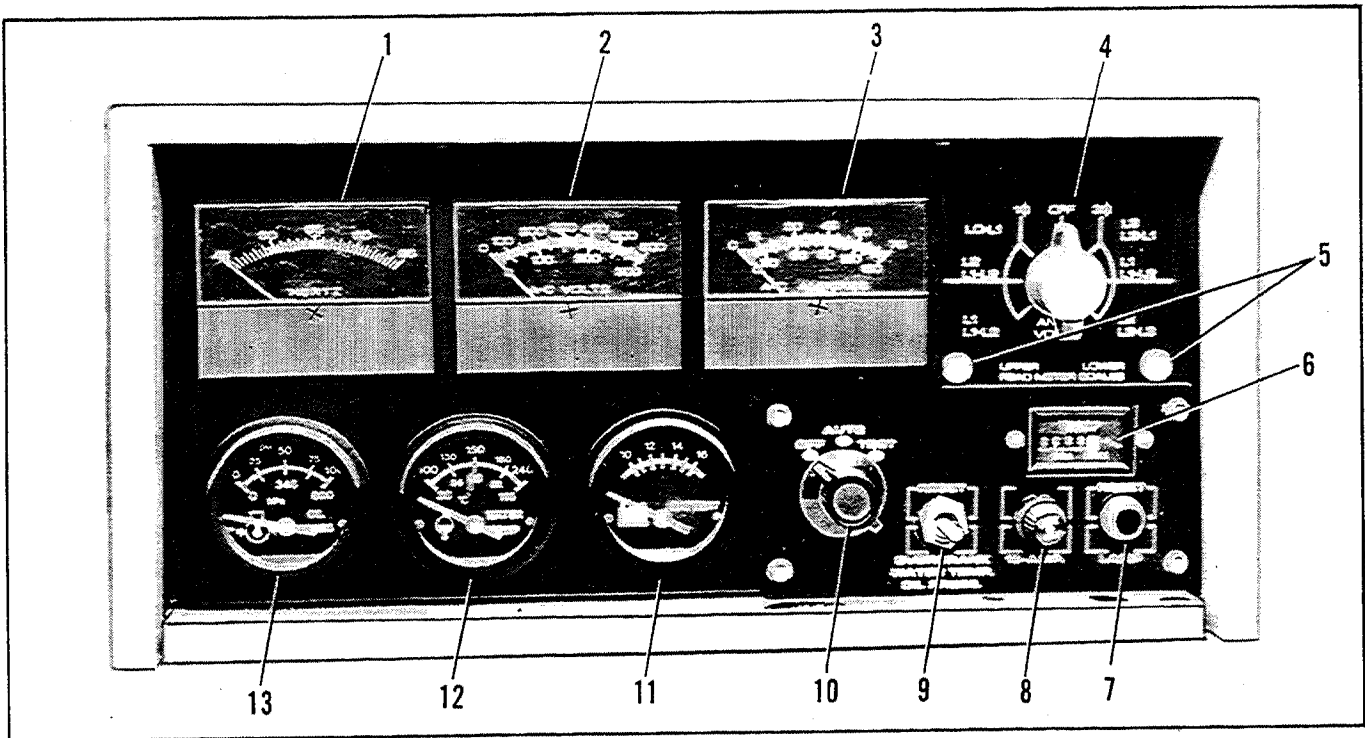


Figure 2-1. Relay Controller - Meter Equipped

For identification of components on each of these controllers, See Figure 2-1; for an explanation of their function refer to the following paragraphs.

1. **Frequency Meter** - measures frequency (Hz) of generator output voltage.
2. **AC Voltmeter** - measures voltage across output leads indicated by selector switch.
3. **AC Ammeter** - measures amperage from output leads indicated by selector switch.
4. **Selector Switch (Voltmeter-Ammeter)** - selects generator output circuits to be measured. If switched to a point with three circuit lead labels, voltage is measured between the lower two leads and amperage on the upper lead. With switch in OFF position, AC voltmeter and ammeter will not register.
5. **Scale Lamps (upper and lower)** - indicate voltmeter and/or ammeter scales to be read.
6. **Hourmeter** - records total generator set operating hours for reference in maintenance scheduling.
7. **Reset Lamp** - lights to indicate that the engine protection circuit has stopped the engine due to:
  - *Overcrank*, if engine fails to start in 30 to 60 seconds.
  - *Low coolant level (if equipped)*, if engine stops due to low coolant level in radiator.
  - *Oil Pressure*, if engine loses oil pressure.See "Resetting" following.
8. **Fuse**—protects DC controller and engine circuits.
9. **Reset Switch**—see "Resetting" following.
10. **Generator Master Switch**—refer to "Testing, Starting and Stopping" following.
11. **DC Voltmeter**—measures voltage of starting battery(ies)/charging system.
12. **Water Temperature**—measures engine coolant temperature.
13. **Oil Pressure**—measures engine oil pressure.

## Relay Controller Operation – cont'd.

### Testing

To test run the generator set at the controller, move the Generator Master Switch to the TEST position.

### Starting

Move Generator Master Switch to AUTO position to allow start-up by automatic transfer switch or remote start-stop switch. If set is not connected to an automatic transfer or remote start-stop switch, move the Generator Master Switch to the TEST position for normal start-up.

### Stopping

1. Run the generator set at no load for 5 minutes to allow engine cool down.

#### NOTE

Run the generator at no load for 5 minutes prior to stopping to insure adequate cooling of the set.

2. Move Generator Master Switch or remote start-stop switch to OFF position.

### Fault Shut-downs

The generator set will shut down automatically, and RESET lamp will light if one of the malfunctions below occurs.

**OVERCRANK:** Shutdown occurs if engine does not start after 30-60 seconds of cranking.

**HIGH TEMPERATURE:** Shutdown occurs 5 seconds after fault.

**LOW COOLANT LEVEL (if equipped):** Shutdown occurs 5 seconds after fault.

**LOW OIL PRESSURE:** Shutdown occurs 5 seconds after fault; 5.5 to 10.5 psi (38 to 72 kPa) on diesel models, 11.5 to 18.5 psi (79 to 126 kPa) on gas-line models.

#### CAUTION

High temperature and low oil pressure shutdown will not function due to low oil or coolant level only! Check for proper oil and coolant levels at engine.

### Resetting

#### NOTE

The reset switch (1TS) is a free-floating toggle.

1. Move Generator Master Switch to OFF position and push reset switch up.
2. Disconnect generator set from load with line circuit breaker or automatic transfer switch.
3. Refer to "Troubleshooting" following; determine cause of fault shutdown.
4. Make necessary repairs to correct problem. Follow "Safety Precautions."
5. Move Generator Master Switch to necessary position (AUTO or TEST) for start-up.
6. Reclose line circuit breaker.

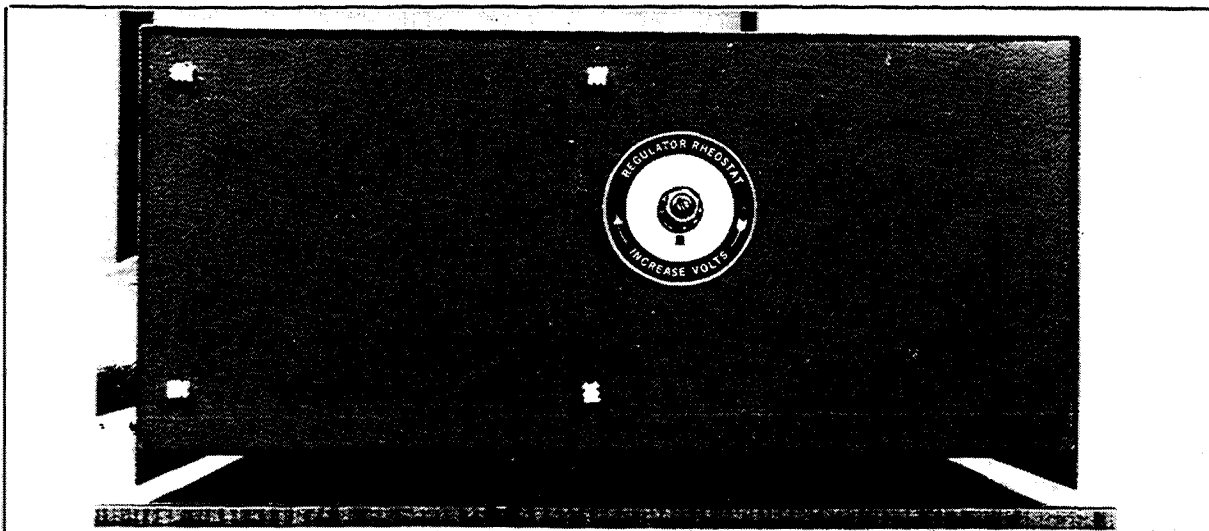


Figure 2-2. Voltage Adjustment

### Voltage Adjustment

Use the rheostat mounted on back of controller to adjust generator output voltage (Figure 2-2).

# Microcomputer Controller Operation

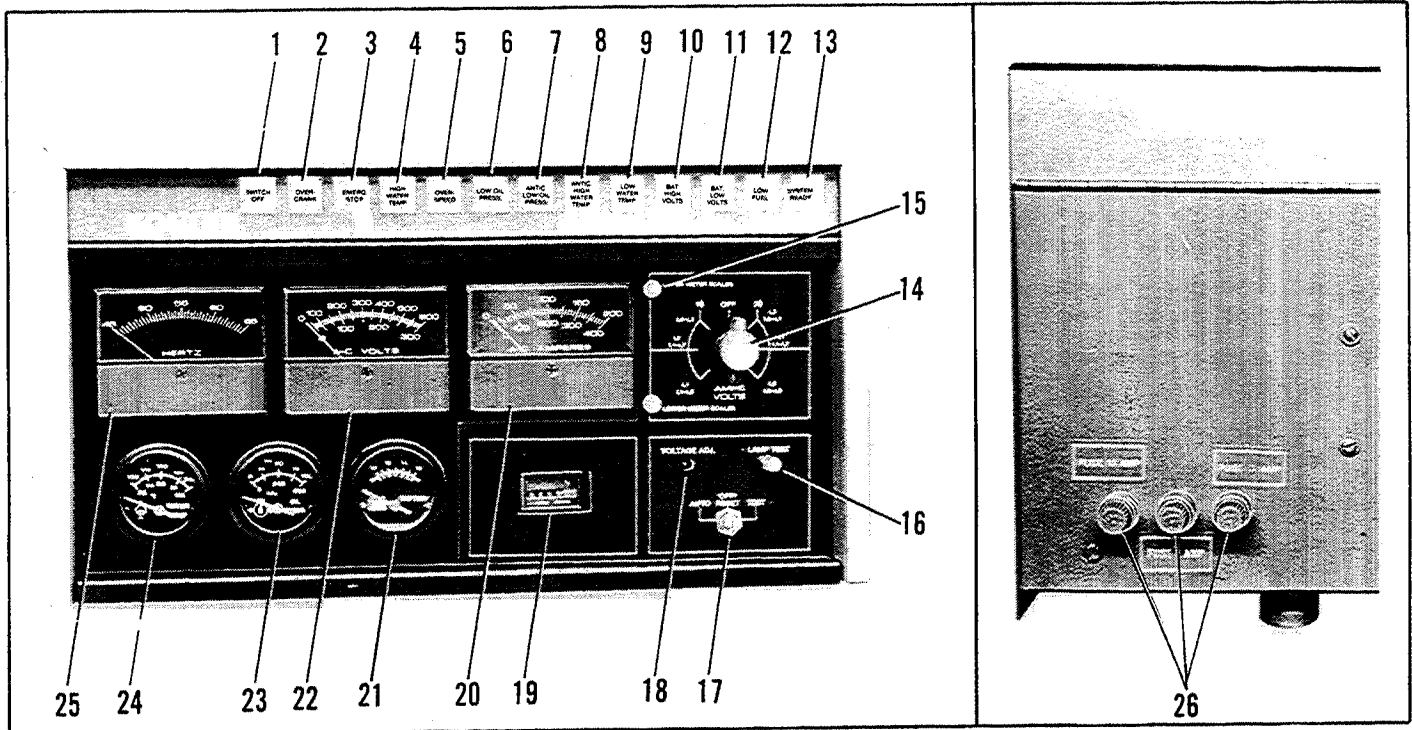


Figure 2-3. Microcomputer Controller

For identification of components, see Figure 2-3; for an explanation of their function refer to the following paragraphs.

### Lamps:

1. **Switch Off** – lamp flashes when Generator Master Switch is in OFF/RESET position. Lamp will not light when Generator Master Switch is in AUTO or TEST position.
2. **Overcrank**
  - cranking stops and overcrank lamp will light if engine does not start after 60 seconds of cyclic cranking.
  - lamp will light after 25 seconds of attempted cranking if starter or engine will not turn (locked rotor).
  - lamp will light and engine will stop after starting and 25 seconds running without speed sensor signal (see Microcomputer Controller Troubleshooting – Speed Sensor).
- Overcrank Flashing** – lamp will flash if speed sensor fails during a normal run. Engine will keep running.
3. **Emergency Stop** – lamp lights if emergency stop has been made or if overvoltage device (if equipped) has shut down. See “Emergency Stopping” following.
4. **High Water Temperature** – lamp lights if set has shut down due to high engine coolant temperature, and if equipped, low coolant level.
5. **Overspeed** – lamp lights if set shuts down due to overspeed.
6. **Low Oil Pressure** – lamp lights if set shuts down due to loss of engine oil pressure.
7. **Anticipated Low Oil Pressure (if equipped)** – lamp lights if engine oil pressure approaches shutdown level.

### Operation

8. **Anticipated High Water Temperature (if equipped)** – lamp lights if engine coolant temperature approaches shutdown level.
9. **Low Water Temperature (if equipped)** – lamp lights if optional engine block heater is not working and/or temperature may be too low (below 70°F, 21°C) for 10-second start-up.
10. **Battery High Volts** – lamp lights if battery or charging voltage exceeds 15 volts for 12-volt systems; 30 volts for 24-volt systems (will also light if over voltage occurs due to battery charger malfunction while set is not operating).
11. **Battery Low Volts** – lamp lights if battery or charging voltage drops below 10 volts for 12-volt systems; 20 volts for 24-volt systems (will also light if under voltage occurs due to battery or charger malfunction while set is not operating).
12. **Low Fuel (if equipped)** – lamp lights if fuel tank level approaches empty.
13. **System Ready** – lamp lights when Generator Master Switch is in AUTO or TEST position and system senses NO faults.

### Switches:

14. **Selector Switch (Voltmeter-Ammeter)** – selects generator output circuits to be measured. If switched to a point with three circuit lead labels, voltage is measured between the lower two leads and amperage on the upper lead. With switch in OFF position, AC voltmeter and ammeter will not register.
15. **Scale Lamps (upper, lower)** – indicate voltmeter and/or ammeter scales to be read.
16. **Lamp Test** – used to test indicator lamps.

## Microcomputer Controller Operation – cont'd.

17. **Generator Master Switch** – see “Testing, Starting and Stopping” following.
18. **Voltage Adjustment** – used to fine-adjust generator output voltage.

### Meters:

19. **Hourmeter** – records total generator set operating hours for reference in maintenance scheduling.
20. **AC Ammeter** – measures amperage from output leads indicated by selector switch.
21. **DC Voltmeter** – measures voltage of starting battery(ies)/charging system.
22. **AC Voltmeter** – measures voltage across output leads indicated by selector switch.
23. **Oil Pressure** – measures engine oil pressure.
24. **Water Temperature** – measures engine coolant temperature.
25. **Frequency Meter** – measures frequency (Hz) of generator output voltage.
26. **Fuses:**
  - 4-Amp-protects remote annunciator circuit, lamp circuit board, and alarm horn circuit (if equipped).
  - 1-Amp-protects control circuit board and control relay coils.
  - 15-Amp-protects engine DC and primary starting circuits.

### NOTE

Earlier models utilize a 3 Amp. fuse to protect remote annunciator and alarm horn circuits. A 4 Amp. fuse protects control and lamp circuit boards and control relay coils.

## “TEST” Starting

To start the generator set at the controller, move the Generator Master Switch to the TEST position.

## “AUTO” Starting

Move Generator Master Switch to AUTO position to allow start-up by automatic transfer switch or remote start-stop switch connected to controller terminals 3 and 4.

### NOTE

The Microcomputer Controller provides up to 60 seconds of cyclic cranking – crank 10 seconds, rest 10 seconds, crank 10 seconds, etc. Three crank/rest cycles, for a total of 60 seconds before overcrank shutdown.

## Stopping

1. Disconnect load from generator set and allow it to run unloaded for 5 minutes.

### NOTE

Run the generator at no load for 5 minutes prior to stopping to insure adequate cooling of the set.

2. Move Generator Master Switch to OFF/RESET position. Engine will stop.

### NOTE

If engine stop is signaled by a remote switch or Automatic Transfer Switch, the generator set will keep running for a cool-down cycle of 5 minutes.

## Emergency Stopping

Turn Generator Master Switch to OFF/RESET, or operate remote emergency stop switch (if equipped), for immediate shutdown.

## Fault Shut-downs

The generator set will shut down automatically under the following fault conditions:

**OVERCRANK:** See “Overcrank”, preceding.

**HIGH TEMPERATURE:** Shutdown occurs 4 seconds after fault. \*

### CAUTION

High temperature shutdown will not function if proper coolant level is not maintained!

**LOW COOLANT LEVEL (if equipped):** Shutdown occurs 4 seconds after fault. \*

**LOW OIL PRESSURE:** Shutdown occurs 4 seconds after fault, 5.5 to 10.5 psi (38 to 72 kPa) on diesel models; 11.5 to 18.5 psi (79 to 126kPa) on gasoline models. \*

### NOTE

\* High temperature, low coolant level, and low oil pressure shutdowns will not function within the first 30 seconds after start-up.

### CAUTION

Low oil pressure shutdown will not function due to low oil level only! Check for proper oil level at engine.

**OVERSPEED:** Unit shuts down immediately, if governed frequency exceeds 70 Hz on 60 Hz sets, or 60 Hz on 50 Hz sets.

**OVERVOLTAGE (if equipped)** Unit will shut down after approximately one second of 15% or more over nominal voltage. EMERG. STOP lamp will light.

### CAUTION

Sensitive equipment may suffer damage in less than one second of an overvoltage condition. On-line equipment requiring faster shutdowns should have its own over-voltage protection.

## Resetting

Use the following procedure to restart set after a fault shutdown.

1. Move Generator Master Switch to OFF/RESET position.
2. Disconnect generator set from load with line circuit breaker or automatic transfer switch.
3. Correct cause of fault shutdown. See "Safety Precautions."
4. Move Generator Master Switch to TEST position for start-up.
5. Verify that cause of shutdown has been corrected.
6. Reconnect to load.
7. Move Generator Master Switch to necessary position (AUTO or TEST) for start-up.

## Remote Annunciator (Decision Monitor)

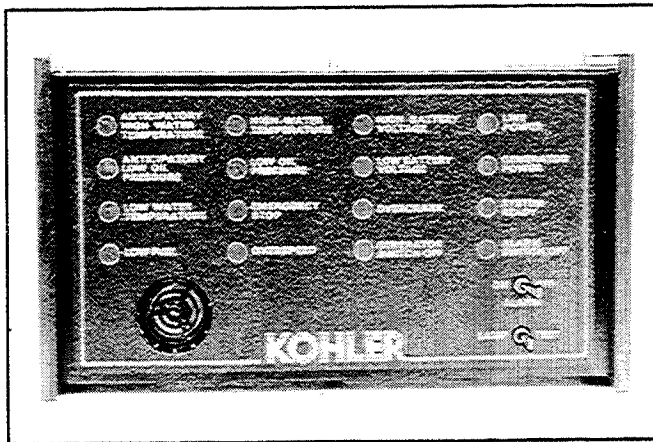


Figure 2-4. Remote Annunciator (Decision Monitor)

An annunciator may be located at a work station remote from the generator set, to allow convenient monitoring of the set's condition. Decision Monitors have the same lamp indicators as the Microcomputer controller, plus the following (see Figure 2-4):

- **Line Power**—indicates commercial utility power in use.
- **Generator Power**—indicates generator power in use.
- **Alarm Switch Off**—indicates ALARM switch in OFF position.
- **Alarm Horn**—sounds if any fault or anticipatory condition occurs.

## Alarm Horn (if equipped)

The generator set may be equipped with a unit-mounted alarm horn and alarm switch. The alarm switch may be used to silence the alarm horn while servicing the set (see Figure 2-5).

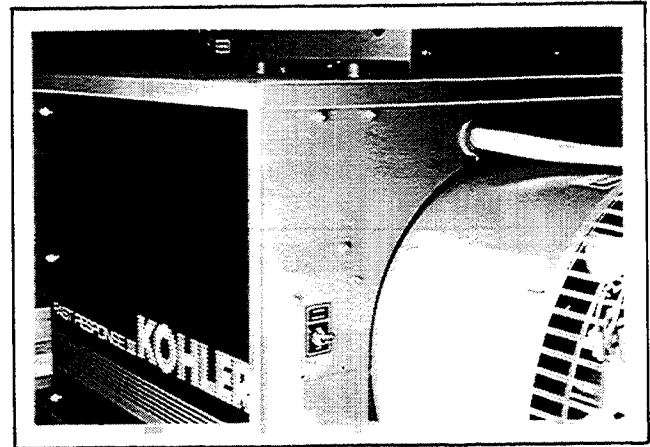


Figure 2-5. Alarm Horn Switch

## Safeguard Breaker (if equipped)

The Safeguard Breaker senses output current on each generator phase, and will shut off the AC voltage regulator in the event of a sustained overload or short circuit. It is not a line circuit breaker, and will not disconnect the generator from the load. See Figure 2-6.

### ⚠ WARNING

**SHOCK HAZARD!** Voltage may be induced in load circuits with Safeguard Breaker open. There is a potential danger of electrocution or shock. Use line circuit breaker or transfer switch to disconnect generator from load.

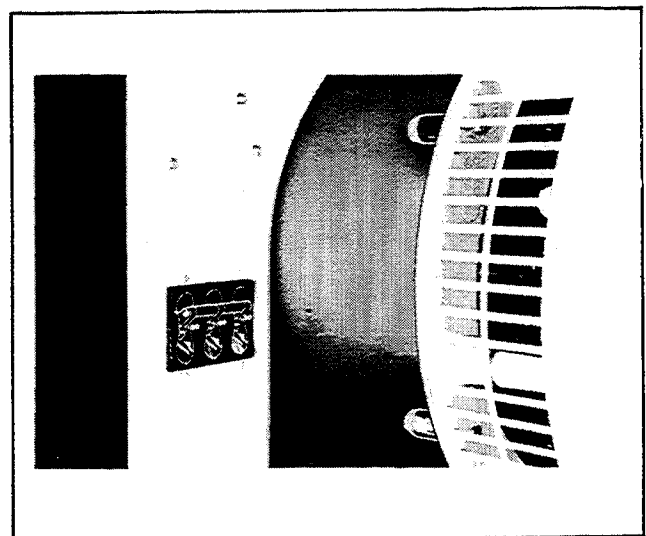


Figure 2-6. Safeguard Breaker

## Line Circuit Breaker (if equipped)

The line circuit breaker interrupts generator output in the event of an overload or short circuit. It should be opened manually to disconnect the generator from load when servicing generator set. See Figure 2-7.

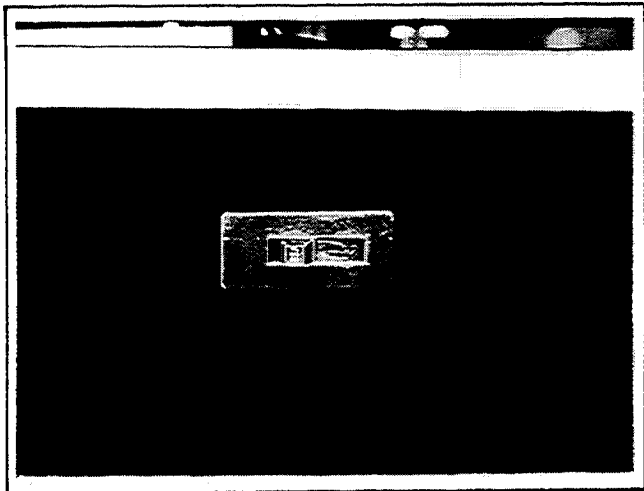


Figure 2-7. Line Circuit Breaker

## Section 3

# CONTROLLER TROUBLESHOOTING

### Relay Controller Sequence of Operation (with or without meters)

The controller is the controlling point for generator set operation. The following sequence of operation should

serve as a good starting point in fault detection. Refer to Figure 3-1 and 3-2, Relay Sequence of Operation when troubleshooting.

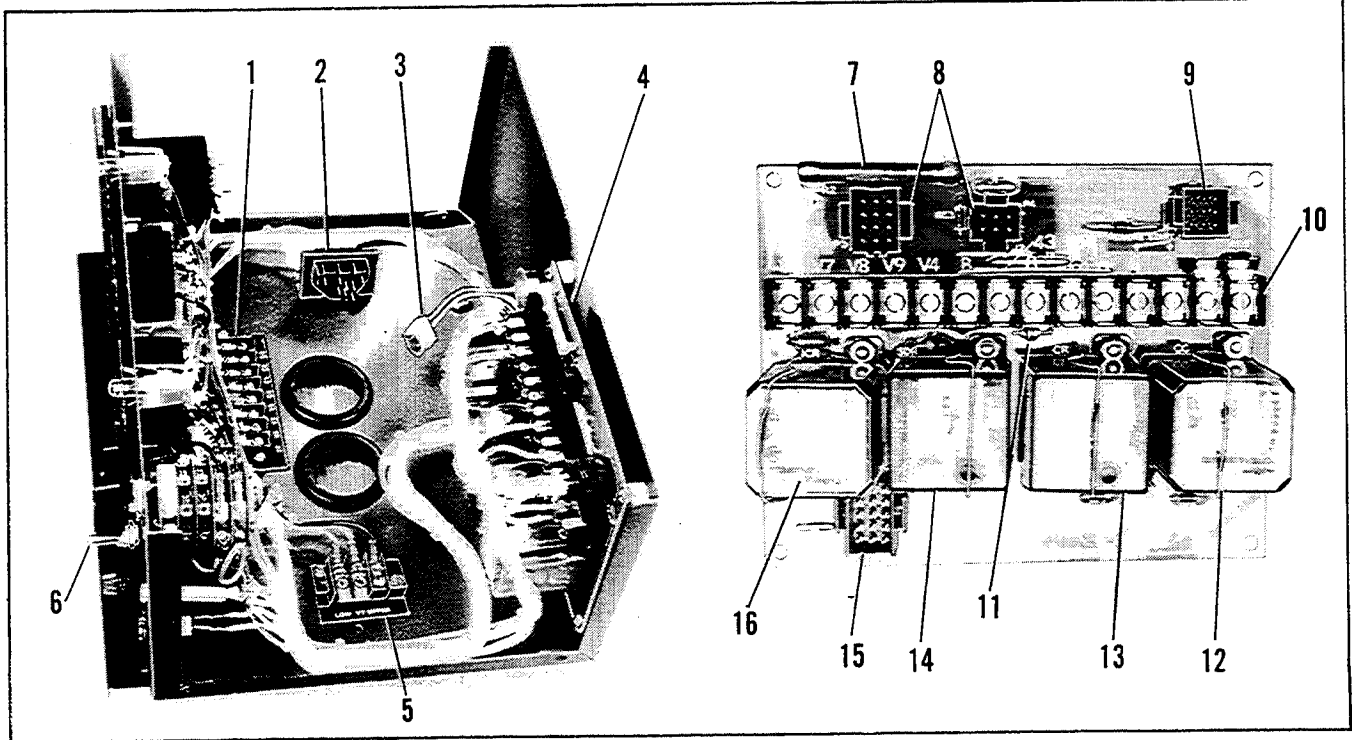


Figure 3-1. Relay Controller Parts

1. Terminal Strip for AC Voltage Sensing and Meters
2. DC Engine Harness Connector (P1-J1)
3. Voltage Adjusting Rheostat Connector
4. Relay Circuit Board
5. Meter Scale Lamp Selection Jumper
6. Reset Switch (1TS)
7. Resistor (R2) for Reset Switch (1TS) Time Limit
8. Connectors (P3, P4) not used
9. Connector (P5), DC to Engine through P1/J1
10. Terminal Strip (see wiring diagram for connections)
11. Diode (RE1), Reverse Battery Polarity Protection
12. CC Relay, DC Cranking Disconnect (6, 12, or 24-Volt)
13. CR Relay, Engine Control
14. SDR Relay, Completes Master Switch Circuit
15. Connector (P6), DC to Controller Panel
16. 1CR Relay, 120-Volt AC Cranking Disconnect

### Cranking

- Move Master Switch to TEST position (or AUTO position if connected to transfer switch for automatic-start up).
- CR Relay energizes. CR contacts close, energizing the SS (starter solenoid) relay and the fuel solenoid or ignition coil (FS).
- Current will flow thru the ITS switch and normally closed 1 CR contacts. The optional engine gauges, voltage regulator, hour meter and battery charging alternator are energized.
- SS Relay contacts close, energizing the starter motor. Starter motor cranks the engine.

### Cranking Disconnect

- As engine starts and generator voltage builds-up, the 1CR Relay will energize.
- The 1CR Relay contacts open, deenergizing the SS Relay.
- SS Relay contacts will open, disconnecting the starter motor (SM).
- The 1CR contacts will open, deenergizing the 1TS and preventing overcrank shutdown.
- CC Relay is energized by battery charging alternator.
- CC contacts open, disconnecting the SS Relay.
- SS contacts open, disconnecting the starter motor (SM).

## Running

The 1CR, CR and CC Relays are energized.

## Stopping

- Move Master Switch to OFF position.
- CR Relay deenergizes. CR Relay contacts open, shutting off the fuel solenoid (FS).
- CC and 1CR relays deenergize.

## Fault Shut-downs

### SAFEGUARD BREAKER (see "Operation")

- If safeguard breaker opens, battery voltage is shut off to the voltage regulator resulting in a loss of generator AC output.
- 1CR Relay deenergizes. 1CR Relay contacts close. 1TS switch will time out, in approximately 30-60 seconds the 1TS will trip causing the CR relay to deenergize. Reset lamp will light.
- CR relay contacts open, shutting off fuel solenoid or ignition coil (FS). Engine stops.

### LOW OIL PRESSURE

- Low oil pressure causes LOP contacts to close.
- 1TS switch will time out, causing the CR relay to deenergize.
- CR relay contacts open, shutting off fuel solenoid or ignition coil (FS).
- Reset lamp lights.

### HIGH WATER TEMPERATURE

- High water temperature causes HWT contacts to close.
- 1TS switch will time out, causing the CR relay to deenergize. Reset lamp will light.
- CR relay contacts open, shutting off fuel solenoid or ignition coil (FS).

### LOW COOLANT LEVEL (if equipped)

- low coolant level causes coolant level switch to close.
- 1TS switch will time out, causing the CR relay to deenergize. Reset lamp will light.
- CR relay contacts open, shutting off fuel solenoid or ignition coil (FS).

### OVERCRANK

- After 30-60 seconds of cranking, the 1CR relay will not energize. Current will still be flowing thru 1TS switch. 1TS will time out causing the CR relay to deenergize. Reset lamp will light.
- CR relay contacts open, shutting off the SS relay, fuel solenoid or ignition coil (FS).

### Fuse

One 15-Amp fuse located in the controller protects against damage in the event of a wiring short circuit or circuit overload. If the fuse "blows" generator set will stop. Unit will not crank with a blown fuse. If set has stopped due to causes other than lack of fuel, or fault shut-down—check the fuse. If blown, replace the fuse and attempt to restart generator set. If the set will not start, or if the fuse blows again, locate and correct the cause.

# Relays

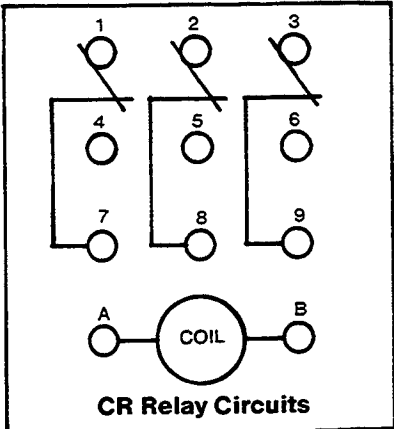
Each relay and the functions it controls is listed below.

1. CR (Control Relay)
  - Initiates cranking
  - Energizes ignition circuit (gas-gasoline)
  - Energizes fuel solenoid (diesel)
  - Energizes 1TS circuit
  - Energizes hourmeter
  - Energizes anti-diesel solenoid (Gasoline only)
  - Energizes water valve (city-water cooled only)
  - Energizes choke (Gasoline only)
  - Energizes gas valve (gas) or fuel pump (gasoline)
2. SS (Starter Solenoid)
  - Energizes starter
3. CC (Cranking Cutout)
  - Deenergizes SS relay
4. 1CR (Control Relay 1)
  - Deenergizes SS relay
  - Deenergizes overcrank
5. • SDR

**NOTE**

In this application, SDR does not energize. It does complete the start switch circuit. Set will not run with SDR removed.

**Troubleshooting**

| Problem   | Possible Cause  | Corrective Action (Refer to Figure 3-2)   | Figure Reference Letter                                |
|---|---|---|--|
| <p><b>Unit Will Not Crank (Controller Switch In TEST Position)</b></p>  | <ul style="list-style-type: none"> <li>•Reversed or Poor battery connections</li> <li>•Weak or Dead Battery</li> <li>•Controller Fuse Blown</li> <li>•Shut-down Due to Fault Protection (open 1TS contacts)</li> </ul>  | <ul style="list-style-type: none"> <li>•Units require a negative ground connection. Battery cable connections must be clean and tight.</li> <li>•Minimum voltage at battery must be 10 volts with controller switch in "TEST" position.</li> <li>•See "Fuse" preceding.</li> <li>•Press reset switch. Low engine oil pressure, high water temperature, low coolant level, engine overcranking or no AC generator output will cause 1TS to trip</li> </ul>         | <p>(A)</p> <p>(A)</p> <p>(B)</p> <p>(C)</p>            |
| <p><b>Will Not Crank (No Voltage to CR coil)</b></p>  <p>The diagram shows three switch assemblies. Each assembly has a top switch (1, 2, 3) and a bottom switch (4, 5, 6) connected to a common terminal (7, 8, 9). These common terminals are connected to a COIL between terminals A and B.</p> <p><b>CR Relay Circuits</b></p> | <ul style="list-style-type: none"> <li>•Open SDR or 1TS Contacts in series with Off/Auto/Test Switch</li> <li>•Open foil pattern on relay circuit board. Open RE1 diode on relay circuit board</li> <li>•Poor pin connection in P6 connector</li> <li>•Faulty CR relay</li> </ul> | <ul style="list-style-type: none"> <li>•Check for battery voltage to lead 44 on master switch. SDR relay must make good contact in socket.</li> <li>•Visually inspect, make continuity check, check diode with ohmmeter</li> <li>•Visually inspect pin 8, 1, 2 and 13. Make continuity check.</li> <li>•12-Volt Coil resistance is approximately 125 Ohms. Measure between terminals A and B. Normally closed contacts (continuity) are 1-7, 2-8, 3-9.</li> </ul> | <p>(D)</p> <p>(F)</p> <p>(G)</p> <p>(E)</p> <p>(H)</p> |

## Troubleshooting

| Problem  | Possible Cause   | Corrective Action<br>(Refer to Figure 3-2)   | Figure Reference Letter |
|--|--|--|-------------------------|
| <b>Will Not Crank<br/>(CR relay energizes)</b>                 | <ul style="list-style-type: none"> <li>•Low battery. Battery cables or connections in poor condition.</li> </ul>                             | <ul style="list-style-type: none"> <li>•Voltage at battery terminals must be at least 10 volts, recharge if necessary. Clean and tighten battery cable connections.</li> </ul>   | (A)                     |
|  | <ul style="list-style-type: none"> <li>•No voltage at SS solenoid coil.</li> </ul>   | <ul style="list-style-type: none"> <li>•Open CR, 1CR or CC contacts in series with SS solenoid. Open in P5 connector (pin 4) Open in P1 connector (pin 16).</li> </ul>   | (I)<br>(J)<br>(K)       |
|  | <ul style="list-style-type: none"> <li>•Faulty SS solenoid-open coil.</li> </ul>   | <ul style="list-style-type: none"> <li>•Check continuity of coil out-of-circuit</li> </ul>   | (I)                     |
| <b>Will Not Crank<br/>(CR relay and SS solenoid energizes)</b> | <ul style="list-style-type: none"> <li>•No Voltage at Starter Motor</li> </ul>   | <ul style="list-style-type: none"> <li>•High resistance or faulty SS contacts.</li> </ul>  | (L)                     |
|  | <ul style="list-style-type: none"> <li>•Loose or corroded starter lead connections</li> </ul>  | <ul style="list-style-type: none"> <li>•Clean and tighten</li> </ul>   | (A) (M)                 |
|  | <ul style="list-style-type: none"> <li>•Faulty starter motor.</li> </ul>   | <ul style="list-style-type: none"> <li>•Repair or replace.</li> </ul>  |                         |
| <b>Unit Cranks but Will Not Start</b>                          | <ul style="list-style-type: none"> <li>•No fuel.</li> </ul>  | <ul style="list-style-type: none"> <li>•Check for fuel at pump or carburetor. Check for clogged fuel filter. Check engine fuel system.</li> </ul>  |                         |
|  | <ul style="list-style-type: none"> <li>•Ignition System</li> </ul>   | <ul style="list-style-type: none"> <li>•Check for battery voltage at ignition coil. Check ignition points. Check engine ignition system.</li> </ul>  | (N)                     |
|  | <ul style="list-style-type: none"> <li>•Open in Wiring Harness</li> </ul>  | <ul style="list-style-type: none"> <li>•While cranking, check for battery voltage (terminal 70) at ignition coil (gas/gasoline) or fuel solenoid (diesel) P1 connector, pin 20 must be battery (+) voltage to connector P5, pin 8, P1 connector, pin 20, to fuel solenoid or ignition coil.</li> </ul> | (N)                     |
| <b>Unit Runs For 30-60 Seconds then Shuts-Down.</b>            | <ul style="list-style-type: none"> <li>•No AC output available to 1CR relay coil. Safeguard breaker (if equipped) must be closed.</li> </ul> | <ul style="list-style-type: none"> <li>•Check for 120 volts AC to controller terminal strip V0 and V7. See Generator troubleshooting (No Output). If 1CR relay does not energize, normally closed contacts of relay will energize 1TS thermal switch and shut down unit.</li> </ul>                    | (O)                     |

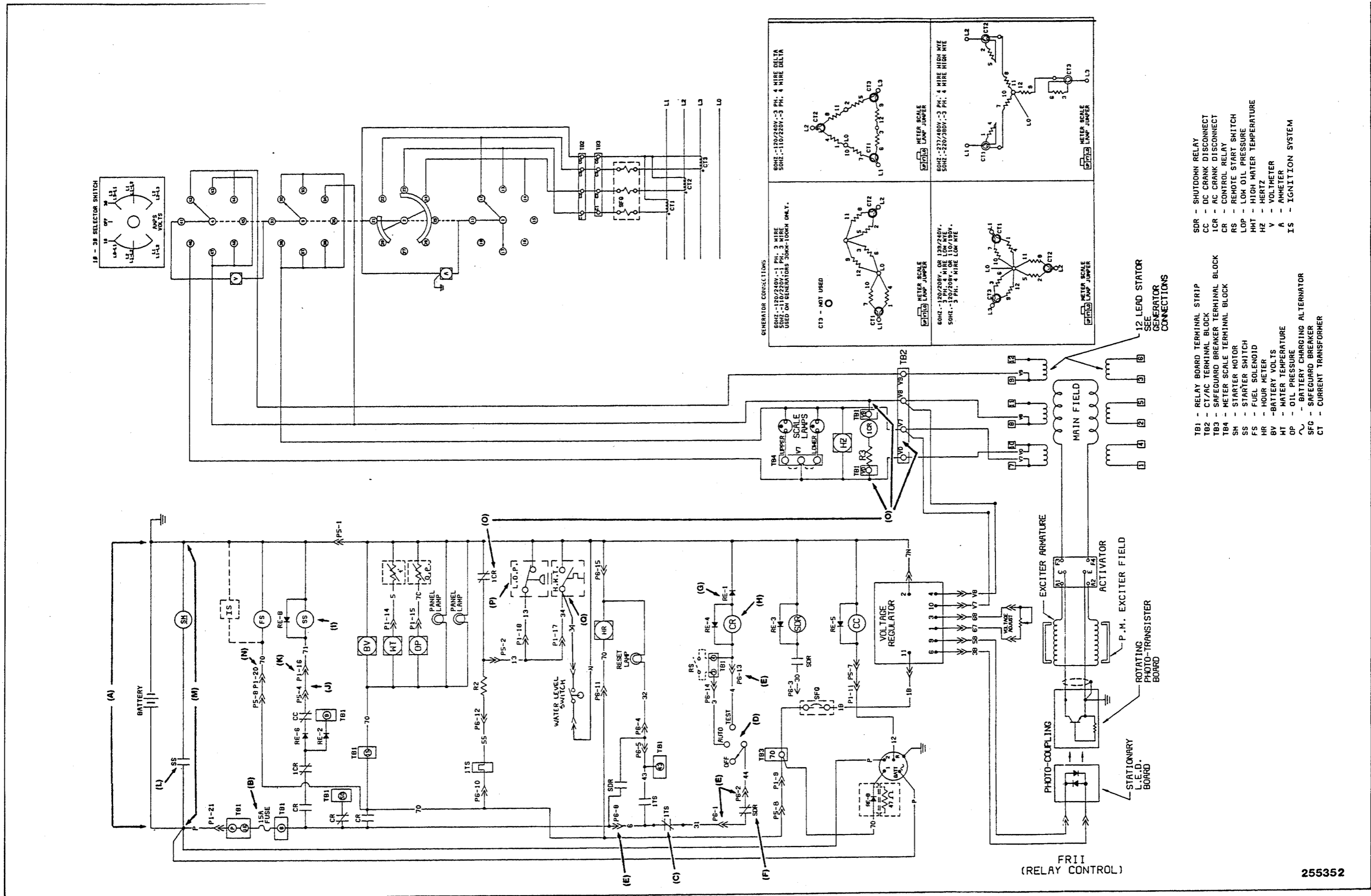


Figure 3-2. Relay Controller Sequence of Operation

**Troubleshooting**

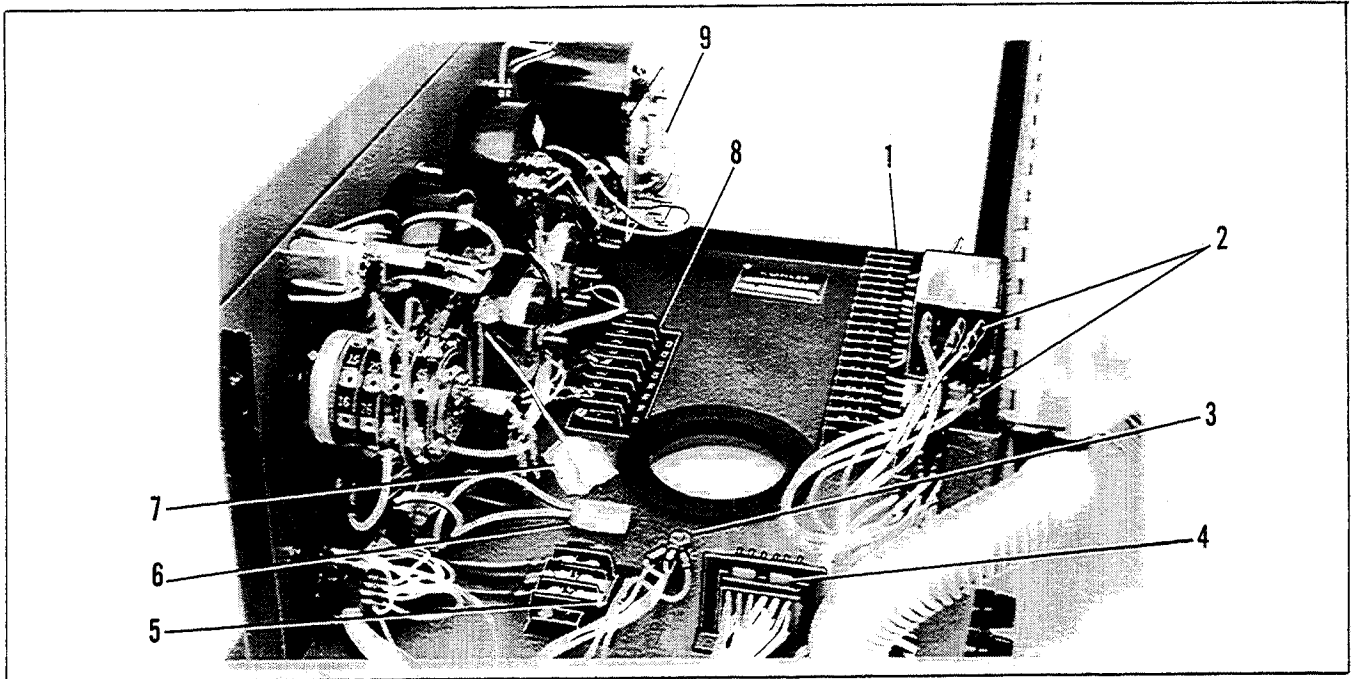
| Problem  | Possible Cause   | Corrective Action<br>(Refer to Figure 3-2)   | Figure Reference Letter |
|--|--|--|-------------------------|
| <p><b>Unit Runs For 30-60 Seconds then Shuts-Down.</b></p> | <ul style="list-style-type: none"> <li>•No or Low Engine Oil Pressure</li> </ul>   | <ul style="list-style-type: none"> <li>•Engine oil pressure must be available to open L.O.P. switch (Closed switch contacts will energize 1TS and shut-down unit). Correct engine oil pressure problem.</li> </ul> | <p><b>(P)</b></p>       |
|  | <ul style="list-style-type: none"> <li>•High Engine Coolant Temperature</li> </ul> | <ul style="list-style-type: none"> <li>•Excessive coolant temperature will activate H.W.T. switch. Check coolant level. Check ignition timing. Check for cooling restrictions and radiator cooling air.</li> </ul> | <p><b>(Q)</b></p>       |

# Microcomputer Controller

## Description

For external features, see Section 2 – “Operation, Microcomputer Controller”. Figures 3-3 to 3-5 show locations of controller components and connections. Figure 3-5A is a

logic schematic showing input/output circuits for troubleshooting reference.



**Figure 3-3. Microcomputer Controller, Lower Cabinet**

1. Terminal strip for Remote Start Switch (terminals 3 and 4) and Remote Annunciator.
2. Control Relays (CR, 1CR).
3. Controller DC Ground Terminal (N).
4. DC Harness Connector (P1).
5. Meter Scale Lamp Selection Jumper.
6. Voltage Adjustment Rheostat Connector.
7. Overvoltage Module Connector (wire 30).
8. Terminal Strip for AC Meter and Voltage Regulator Sensing Connection.
9. AC Interlock Circuit Board (for cranking disconnect after engine starts).



# Microcomputer Controller - cont'd.

## P4 CONNECTOR PINS

4. Ground (-), wire 2
5. Not used
6. Input from emergency stop/overvoltage, wire 30
7. Input from lamp test switch, wire 43
8. Output to high water temperature lamp, wire 36
9. Output to low oil pressure lamp, wire 38
10. Output to emergency stop lamp, wire 48
11. Output to overcrank lamp, wire 12
12. Output to overspeed lamp, wire 39
13. Output to alarm horn, wire 32
14. Output to low battery volt lamp, wire 62
15. Output to system ready lamp, wire 60
16. Output to switch off lamp, wire 80
17. Output to anticipatory low oil pressure lamp, wire 41
18. Output to high battery volt lamp, wire 61
19. Output to anticipatory high water temperature, wire 40
20. Output to low fuel lamp, wire 63
21. Output to low water temperature lamp, wire 35

## P5 CONNECTOR PINS

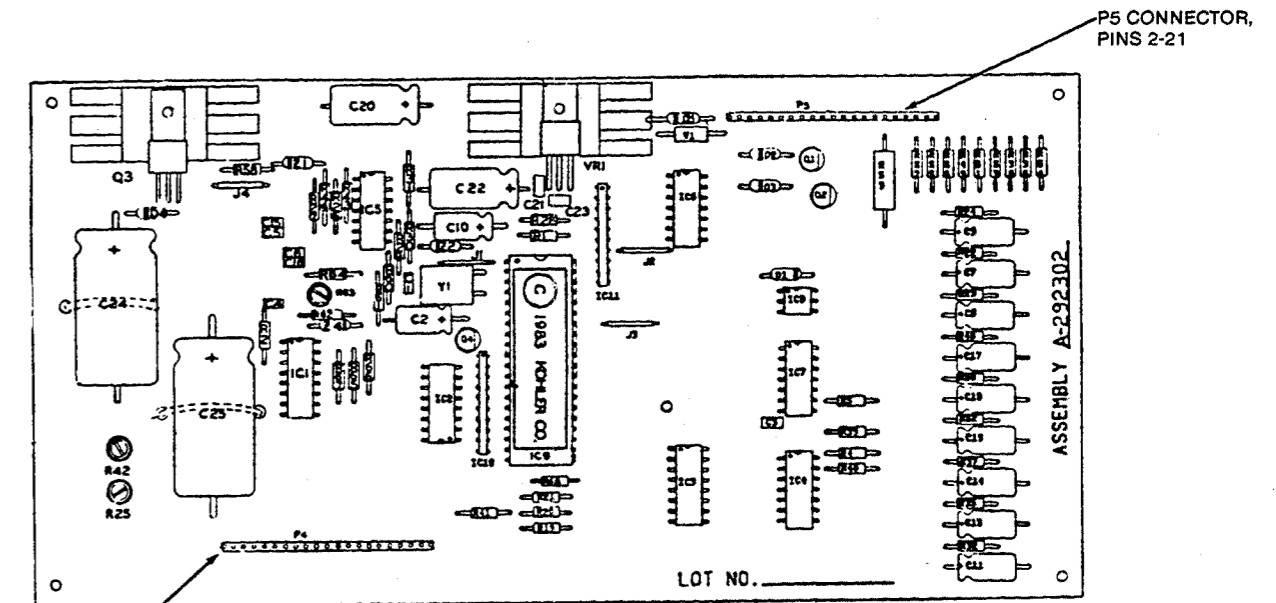
2. Input from battery (+), wire LC
3. Ground (-), wire N
4. Ground (-), wire 2 for speed sensor
5. Output to speed sensor, wire 24
6. Input from AC interlock board, wire 77
7. Input from AC interlock board, wire 78
8. Input from speed sensor, wire 16
9. Output to CR relay coil, wire 7 (-)
10. Output to 1CR relay coil, wire 8 (-)
11. Input from transfer switch, wire 4 from remote start terminal.
12. Input from master switch AUTO position, wire 46
13. Input from master switch, TEST position, wire 47
14. Input from anticipatory high water temperature switch, wire 40A
15. Input from low fuel switch, wire 65
16. Input from low water temperature switch, wire 35A
17. Input from low oil pressure switch, wire 13
18. Input from anticipatory low oil pressure switch, wire 41A
19. Input from high water temperature switch and low coolant level switch (if equipped), wire 34
20. Ground (-), wire S2 for speed sensor
21. Ground (-), wire 3 (not used)

## P6 CONNECTOR PINS

2. Ground (-), wire 2
3. Output to emergency stop, wire 30
4. Input to high water temperature lamp, wire 36
5. Input to low oil pressure lamp, wire 38
6. Input to emergency stop lamp, wire 48
7. Input to overcrank lamp, wire 12
8. Input to overspeed lamp, wire 39
9. Input to alarm horn, wire 32
10. Input to low battery volt lamp, wire 62
11. Input to system ready lamp, wire 60
12. Input to switch off lamp, wire 80
13. Input to anticipatory low oil pressure lamp, wire 41
14. Input to high battery volt lamp, wire 61
15. Input to anticipatory high water temperature lamp, wire 40
16. Input to low fuel lamp, wire 63
17. Input to low water temperature lamp, wire 35

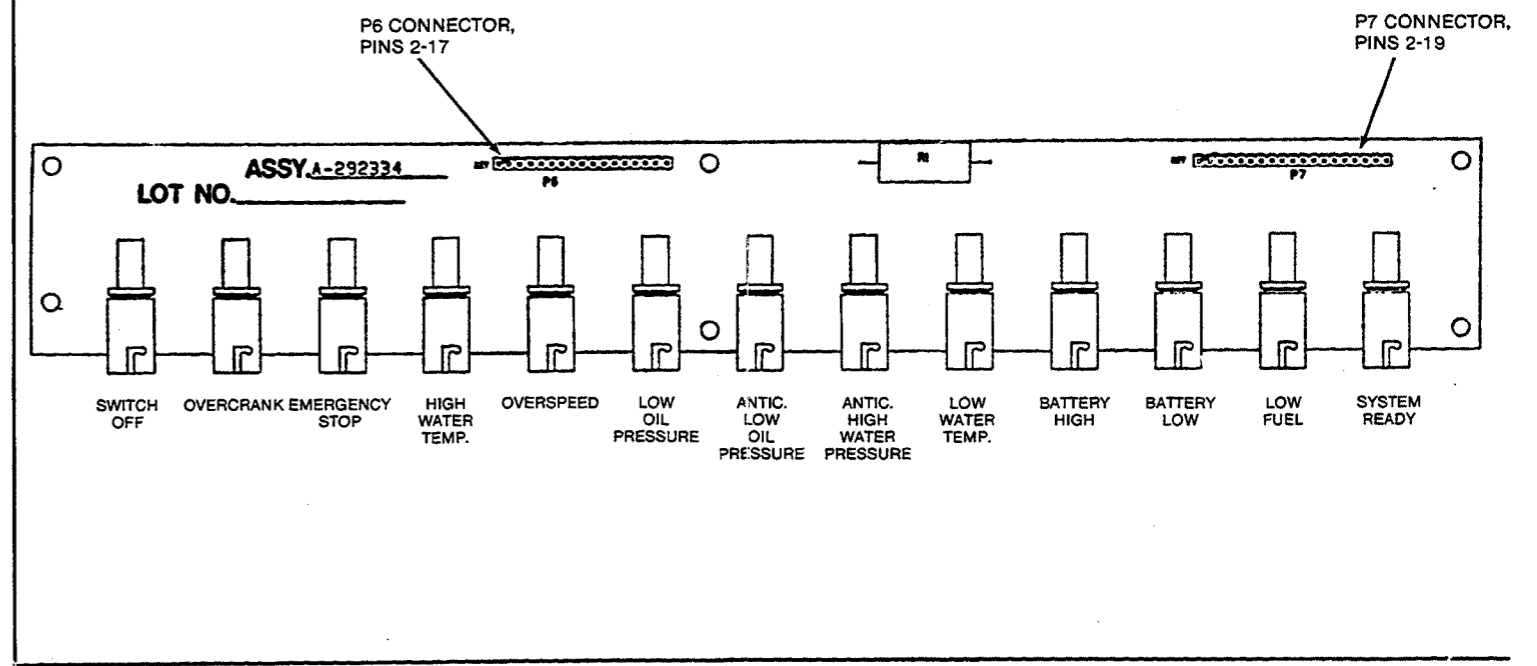
## P7 CONNECTOR PINS

2. Battery (+) supply to annunciator strip terminal 54, lamp test
3. Output to annunciator strip terminal 2, ground (N)
4. Output to annunciator strip terminal 80, switch off
5. Output to annunciator strip terminal 12, overcrank
6. Output to annunciator strip terminal 48, emergency stop
7. Output to annunciator strip terminal 36, high water temperature
8. Output to annunciator strip terminal 39, overspeed
9. Output to annunciator strip terminal 38, low oil pressure
10. Output to annunciator strip terminal 41, antic. low oil pressure
11. Output to annunciator strip terminal 40, antic. high water temperature
12. Output to annunciator strip terminal 35, low water temperature
13. Output to annunciator strip terminal 61, high battery volts
14. Output to annunciator strip terminal 62, low battery volts
15. Output to annunciator strip terminal 63, low fuel
16. Battery (+) from 4-Amp fuse, wire LC
17. Output to annunciator strip terminal 60, system ready
18. Output to annunciator strip terminal 32, annunciator alarm horn (-)
19. Input from emergency stop/over voltage, wire 30



P4 CONNECTOR, PINS 4-21

P5 CONNECTOR, PINS 2-21



P6 CONNECTOR, PINS 2-17

P7 CONNECTOR, PINS 2-19

Figure 3-5. Microcomputer and Lamp Board Input/Output Circuits and Connections

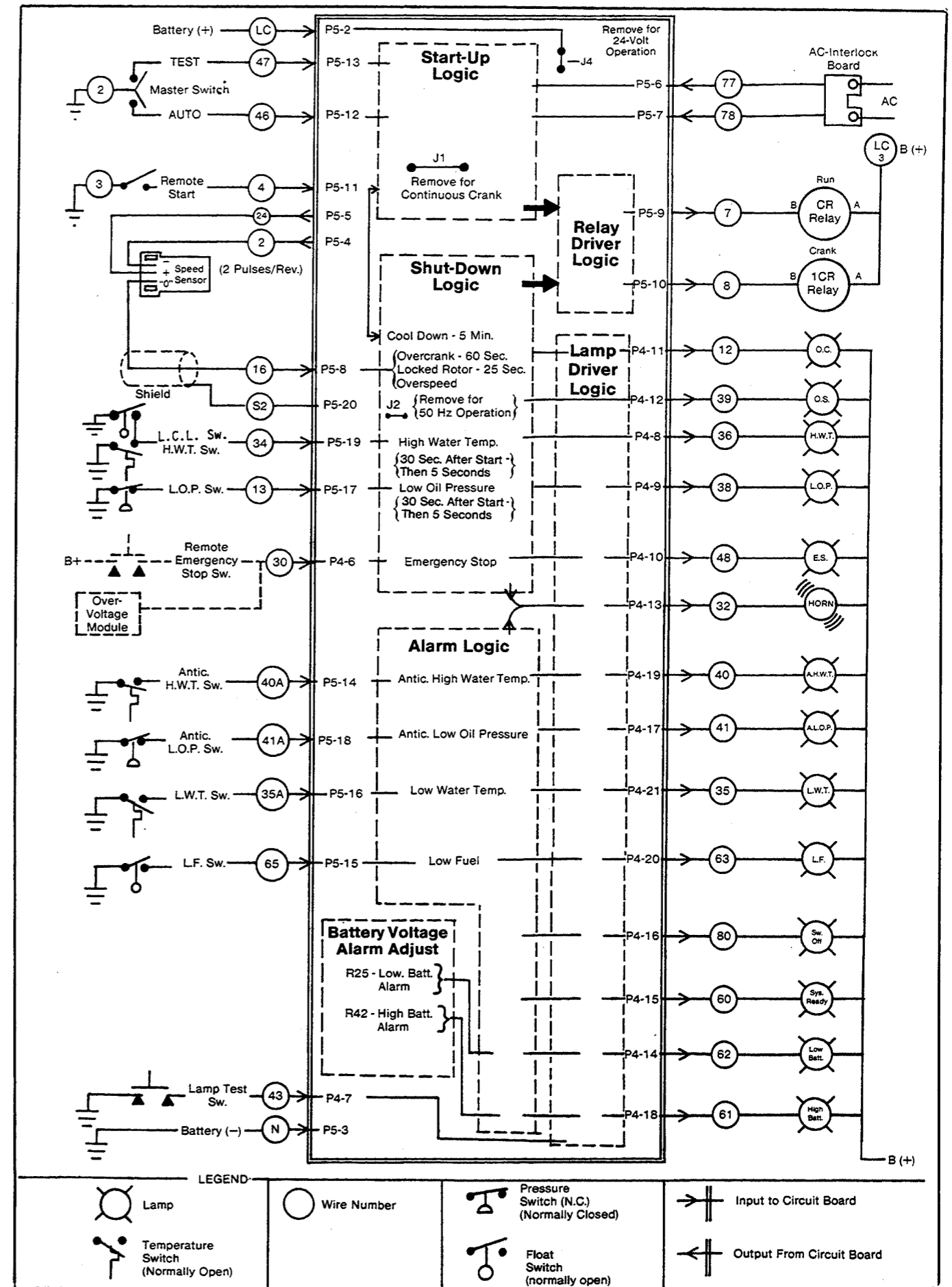


Figure 3-5A. Logic Schematic, Microcomputer Circuit Board

**NOTE**

**Negative Ground Control System!** if battery connections are reversed, 1-Amp fuse will blow, making generator set inoperable.

**Troubleshooting**

| Problem  | Possible Cause   | Corrective Action   |
|--|--|---|
| <p><b>Engine will not crank with master switch in TEST position (CR and 1CR relays not energizing)</b></p> | <ul style="list-style-type: none"> <li>● Battery weak or dead</li> <li>● Reversed or loose battery connections</li> <li>● 1-Amp controller fuse blown</li> <li>● Open circuit (P) in DC harness connector (P1, pin 21), battery voltage input to controller.</li> <li>● Defective master switch or wiring</li> <li>● Loose DC harness connector (P1) or loose circuit board connectors (P4, P5, P6, P7)</li> <li>● Defective CR or 1CR relays</li> </ul> | <ul style="list-style-type: none"> <li>● Recharge or replace battery. Check battery charger.</li> <li>● Check battery for proper connection (negative ground), clean and tighten connections.</li> <li>● Replace fuse. With master switch in TEST position, check for battery voltage at "A" terminals of master switch, and "A" (coil) terminals of CR and 1CR relays.</li> <li>● Check connection. See "Notes" following.</li> <li>● Check for battery voltage at switch terminals "A" with switch in TEST or AUTO positions – check for battery voltage at coil terminal "A" of 1CR relay. Check for ground continuity from connector P5, pin 13 (wire 47) with master switch in TEST position. Wire 2 from master switch completes ground circuit.</li> <li>● Check connections. Set will not crank or run if any connector is loose or disconnected.</li> <li>● Check relay connections and operation. Replace if required.</li> </ul> |

**CAUTION**

Use care when contacting connector pins with meter probe! Contact only one pin at a time. Short circuiting pins may cause circuit board failure.

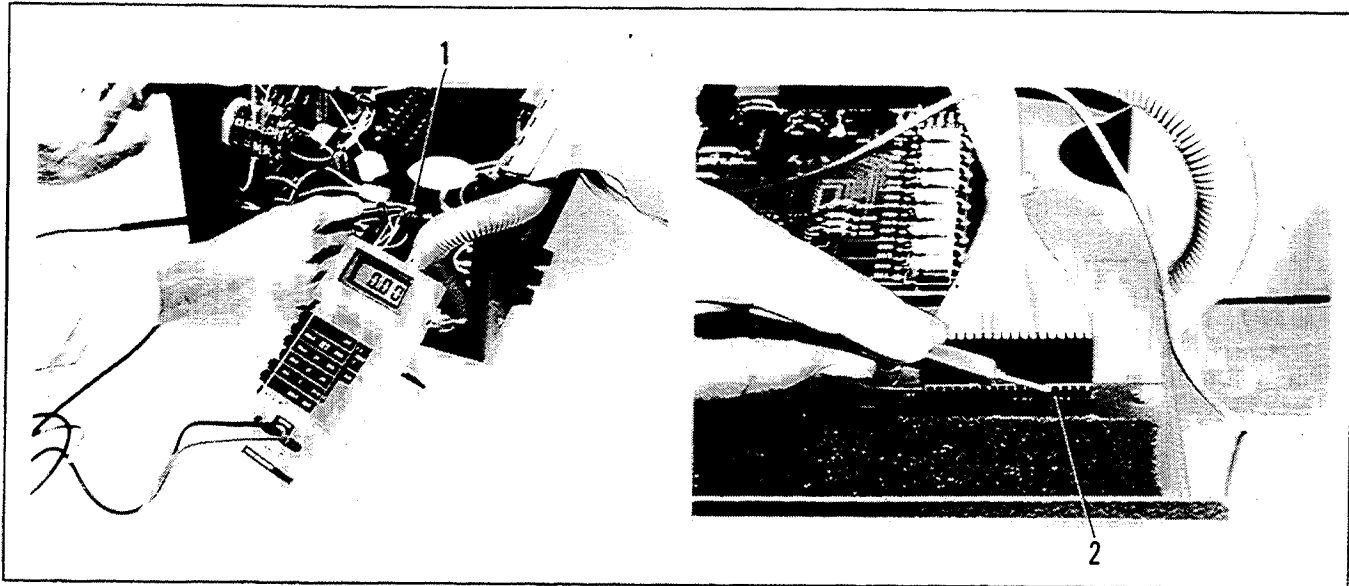
# Microcomputer Controller – cont'd.

**NOTE**

Battery voltage must show at connector P7, pin 16, P5, pin 2, and P4, pin 2 in order for controller to function. Check voltage from each pin to ground (Figure 3-6).

**NOTE**

Circuit board must supply a negative (ground) potential to P5 connector, pin 10 to energize 1CR (cranking) relay. Measure with DC voltmeter from battery positive (+) to P5, pin 10 with master switch in TEST position.



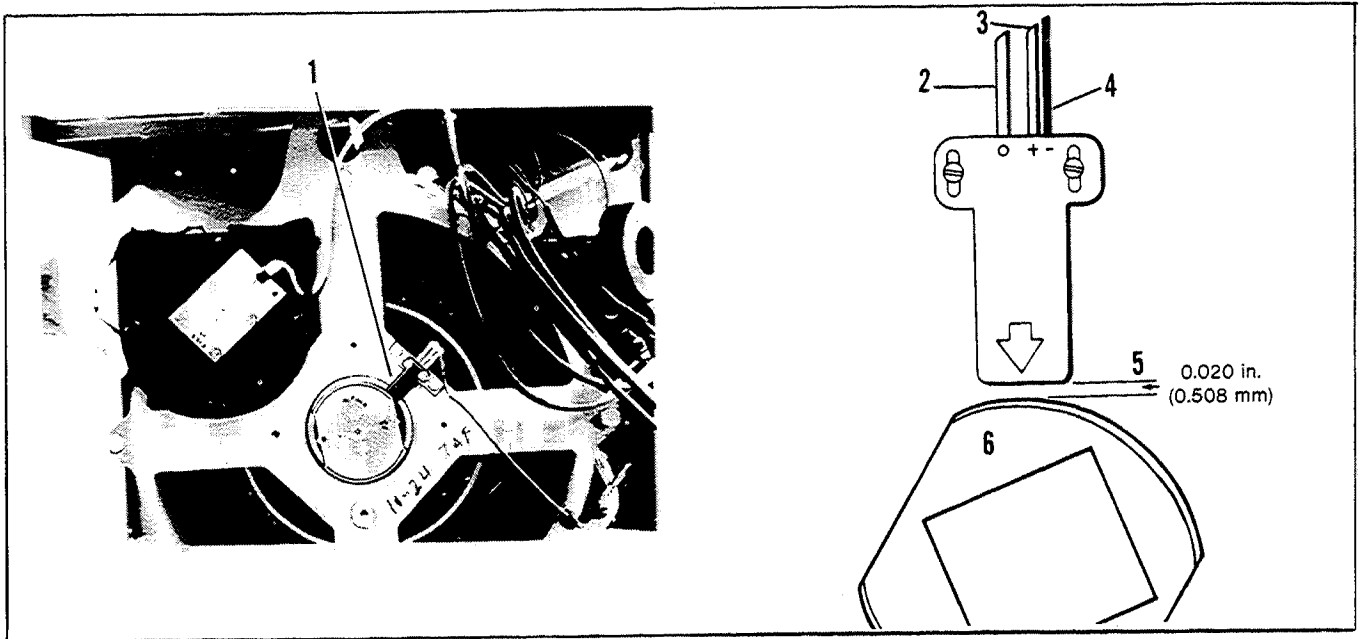
**Figure 3-6. Voltage or Continuity Check at Connector Pin.**

1. Meter ground connection      2. Meter probe contact at connector pin

**NOTE**

Be sure you have checked all wiring and connections thoroughly, before replacing microcomputer circuit board.

| Problem   | Possible Cause  | Corrective Action  |
|---|---|--|
| <p><b>Engine cranks but will not start</b></p>                                  | <ul style="list-style-type: none"> <li>● Low Fuel</li> <li>● CR relay not energizing.</li> <li>● No battery voltage to ignition coil (gas/gasoline) or injector pump (diesel).</li> </ul> | <ul style="list-style-type: none"> <li>● Check fuel supply, replenish as necessary.</li> <li>● Check for proper ground through P5 connector, pin 9 at microcomputer circuit board.</li> <li>● Check for open circuit in P1 connector (pin 9, wire 70).</li> </ul>  |
| <p><b>Engine starts and runs, but stops after approximately 25 seconds.</b></p> | <ul style="list-style-type: none"> <li>● Excessive speed sensor air gap.</li> <li>● Open speed sensor circuit.</li> <li>● Defective speed sensor</li> </ul>                               | <ul style="list-style-type: none"> <li>● Adjust to 0.020 in. (0.508 mm). See Figure 3-7.</li> <li>● – Check continuity, wire 2 (black) through P1 connector, to P5 connector pin 4.</li> <li>– Check continuity, wire 16 (white) through P1 connector, to P5 connector pin 8.</li> <li>– Check continuity, wire 24 (red) through P1 connector, to P5 connector pin 5.</li> <li>● See “Speed Sensor Test” following.</li> </ul> |



**Figure 3-7. Speed Sensor Air Gap**

1. Speed Sensor
2. Wire 16 - White/Clear
3. Wire 24 - Red
4. Wire 2 - Black
5. Air Gap - 0.020 in. (0.508 mm)
6. Actuator Cup

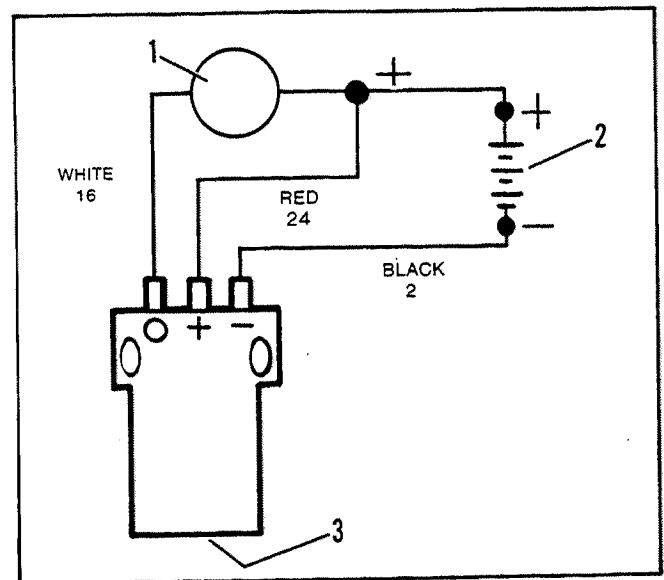
## Speed Sensor Test

To determine if the signal from the speed sensor is being received at the controller follow the procedure outlined below:

1. Connect DC voltmeter between P5 connector, pin 5 on circuit board, and ground - voltmeter should read battery voltage on 12-volt systems, or 16-volts on 24-volt systems.
2. With generator set running, connect DC voltmeter between P5 connector, pin 8 on the circuit board, and ground - voltmeter reading should equal voltage read in Step 1 minus approximately 2-Volts.

If the speed sensor signal is not being received at the generator set controller, test speed sensor:

1. Connect speed sensor, voltmeter and DC voltage source as shown in Figure 3-8.
2. Touch sensing surface with a flat piece of iron or steel - at least 1/4 cubic inch (4.1 cm<sup>3</sup>).
3. Test voltmeter reading should equal voltage source volts.
4. Remove iron or steel from sensing surface and observe NO test voltmeter reading.



1. DC Voltmeter
2. 12-Volt DC Power Supply
3. Sensing Surface

**Figure 3-8. Speed Sensor Test**

## Microcomputer Controller – cont'd.

### Fast Check Features and Operation

The Fast Check is an engine simulator for testing and troubleshooting the Microcomputer Controller.

#### Operation

The Fast Check can be used to test the Microcomputer Controller on the generator set when troubleshooting start-up problems, or to test, troubleshoot, and adjust the controller when removed from the generator set.

To operate the Fast Check, the following equipment is required:

- Fast Check and harness (A-291930 and 269955)
- Variable low-voltage DC power supply; 0 to 30 volt, 3 amp minimum current, 0.5% maximum output voltage ripple at 30 volts DC. A 12- or 24-volt battery (depending on system voltage) can also be used to operate Fast Check.

#### Features (Figure 3-9)

Engine conditions are simulated by the following engine switch positions:

- **OFF** – locked engine (starter energized but not turning).
- **CRANK** – engine cranking, but not started
- **RUN** – engine running

Indicator Lamps:

- **IGN.** – (ignition) lamp shows:
  - battery voltage supplied to ignition, fuel valves, water valve (city water cooled sets)
  - lights during cranking and running
- **CRK** – (crank) lamp shows:
  - battery voltage switched to starter (engine not necessarily turning)
  - lights only during “on-crank” cycles
- **REG.** – (regulator) lamp shows:
  - battery voltage supplied to generator’s AC voltage regulator
  - lights during cranking and running
- **A.D.** – (anti-diesel, fuel shut-off solenoid) lamp:
  - lights during normal or fault shut-down or any non-run condition
- **ALARM** – alarm lamp:
  - lights when engine fault is simulated by one of three upper toggle switches or OVERSPEED button
- **BATT.** – (battery) lamp:
  - lights when test battery(ies) or DC power supply is live and properly connected

#### NOTE

L.O.P., H.W.T. and OVERSPEED simulate malfunctions causing engine shut-down. L.O.P. and H.W.T. circuits will start timing after “engine has been running” for 30 seconds. “Engine shut-down” should occur 5 seconds after pushing switch.

Switches:

- **L.O.P.** – low oil pressure
- **H.W.T.** – high water temperature
- **OVERSPEED** – simulates a 70 Hz overspeed condition
- **L.F.** – low fuel
- **L.W.T.** – low engine water temperature
- **A.O.P.** – anticipatory (low) oil pressure
- **A.W.T.** – anticipatory (high) water temperature.

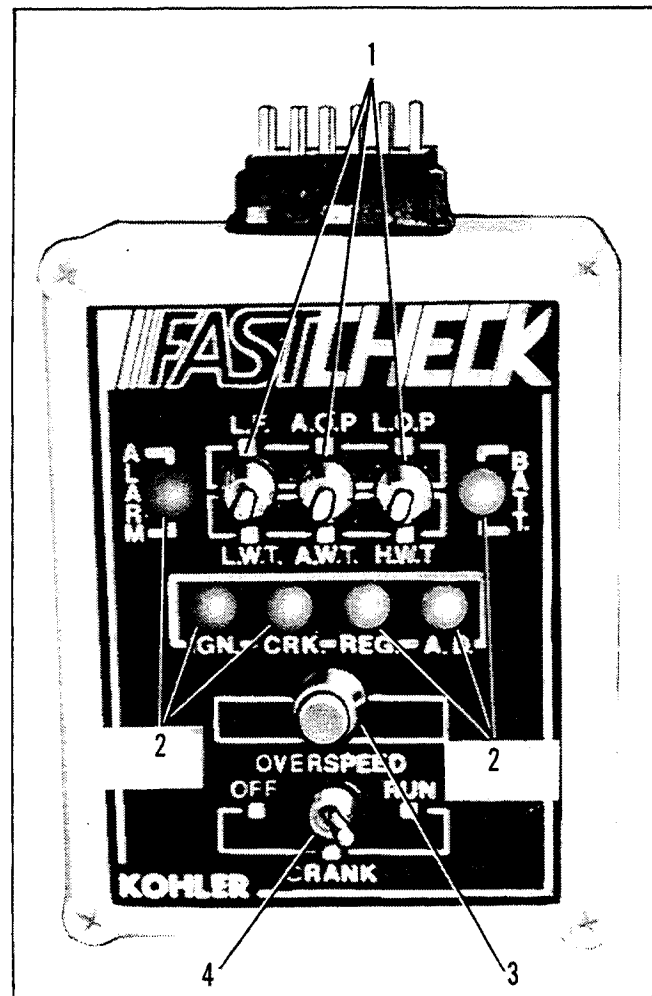


Figure 3-9. Fast Check

1. Toggle Switches
2. Indicator Lamps
3. Overspeed Button
4. Engine Switch

To connect the Fast Check:

1. Unplug DC engine harness from DC harness connector (P1) (Figure 3-10).
2. Plug Fast Check harness onto DC harness connector and top of Fast Check (Figure 3-9).
3. Move Microcomputer Controller Master Switch to OFF position.
4. Move Fast Check engine switch to OFF.
5. Clip red (+) and black (-) harness leads to battery(ies) or DC power supply of proper voltage for generator set (12 or 24 volt). See BATT rating on nameplate. Generator set's battery(ies) may be used if accessible and fully charged.

### Cyclic Cranking

1. CR relay test: with Generator Master Switch in "TEST" position; tester, in CRANK position, CR and 1CR relays should energize. 1 CR should cycle every 10 seconds.
  - A. With a voltmeter, check for a reading of 0.5 to 1.0 volts from connector P5, pin 9 to ground, as shown in Figure 3-11.
  - B. If reading is correct, but CR relay doesn't energize, proceed to step D.
  - C. If reading does not fall within the range required, check for a voltmeter reading of 0 volts from connector, P5, pin 13 to ground.
  - D. Disconnect the CR relay coil. Check relay with an external power supply (battery) for proper relay operation.
  - E. Replace relay if necessary. If relay is operating properly, check wiring to CR relay coil.

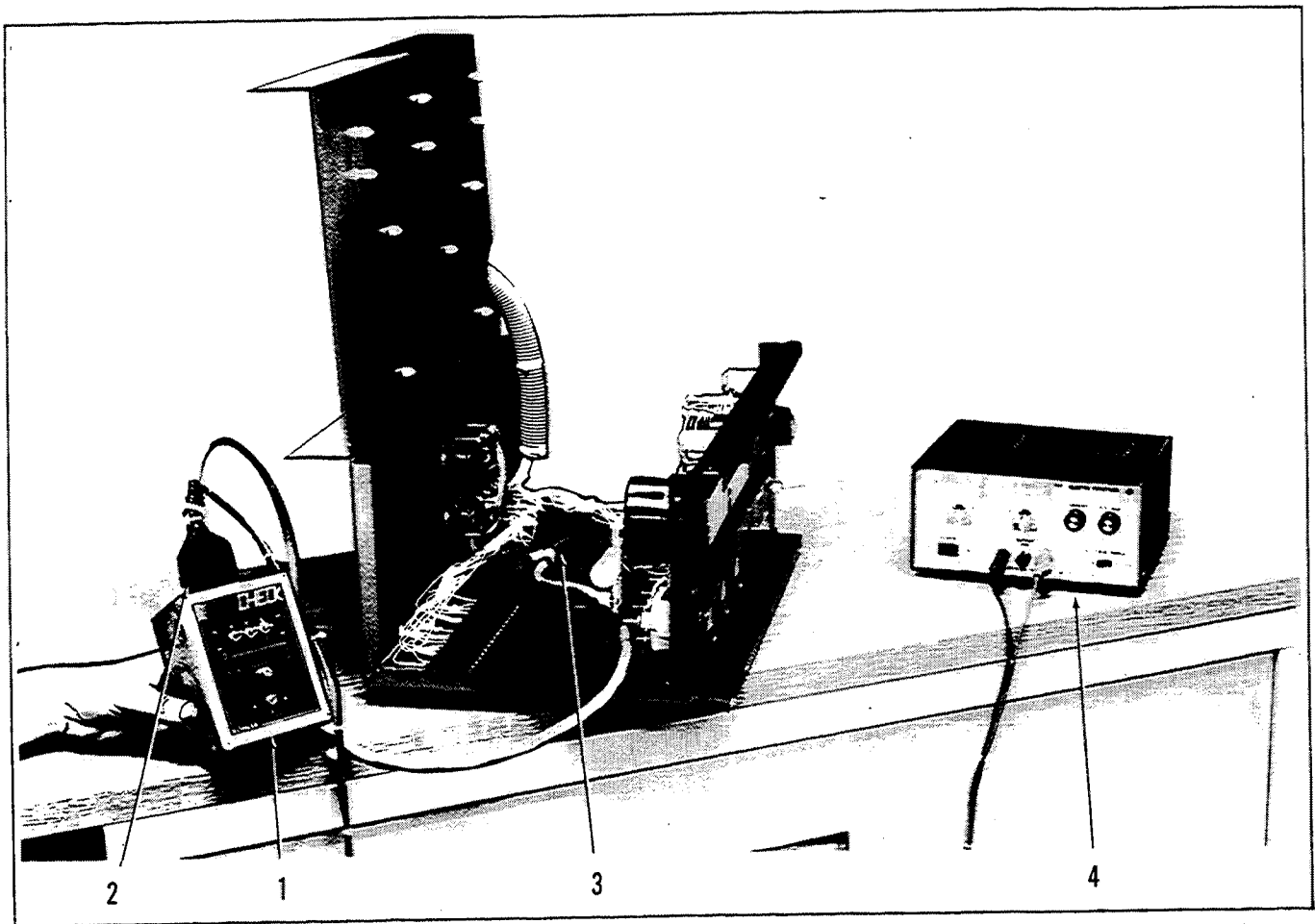


Figure 3-10. Fast Check Connections

- |                              |                              |
|------------------------------|------------------------------|
| 1. Fast Check                | 3. DC Harness Connector (P1) |
| 2. Fast Check Wiring Harness | 4. DC Power Supply           |

## Microcomputer Controller – cont'd.

2. 1CR relay test: with Generator Master Switch in "TEST" position. If 1CR doesn't energize:
  - A. With a voltmeter, check for a reading of 0.5 to 1.0 volts from connector P5, pin 10 to ground during on-crank cycle; battery voltage during off-crank cycle.
  - B. Check for a voltmeter reading of 0 volts from connector P5, pin 13 to ground.
  - C. Disconnect the 1CR relay coil. Check relay with an external power supply (battery) for proper relay operation.
  - D. Replace relay if necessary. If relay is operating properly, check wiring to 1CR relay coil.

### Overcrank

To check the controller's ability to:

- Detect a locked engine.
  - Stop a start-up attempt if starter should lock, or starter will not engage.
1. Make sure Fast Check engine switch is OFF.
  2. Move Generator Master Switch to TEST position.
  3. IGN., CRK., and REG., lamps of Fast Check should light (CRK. lamp should light for around 10 seconds).
  4. CRK. lamp should go out (for approximately 10 seconds), then light again for a second cranking cycle. After five seconds into the second cranking cycle, IGN., CRK. and REG. lamps on Fast Check should go out (after approximately 25 seconds of cyclic cranking). OVERCRANK lamp on controller, plus alarm lamps on Fast Check should light. If not:

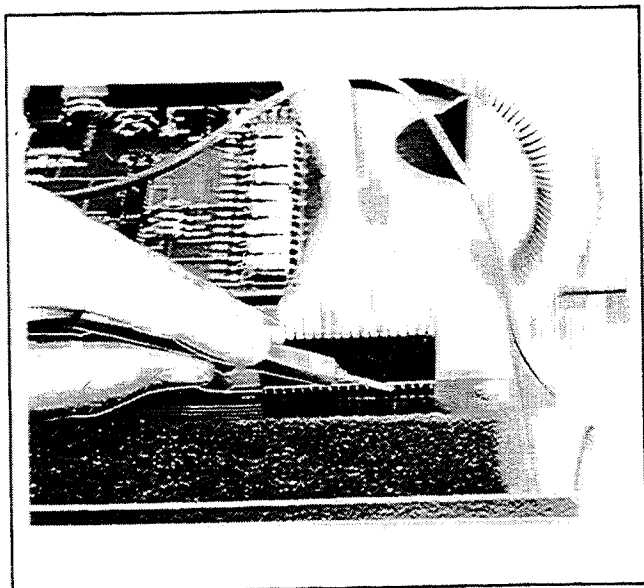


Figure 3-11. Voltage Check at Connector Pin

- A. With an ohmmeter, check the speed sensor circuits for continuity: (See Figure 3-12):

1. Connector P5, pin 4 to DC harness connector, (P1) pin 2.
  2. Connector P5, pin 8 to DC harness connector, (P1) pin 24.
  3. Connector P5, pin 5 to DC harness connector, (P1) pin 6.
- B. Replace main circuit board if you read continuity at all points in step A.

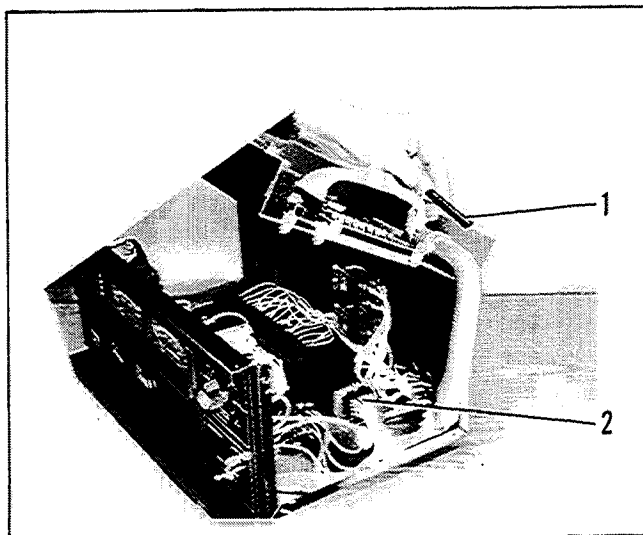


Figure 3-12. Continuity Check Points

1. Connector (P4, P5, P6, P7)
2. DC Harness (P1)

To test the main circuit board's ability to stop a start-up attempt if starter works but engine will not run.

1. Move Fast Check engine switch to OFF.
2. Move Generator Master Switch to TEST.
3. Move Fast Check's engine to CRANK.

#### NOTE

The main circuit board gives a restart cranking delay of about one to two seconds. CRK. lamp on Fast Check may not light immediately when engine switch is moved to CRANK from OFF.

4. IGN., CRK. and REG. lamps on Fast Check should light to show "on-crank" cycle. CRK. lamp will go out during "off-crank" cycles.
5. After 60 seconds of cyclic cranking, IGN., CRK. and REG. lamps on Fast Check should go out; ALARM lamp plus OVERCRANK lamp on controller should light. If cyclic cranking does not stop after 60 seconds:
  - A. Check the following connections for continuity:
    1. Connector P5, pin 4 to DC harness connector, (P1) pin 2.
    2. Connector P5, pin 8 to DC harness connector, (P1) pin 24.
    3. Connector P5, pin 5 to DC harness connector, (P1) pin 6.
  - B. Replace main circuit board if all connections in step A check out.

## OVERSPEED

### NOTE

The overspeed signal to the controller is supplied by the speed sensor. The Fast-Check tester simulates the speed sensor signal.

To test overspeed safety feature:

### NOTE

Earlier Fast-Check testers may require slightly higher battery voltage (13-14 Volts for 12-Volt systems) for this test.

1. Move Generator Master Switch to TEST position. Move Fast Check engine switch to run.
2. Push and hold OVERSPEED button on Fast Check.
3. OVERSPEED lamp on controller should light immediately. ALARM lamp on Fast Check should light (IGN. and REG. lamp on Fast Check should be out).
4. If engine does not shutdown:
  - A. Check the following connection points for continuity:

1. Connector P5, pin 4 to DC harness connector, (P1) pin 2.
2. Connector P5, pin 8 to DC harness connector, (P1) pin 24.
3. Connector P5, pin 5 to DC harness connector, (P1) pin 6.

## Engine Condition Indicators

Refer to Table 3-1 to test operation of the controller's engine condition indicator lamps.

To test each indicator place master switch and Fast-Check engine switch in the positions shown in the table. Check for voltage at the indicated test points with the toggle switch in the position shown.

Push LAMP TEST button on controller to be sure that all lamps work. Lamps will appear dim due to current limiting by resistor on lamp board. Replace any defective bulbs. Different bulbs are used on 12 and 24-Volt controllers.

### CAUTION

Make continuity checks with DC power source turned off.

### NOTE

Leave engine switch in RUN position for at least 30 seconds before pushing toggle switches.

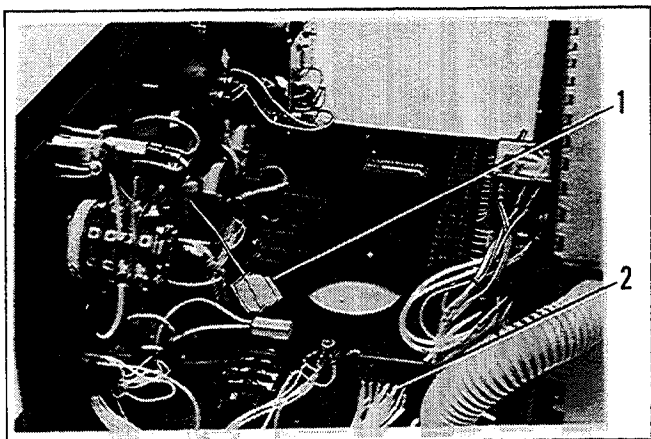
| INDICATOR                                    | SWITCH POSITIONS  | TEST POINTS          |                          | TEST VOLTAGE      |                  |
|--|---|----------------------|--------------------------|-------------------|------------------|
|  |   | VOLTAGE AT:          | CONTINUITY               | TOGGLE SWITCH OFF | TOGGLE SWITCH ON |
| High Water Temperature - H.W.T.              | Master switch in TEST; engine switch in RUN; hold toggle switch to H.W.T. for approx. 5 seconds | P5, pin 19 to ground | P5, pin 19 to P1, pin 17 | 5                 | 0                |
| Low Oil Pressure - L.O.P.                    | Master switch in TEST; engine switch in RUN; hold toggle switch to L.O.P. for approx. 5 seconds | P5, pin 17 to ground | P5, pin 17 to P1, pin 18 | 5                 | 0                |
| Anticipatory Low Oil Pressure - A.O.P.       | Master switch in TEST; engine switch in RUN; hold toggle switch to A.O.P.                       | P5, pin 18 to ground | P5, pin 18 to P1, pin 13 | 5                 | 0                |
| Anticipatory High Water Temperature - A.W.I. | Master switch in any position; hold toggle switch to A.W.T.                                     | P5, pin 14 to ground | P5, pin 14 to P1, pin 12 | 5                 | 0                |
| Low Water Temperature - L.W.T.               | Master switch in any position; hold toggle switch to L.W.T.                                     | P5, pin 16 to ground | P5, pin 16 to P1, pin 5  | 5                 | 0                |
| Low Fuel - L.F.                              | Master switch in any position; hold toggle switch to L.F.                                       | P5, pin 15 to ground | P5, pin 15 to P1, pin 8  | 5                 | 0                |
| Switch Off                                   | Master switch in OFF position   | P4, pin 16 to ground | P4, pin 16 to P6, pin 12 | 1 to 12 pulsing   |                  |
| System Ready                                 | Master switch in OFF position<br>Master switch in AUTO position                                 | P4, pin 15 to ground | P4, pin 15 to P6, pin 11 | 12<br>0           |                  |

Table 3-1. Fast-Check Test for Engine Condition Indicators

## Microcomputer Controller - cont'd.

### Emergency Stop (optional)

The emergency stop circuit will cause immediate engine shut-down when it is triggered by a 4-to-24-Volt DC signal from an over voltage shut-down option, or a remote emergency stop switch. A remote emergency stop switch may be connected to the controller via DC harness connector (P1), pin 23. The over voltage option connects to wire 30 in the controller (see Figure 3-13).



**Figure 3-13. Emergency Stop Connections**

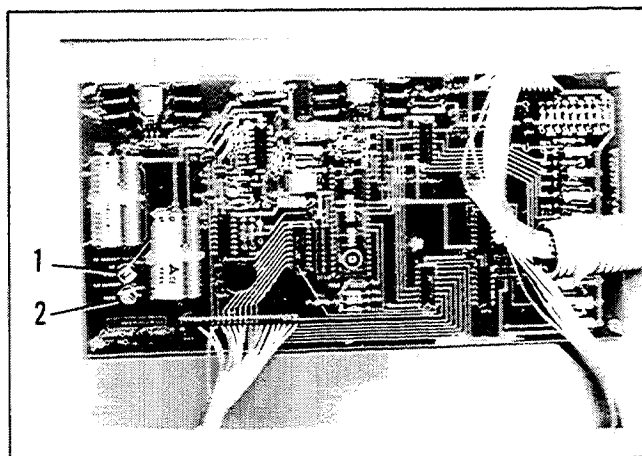
1. Over Voltage Option Connector
2. DC Harness Connector (P1)

### High and Low Battery Voltage Indicators

To adjust high and low battery voltage indicators:

1. Move Generator Master Switch to AUTO position. SYSTEM READY lamp should go on.

2. Rotate potentiometers R42 (High Batt. Volts) and R25 (Low Batt. Volts) fully counterclockwise (Figure 3-14).
3. Set DC power supply at 10 volts (20 volts for 24 volt units). Slowly rotate pot R25 clockwise until BAT. LOW VOLTS lamp lights on controller.
4. Set DC power supply at 15 volts (30 volts for 24 volt units). Slowly rotate pot R42 clockwise until BAT. HIGH VOLTS lamp lights on controller.
5. Set DC power supply between 10 to 15 volts (20 to 30 volts for 24 volt units). SYSTEM READY lamp should be on.
6. Seal pots after settings have been established.



**Figure 3-14. Battery Voltage Indicator Adjustment Points.**

1. Battery Hi Volts Potentiometer (R42)
2. Battery Lo Volts Potentiometer (R25)

# Section 4

## GENERATOR TROUBLESHOOTING

### Generator Conditions

This section will serve as a guide when troubleshooting your generator set. The generator conditions listed below are covered in this section.

- I. No Output On Any Phase
- II. Over Voltage
- III. Fluctuating Voltage

#### WARNING

**HIGH VOLTAGE!** High output during tests may endanger human life or damage equipment! Disconnect generator from load when troubleshooting. Trip all line circuit breakers to "OFF" or remove generator output leads from connections to load circuits and heavily insulate ends of leads!

#### WARNING

**UNIT STARTS WITHOUT NOTICE!** Disconnect wires 3 and 4 from terminal strip in controller to prevent remote start-up while working on generator set. Potential injury or electrocution can result. Disconnect battery negative (-) lead from ground on generator set before working near rotor or attached parts.

Follow all safety precautions in front of this manual and the additional warnings within the text. Figure 4-1, AC Voltage Control, will assist you when troubleshooting. In addition, Table 4-1 lists the various generator output conditions and component tests to be used.

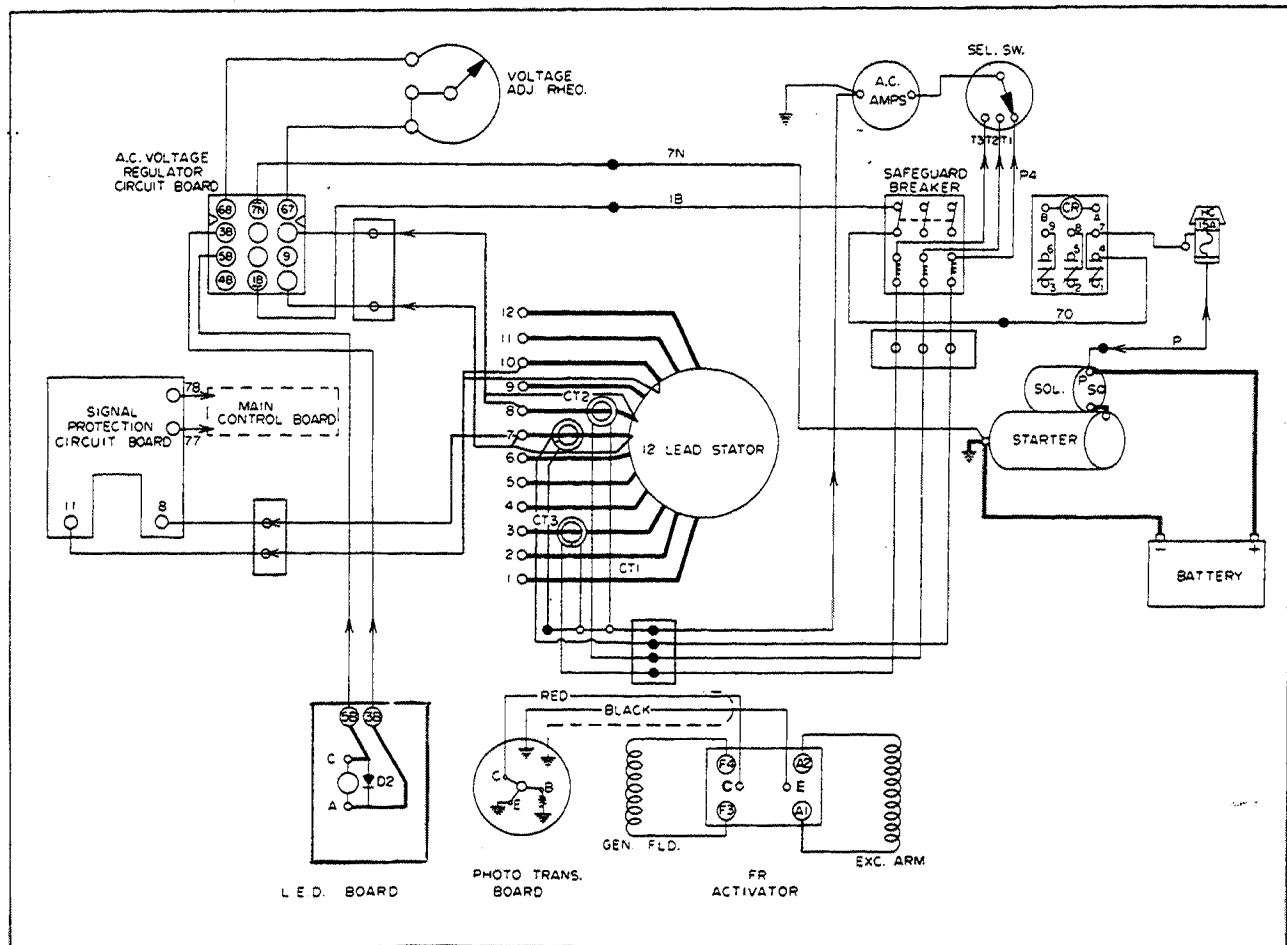


Figure 4-1. AC Voltage Control

| COMPONENTS AND CIRCUITS    |           |                        |                                   |              |                   |                  |                 |                  |
|----------------------------|-----------|------------------------|-----------------------------------|--------------|-------------------|------------------|-----------------|------------------|
| Generator Output Condition | LED Board | Photo Transistor Board | AVR – Automatic Voltage Regulator | FR Activator | Safeguard Breaker | Exciter Armature | Generator Field | Generator Stator |
| No Output                  | •         | •                      | •                                 | •            | •                 | •                | •               | •                |
| Over Voltage               |           | •                      | •                                 | •            |                   |                  |                 |                  |
| Fluctuating Voltage        | •         | •                      | •                                 | •            |                   | •                | •               | •                |

Table 4-1. Troubleshooting Guide

### No Output On Any Phase

1. Check the safeguard breaker (if equipped). If open, close, and with set running check AC voltmeter for proper output voltage.
2. If proper output does not show:
  - a. Check the 15-amp fuse on controller.
  - b. Check wire 1B from safeguard breaker and wire 7N (ground) to voltage regulator.
  - c. Check wire 70 between CR relay and Safeguard breaker (if equipped) through DC engine harness connector (P1, J1) pin 20.
3. If all items in step 2 are okay, proceed to the LED circuit board flashlight test and AVR (voltage regulator) test as described in Component Testing.
4. If tests indicate LED and AVR are functioning properly, proceed to the Photo Transistor Board test as described in Component Testing.
5. If the Photo Transistor Board test indicates it is functioning properly, proceed to the Exciter Armature test as described in Component Testing.
6. If the Exciter Armature test indicates the armature is functioning properly, proceed to the Generator Field test as described in Component Testing.
7. If the Generator Field test indicates the field is functioning properly, replace the FR Activator as described in Component Testing.

### Over-Voltage

#### NOTE

If over-voltage occurs, disconnect harness plug at voltage regulator. If over-voltage continues, problem lies in photo transistor circuit, and/or FR-Activator. If output voltage disappears, problem lies in voltage regulator, connections or wiring. See "Component Testing."

1. If over-voltage is read with the Safeguard breaker open or closed check the photo transistor board for a grounded "C" lead. Check the photo transistor board as described in "Component Testing."
2. If the Photo Transistor Board is functioning properly, check for reversed E and C leads on the FR Activator.
3. If Photo Transistor Board functions properly and is properly connected, but ceiling voltage is read, replace FR Activator. See "Component Testing – FR Activator."
4. If over-voltage is read with the Safeguard breaker closed only, check for an open circuit in leads V7 and V8 to the voltage regulator. If these circuits are open or shorted, repair or replace. Check the voltage rheostat circuit (leads 67 and 68). Repair and replace as necessary.
5. If all the circuits in step 4 are okay, check the voltage regulator (AVR) as described in "Component Testing."

### Fluctuating Voltage

1. Check the generator output leads for proper connections (refer to Section 7, Wiring Diagrams).
2. Check for loose connections to the voltage regulator, LED board, photo transistor board or FR Activator.
3. Check the stator for shorted or open windings, refer to Component Testing.

## Component Testing

### LED Circuit Board Test

#### WARNING

Keep all other light sources away from generator end bracket during the following tests. Dangerous HIGH VOLTAGE MAY RESULT!

#### WARNING

**HIGH VOLTAGE!** High output during test may endanger human life or damage equipment. Disconnect generator from load when troubleshooting. Trip all line circuit breakers to "OFF" or remove generator output leads from connections to load circuits and heavily insulate ends of leads!

#### WARNING

**UNIT STARTS WITHOUT NOTICE!** Disconnect wires 3 and 4 from terminal strip in controller to prevent remote start-up while working on generator set. Potential injury or electrocution can result if generator is connected. Disconnect battery negative (-) lead from ground on generator set before working near rotor or attached parts.

1. Remove junction box panels from generator end of unit (Figure 4-2), and remove photo transistor board cover.

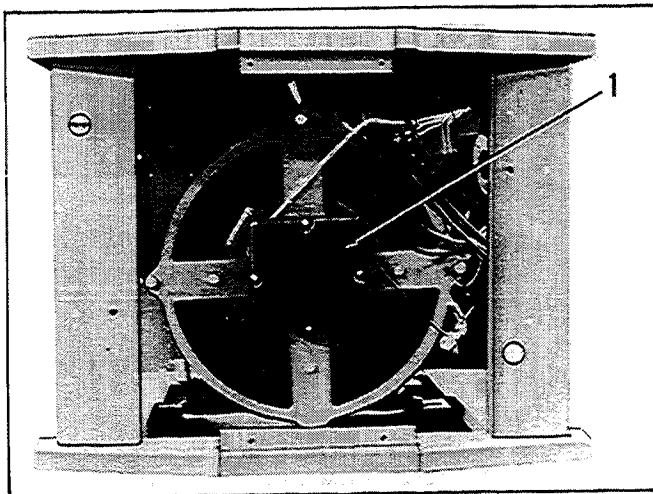


Figure 4-2. Panels Removed

1. Photo Transistor Board Cover

2. With the generator set running at no load, shine a flashlight on the exposed photo transistor board. Figure 4-4.

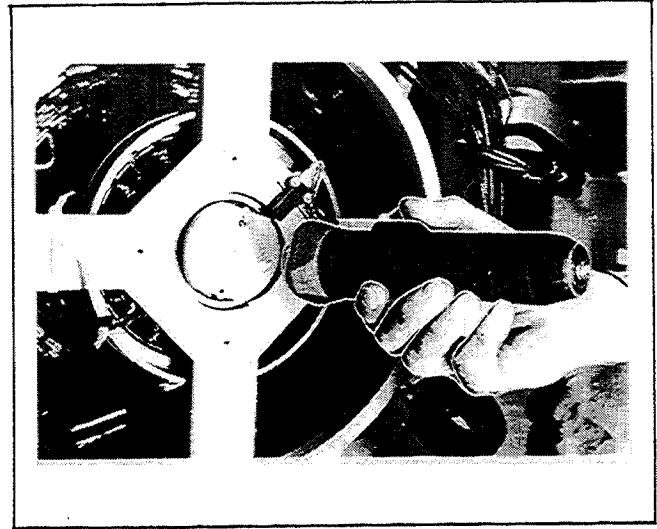


Figure 4-4. LED Flashlite Test

3. Observe the AC output voltmeter. High AC output voltage indicates the photo transistor board and FR Activator are functioning properly, and the fault is in the AVR, wiring, or LED circuit board (output voltage should drop to low level when flashlight is removed). If no output is observed, check the photo transistor board and the FR Activator.
4. With the generator set running, approximately 1-2 Volts DC should be observed at 3B (+) and 5B (-) at the LED board (see Figure 4-3). Shine flashlight on photo transistor. DC voltage reading should drop, showing that AVR is functioning properly. If voltages are not observed, refer to the AVR test.

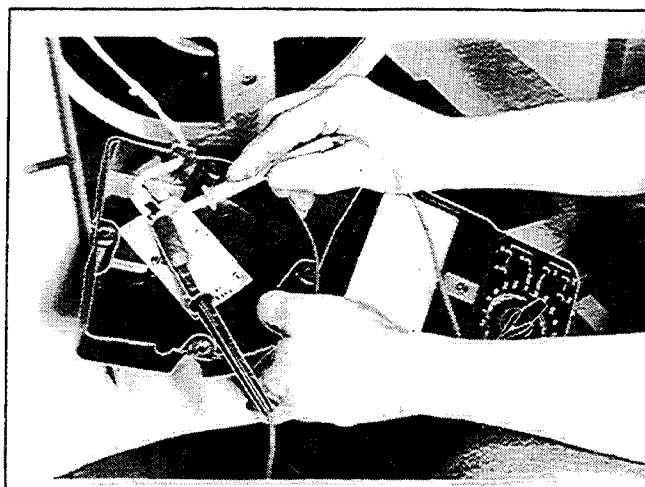


Figure 4-3. Checking LED Board

**FR Activator**

Whenever replacing an FR Activator, use an ohmmeter to check for continuity between terminals E and F3 of the FR Activator with leads disconnected. No continuity indicates that FR Activator is defective and/or generator rotor is shorted to ground. Replace or repair generator rotor assembly and replace FR Activator.

To replace the FR Activator, see “End Bracket Removal and Replacement.” Observe the label markings on the FR Activator. Leads F3 and F4 are the generator field leads; leads A1 and A2 are the exciter armature leads; lead E (black) is the emitter of the photo transistor board and lead C (red) is the collector for the photo transistor board (see Figure 4-5).

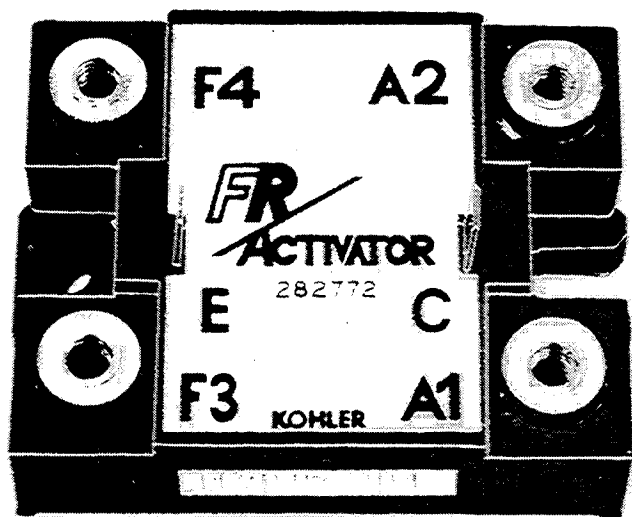
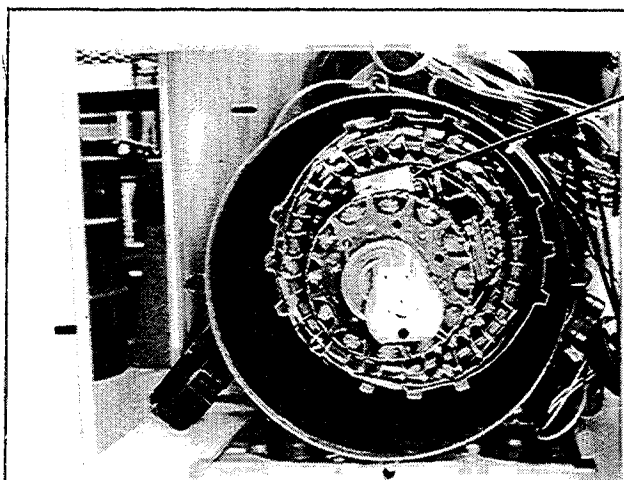


Figure 4-5. FR Activator and Location

**WARNING**

**HIGH VOLTAGE!** Do not reverse leads E and C. Ceiling voltage will result, causing equipment damage and possible personal injury.

**CAUTION**

Make sure FR Activator and heat sink mounting surfaces are flat, clean and free of dirt or metal chips. Be sure ceramic surface on back of FR Activator is not cracked or damaged.

1. Apply a thin coating of thermal compound to back of activator before mounting.
2. Using new washers install washers so the convex side is against socket cap screwhead.
3. Tighten FR Activator mounting screws to 20-25 in. lbs. (2.3-2.8 Nm) or only as necessary to compress washers.

**CAUTION**

**FR ACTIVATOR DAMAGE!** Overtightening FR Activator screws can cause activator failure. Do not exceed maximum torque settings.

4. Connect leads to FR Activator, tighten A and F terminal screws to 20-25 in. lbs. (2.3-2.8 Nm).

**CAUTION**

**FR ACTIVATOR DAMAGE!** Do not bend C and E terminals on FR Activator. Internal damage and failure may result.

5. Secure leads with tie cable. These leads rotate with the rotor shaft during operation and must be secured to prevent damage.

## AVR

With the safeguard breaker closed (if equipped).

1. Check for an open circuit between leads V7 and V8 (voltage sensing leads) from voltage regulator (AVR) to terminal strip controller (see Figure 4-6). If these circuits are open or shorted, repair or replace. Check 15-Amp fuse (if equipped).
2. If continuity is read, check the voltage rheostat circuit (leads 67 and 68). Repair or replace as necessary.
3. To check for input battery voltage to the regulator, with the generator running, check for battery voltage at 1B

(+) and 7N (-) at the voltage regulator harness plug. If you do not get a voltage reading, check the wiring to the Safeguard breaker, CR relay or 15-Amp fuse.

4. Check for approximately 1-2 Volts DC output at terminals 3B (+) and 5B (-) on the LED board. Separate 3B/5B connector and check for battery voltage at connector. If voltage is not read at connection points, repair wiring or replace voltage regulator. If voltage is read, replace LED board.

### NOTE

If installing new voltage regulator in 24-Volt system, remove R16 resistor from regulator circuit board.

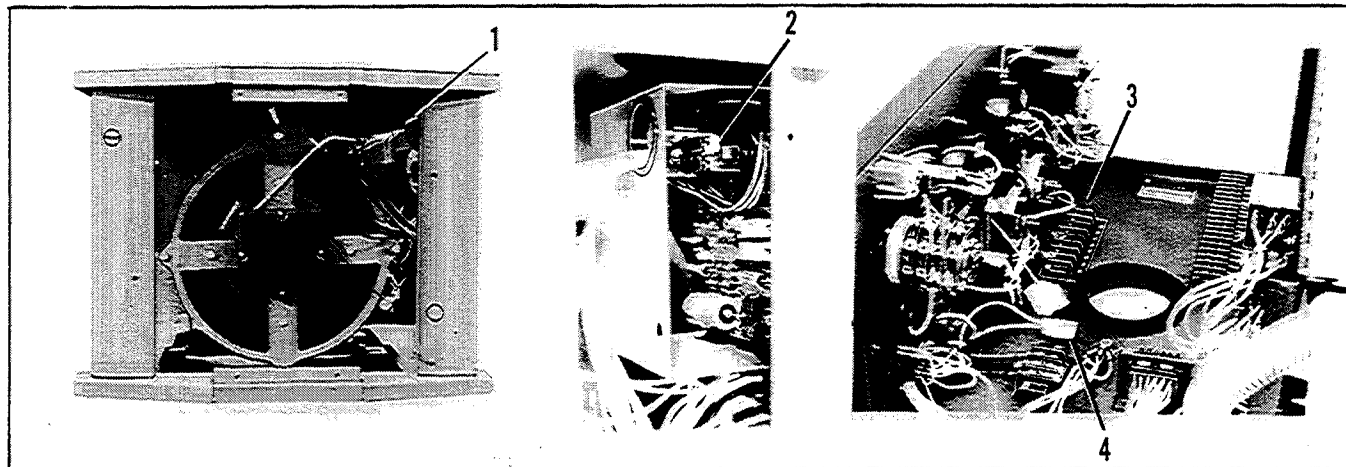


Figure 4-6. AVR and Connections

1. AVR
2. Harness Plug
3. Controller Terminal Strip
4. Voltage Rheostat

## Stator

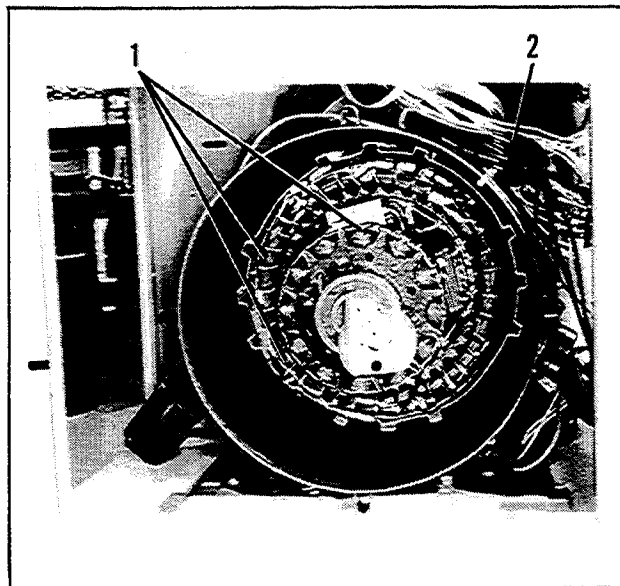


Figure 4-7. Stator

1. Windings
2. Leads

1. Check the generator output leads for proper connections (see wiring diagrams, Section 7).
2. Check the stator windings for:
  - Shorted windings: inspect for burnt or hot windings. Replace stator if windings are burnt or hot.

### NOTE

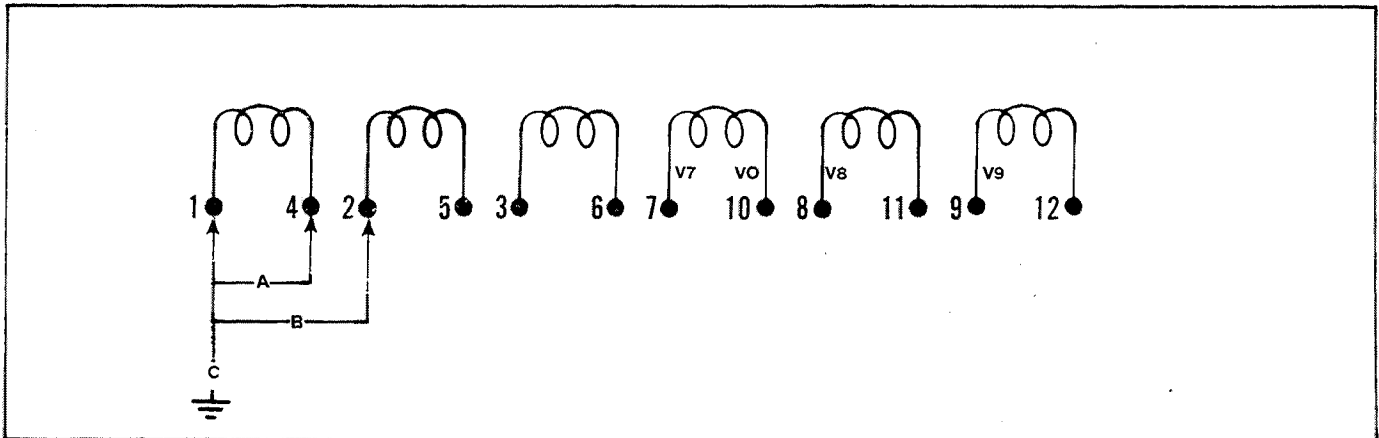
Later FRII models use a skewed (slanted) rotor with a straight stator. When replacing either rotor or stator, be sure replacement is the same as the original. Rotor and stator must be of dissimilar styles (skewed rotor with straight stator or straight rotor with skewed stator) for the generator to function properly.

## Component Testing – cont'd.

- Open windings: with an ohmmeter, repeat check for **each pair** of leads for high resistance readings. High resistance across “A”, or continuity across “B” and ground indicates a faulty stator—replace (see Figure 4-8).

### NOTE

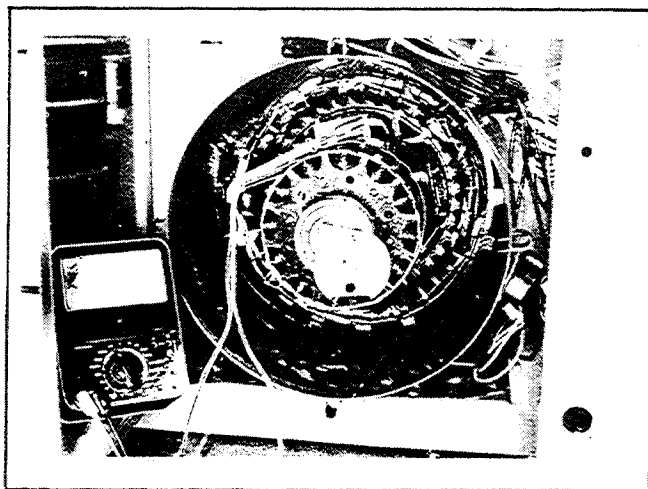
Disconnect V7, V8, V9, V0 at AC terminal strip in controller before doing this test.



**Figure 4-8. Stator Winding Test**  
A. Continuity/Resistance  
B., C. No Continuity

### Generator Field

1. Disconnect battery (negative lead first). See “End Bracket Removal and Replacement.” Remove end bracket. Disconnect F3 and F4 from FR Activator.
2. With an ohmmeter check for continuity across F3 and F4 leads (see Figure 4-9). Resistance readings should be 2-3.75 ohms,  $\pm 5\%$ .



**Figure 4-9. Field Continuity Check**

3. Check for a grounded generator field. There should be no continuity between field leads and rotor assembly (see Figure 4-10).

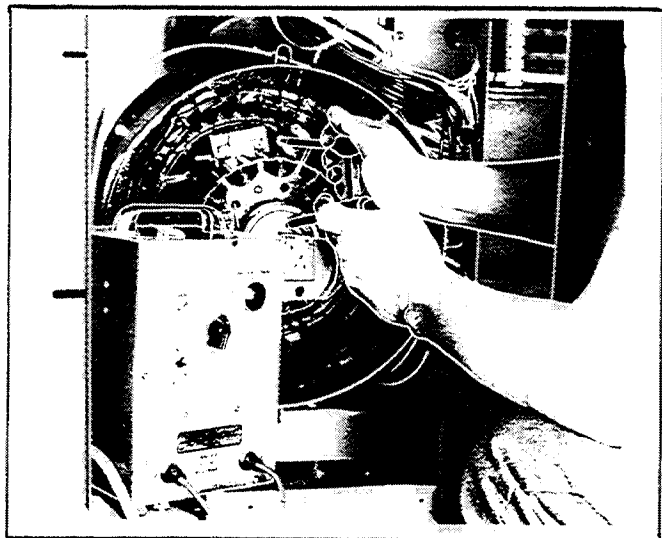
### WARNING

**HOT FIELD!** Generator field will get hot if field is shorted. Avoid touching generator field, severe burns may result.

### WARNING

**HIGH VOLTAGE!** Use high voltage test only as directed. High voltage may result in electrocution or severe injury. Follow manufacturer's instructions to operate tester.

4. Apply 1,100 volts AC to either F3 or F4 lead and shaft for **NOT MORE THAN ONE SECOND. DO NOT REPEAT TEST.**



**Figure 4-10. High Voltage Test**

5. Repair F3 and F4 if test should show leads shorted to ground. Solder and insulate splices. Use new sleeving when tying leads to shaft or heat sink.
6. Replace generator rotor assembly if tests show a short or ground.

## Exciter Armature

1. Disconnect battery (negative lead first). See "End Bracket Removal and Replacement." Remove end bracket. Disconnect leads A1 and A2 from FR Activator.
2. With an ohmmeter, check for continuity across A1 and A2 leads (see Figure 4-11).

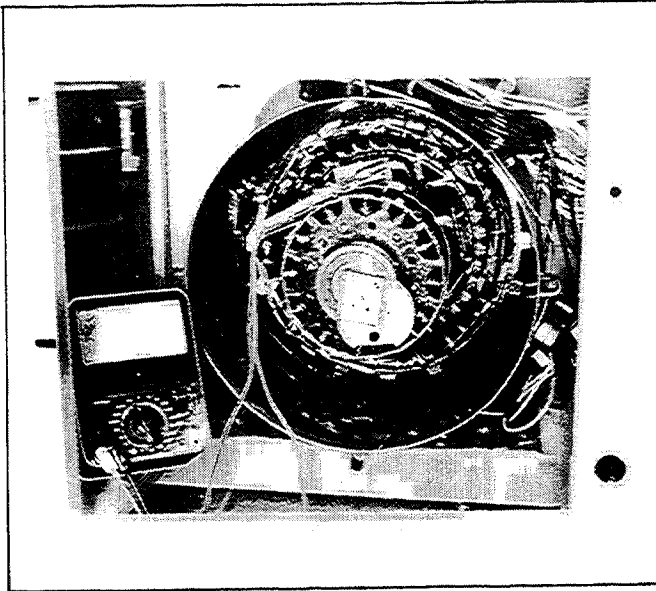


Figure 4-11. Exciter Armature Continuity Check

3. Repair A1 and A2 leads if damaged or open. Solder and insulate splices. Use new sleeving when tying leads to shaft or heat sink.
4. Visually check exciter armature for shorted winding(s), with an ohmmeter check for low resistance readings (under 0.1-0.2 ohms) Figure 4-11. Low resistance readings indicates a faulty exciter armature - replace rotor assembly.

### WARNING

**HOT ARMATURE!** Exciter armature will get hot if armature is shorted. Avoid touching armature or severe burns can result.

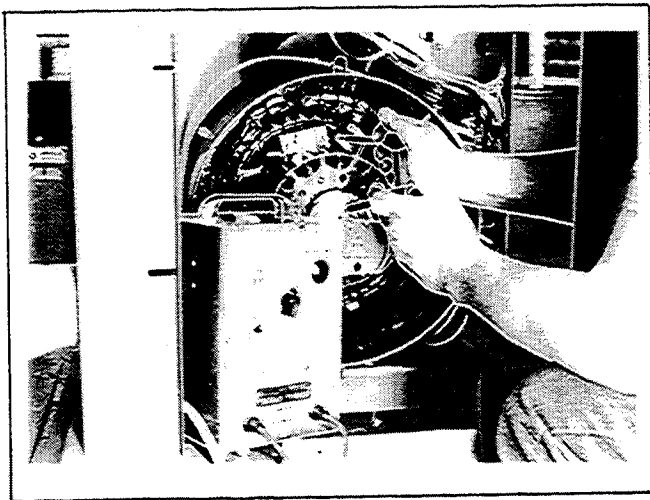


Figure 4-12. High Voltage Test

### WARNING

**HIGH VOLTAGE!** Use high voltage test only as directed! High voltage may result in electrocution or severe injury. Follow manufacturer's instructions when operating tester.

5. Check for a grounded exciter armature by applying 1,100 volts AC to either A1 or A2 and rotor shaft for NOT MORE THAN ONE SECOND. See Figure 4-12. DO NOT REPEAT TEST.
6. Repair A1 and A2 leads if test indicates leads shorted to ground. Solder and insulate splices. Use new sleeving when tying leads to shaft or heat sink.
7. Replace rotor assembly if test should show armature shorted or grounded.

## Photo Transistor Board

1. Disconnect battery, negative lead first.
2. Disconnect leads E and C from FR Activator.
3. Connect red and black photo transistor leads to ohmmeter (+) and (-). Cover the phototransistor. Meter should read 300K ohms or higher.
4. Shine a bright flashlight on photo transistor board; meter should read 5K ohms or lower.
5. If ohmmeter does not respond, reverse ohmmeter leads and repeat check (meter polarity may be reversed).
6. If ohmmeter does not respond, replace photo transistor board and harness assembly.
7. Reconnect C (red) and E (black) photo transistor board leads to C and E terminals of FR Activator.

### WARNING

**HIGH VOLTAGE!** Make sure leads "C" and "E" to FR Activator are connected to the correct terminals. Reversal of these leads, or grounding of "C" (red) lead will turn the FR Activator full on, resulting in ceiling output voltage. Damage to equipment or personal injury can result.

### WARNING

**FR ACTIVATOR DAMAGE!** Do not bend C and E terminals on FR Activator. Internal damage and failure may result.

## Component Testing – cont'd.

8. Start set, shine bright flashlight on photo transistor board (see Figure 4-13). AC voltmeter should show ceiling voltage and return to very low voltage when flashlight is removed. Repeat test 7 times. If output does not drop to low voltage when flashlight is removed, replace FR Activator. See "FR Activator". If ceiling voltage is not read, go to exciter armature test.

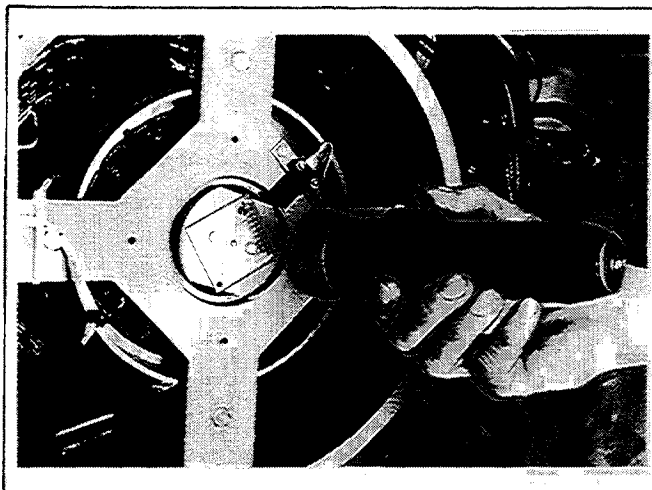


Figure 4-13. Flashlight Test

3. Reach in and remove leads C and E from FR Activator. This will allow slack when removing the end bracket.

### CAUTION

**FRACTIVATOR DAMAGE!** Do not bend C and E terminals on FR Activator. Internal damage and failure may result.

4. Remove 4 bolts holding end bracket to stator.
5. Remove end bracket by using a puller, Figure 4-14.

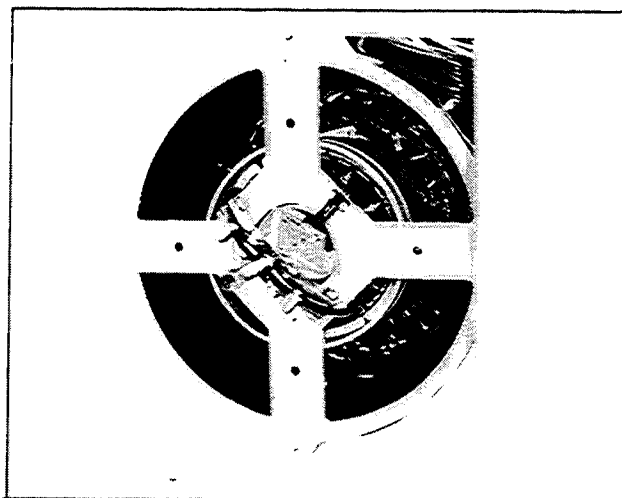


Figure 4-14. Removing End Bracket

## End Bracket Removal and Replacement

### NOTE

On 30kW models, remove the end bracket mounting bolts. On 40kW models, the junction box must be loosened to allow end bracket removal. Remove the six (6) junction box mounting screws and pull the junction box away from the engine allowing end bracket removal.

1. Remove LED board and cover. Disconnect leads from speed sensor.
2. Remove screws holding actuator cup and photo transistor board.

### CAUTION

Do not try to remove the end bracket by pounding with a hammer, you may loosen the exciter field magnets.

6. Pull the end bracket and exciter field assembly over the exciter armature, taking care not to damage exciter field magnets, or photo transistor board.
7. Reverse order of disassembly to reinstall end bracket-exciter field assembly.

# Section 5 GENERATOR RECONNECTION

1. Move controller Master Switch to OFF/RESET or OFF position.

### WARNING

**ELECTRICAL SHOCK!** Battery can cause electrical burns and shocks. Remove rings, watches and jewelry that can cause short circuits. When disconnecting battery, disconnect ground lead first and reconnect it last to minimize the probability that tools will cause short circuits.

2. Disconnect engine starting battery, negative (-) lead first.

3. Select desired voltage connection from Figure 5-1. Route leads through current transformers and connect leads per diagram for desired voltage.

### NOTE

With CT1 and CT3, place Dot or "HI" mark side away from generator set. With CT2, place Dot or "HI" mark toward generator set.

### NOTE

Current transformers (CT's) will only be used on generator sets with meter equipped controllers and/or Safeguard Breakers.

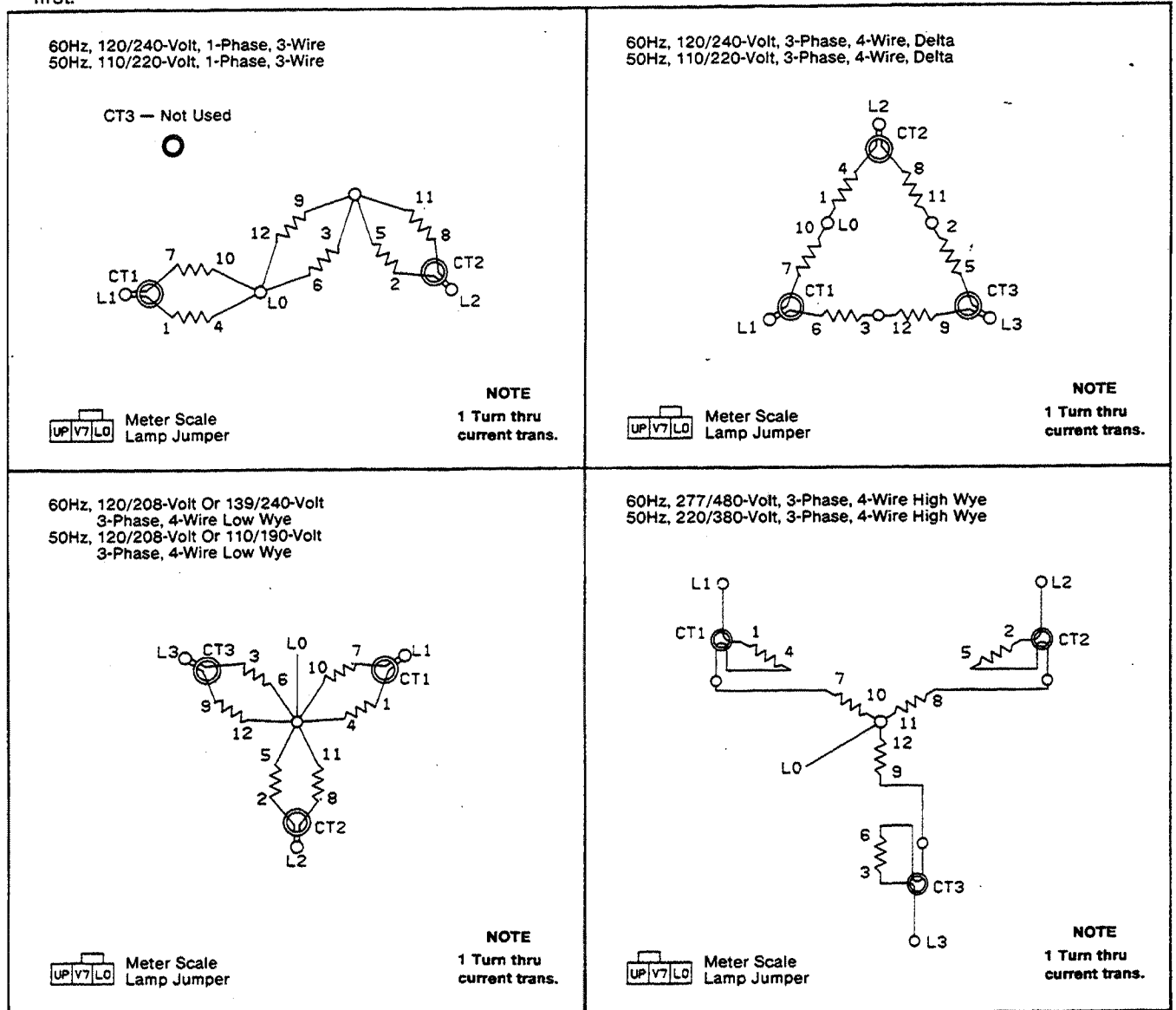


Figure 5-1. Generator Connections

## Reconnection – cont'd.

### WARNING

**HIGH VOLTAGE!** Remember that the function of a generator set is to produce electricity and wherever electrical energy is present, there is the potential danger of electrocution. Keep everyone, especially children, away from the set while it is running and take precautions to prevent unqualified personnel from tampering with or attempting to operate your generator set. Have the set and electrical circuits serviced only by qualified technicians. Wiring should be inspected frequently – replace leads that are frayed or in poor condition. Do not operate electrical equipment when standing in water, on wet ground or when your hands are wet.

4. If controller is equipped with meters, remove controller cover and reposition meter scale lamp jumper (see Figure 5-2), if necessary, to match proper position for desired voltage as shown in Figure 5-1. Reinstall cover.
5. If controller is equipped with meters, turn phase selector switch to L1-L2 position (1Ø or 3Ø depending on generator connection). If controller is not equipped with meters, connect voltmeter across L1-L2.

### CAUTION

**EQUIPMENT DAMAGE!** Be sure that line circuit breakers, transfer switch and any other accessories using line voltage are properly sized for the voltage selected.

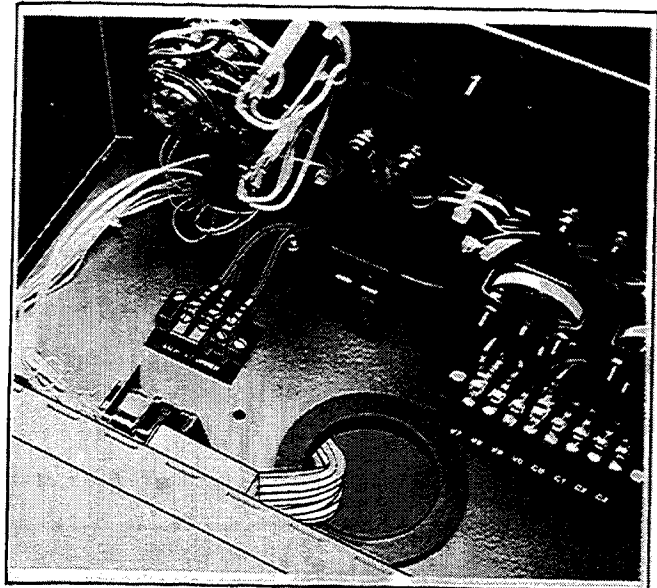


Figure 5-2. Meter Scale Lamp Jumper

6. Reconnect starting battery. Move controller master switch to TEST position to start generator set. Check voltmeter for proper voltage. Adjust voltage, if necessary, with VOLTAGE ADJ./REGULATOR RHEOSTAT (front-mounted on Microcomputer Controller; rear-mounted on relay controller). See Figure 5-3.

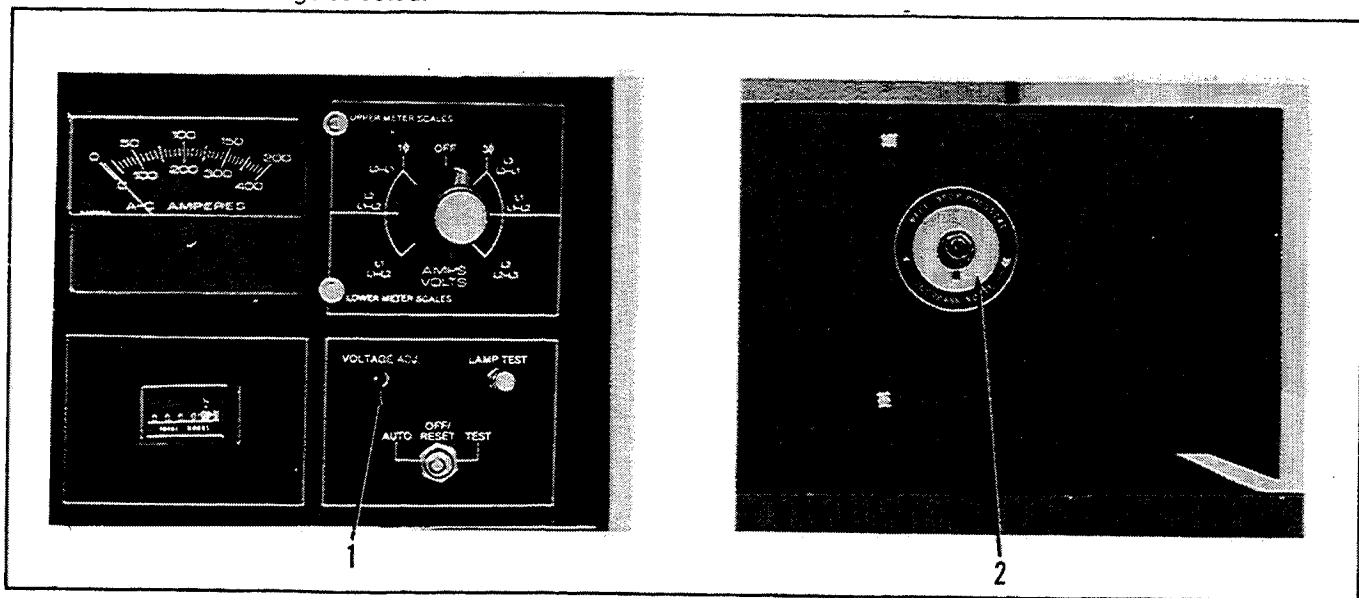


Figure 5-3. Voltage Adjustment

1. Microcomputer Controller
2. Relay Controller

# Section 6

## GENERATOR DISASSEMBLY/REASSEMBLY

### WARNING

Before beginning to disassemble generator set carefully read all Safety Precautions at the beginning of this manual. Please do not neglect the importance of these precautions.

1. Disconnect and remove starting batteries from work area to prevent fire hazard. Disconnect any AC accessories such as battery charger, block heater and fuel transfer pump.
2. Shut off fuel supply. Drain fuel system as necessary, emptying fuel into proper containers. Remove any fuel containers from work areas to prevent fire hazard. Ventilate work area to clear fumes.
3. Disconnect fuel, cooling and exhaust systems as necessary to tilt generator set. Disconnect output leads or load circuit cables at generator.
4. Any cranes, hoists or other devices used in disassembly or reassembly must be rated for weight of generator set. Check generator nameplate for weight.

### Disassembly

1. Disconnect all controller-to-engine and engine-to-generator harnesses and wiring. Disconnect alarm horn circuit board connector (if equipped); LED board and housing; and speed sensor. Junction box and controller can be removed as a unit.
2. Remove bolts from generator vibro-mounts.
3. Suspend the generator at both ends with hooks in eyes. Raise generator end with a hoist, lifting off of vibro-mounts. Figure 6-1.
4. Support the engine by placing wood blocks under flywheel housing. Lower generator end allowing flywheel to rest on blocks. Figure 6-1.

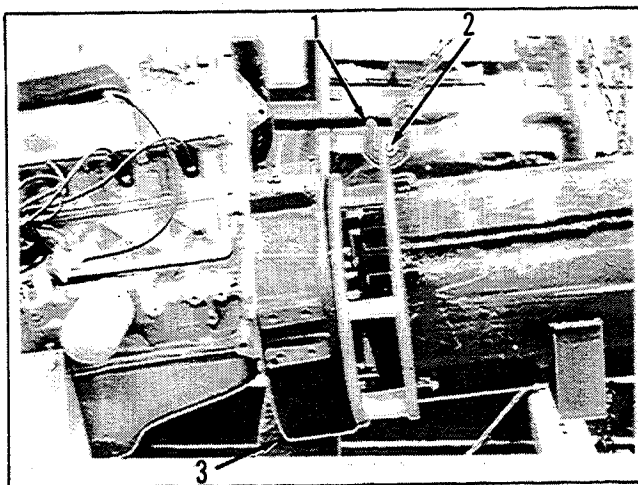


Figure 6-1. Hoisting Generator  
1. Hook      3. Wood Block(s)  
2. Adapter

5. Remove fan guard. Remove bolts holding adapter to flywheel housing.
6. Remove nuts and spacers holding drive discs to flywheel.
7. Work drive discs over studs to separate generator from engine. Figure 6-2.

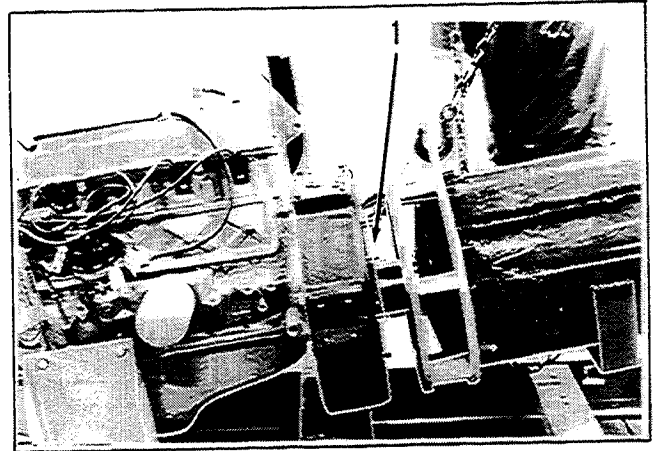


Figure 6-2. Separating Generator & Engine  
1. Drive Discs

8. Set the generator assembly horizontally on the floor. Remove slings or chains.
9. To remove the rotor assembly, hook hoist to adapter and place generator assembly vertically on floor. Before lowering assembly, place boards along the edge of end bracket to prevent damage to photo transistor board when lowering. Figure 6-3.
10. Remove drive discs and fan from generator assembly. Figure 6-3.

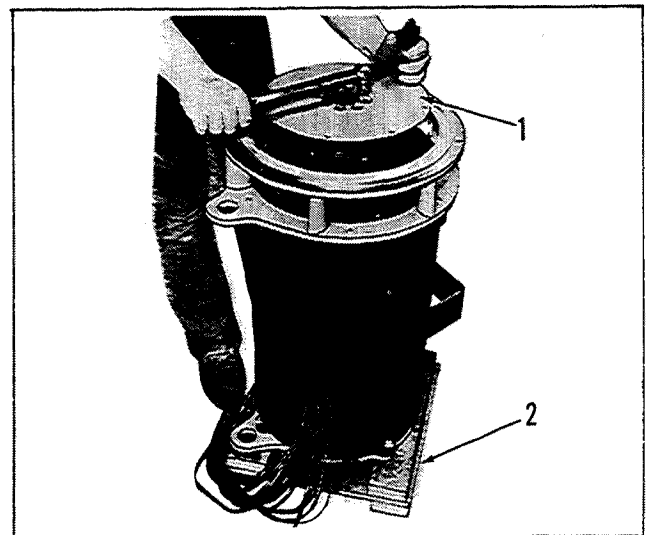
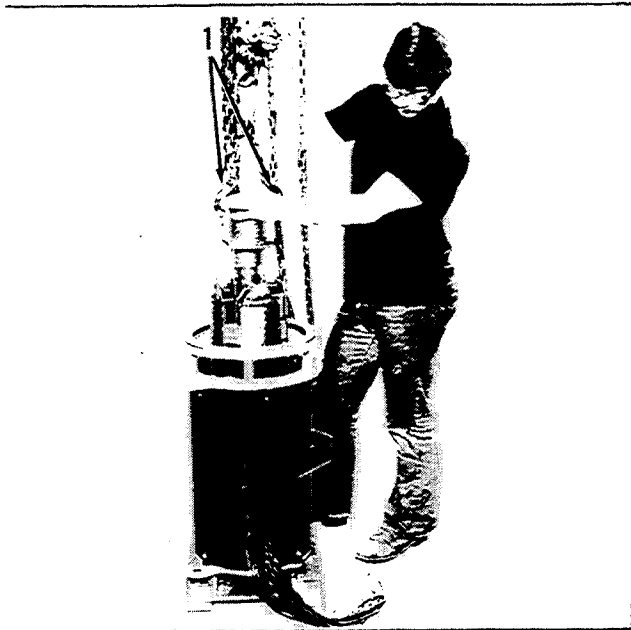


Figure 6-3. Generator Support/Drive Disc and Fan Removal  
1. Drive Disc Removal  
2. End Bracket Support

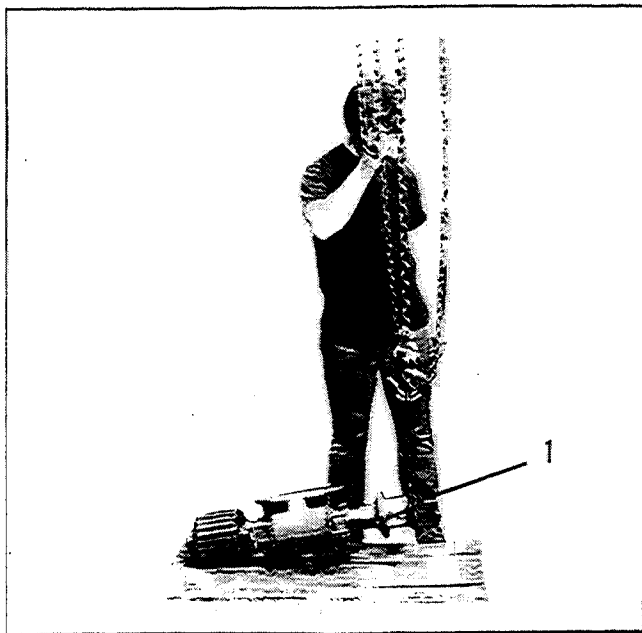
## Disassembly – cont'd.

1. Fasten lifting eye and hoist hook to rotor flange. Hoist rotor, take care not to damage exciter armature or exciter field magnets while removing. Figure 6-4.



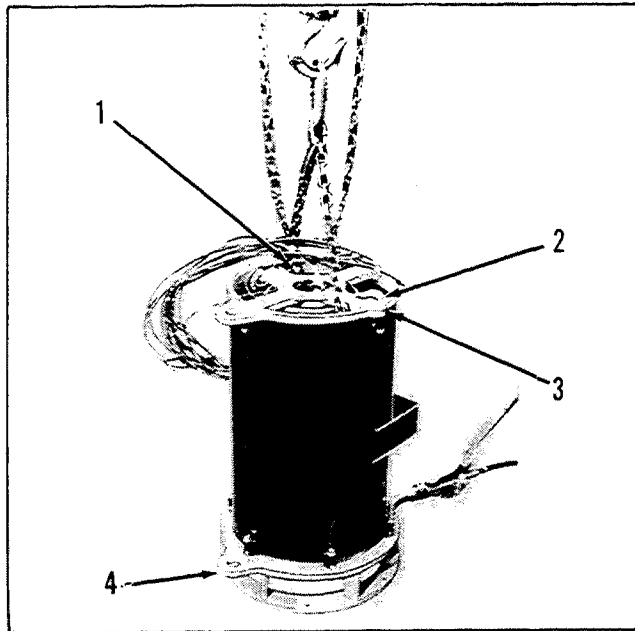
**Figure 6-4. Rotor Removal**  
1. Hoist Hook Locations

12. While rotor is suspended, remove photo transistor board and actuator cup. Remove leads C (red) and E (black) from FR Activator. Cut off terminals on the photo transistor board in order to remove; if photo transistor board will be re-used, leave leads as long as possible.
13. Slowly lower rotor to horizontal position. Set the rotor on a wooden surface. Take care not to damage windings, laminations or bearing. Figure 6-5.



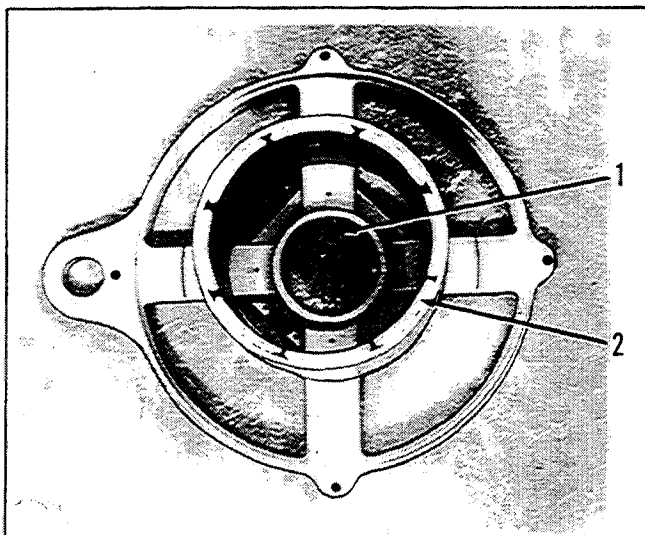
**Figure 6-5. Lowering Rotor**  
1. Rotor Assembly

14. In order to remove the adapter and end bracket from the stator, the generator assembly must be set on the adapter end. Fasten chains to adapter and lower to a horizontal position. Fasten hook to end bracket eye and hoist to a vertical position. Figure 6-6.



**Figure 6-6. Removing Adapter**  
1. Hoist Hook 3. End Bracket  
2. Hoist Hook 4. Adapter

15. Remove adapter mounting bolts. Fasten hoist hooks to end bracket and raise assembly slightly. Bump adapter loose by using a rubber mallet.
16. Lower stator assembly. Remove end bracket mounting bolts. Remove end bracket from stator by bumping loose with a rubber mallet.
17. Remove field magnets. A flat edge screw driver can be used to remove tolerance ring. Figure 6-7.



**Figure 6-7. End Bracket View**  
1. Tolerance Ring  
2. Exciter Magnets

## Reassembly

1. Install new tolerance ring in end bracket. Mount exciter field to end bracket with four mounting screws. Figure 6-7.
2. Place the stator in a vertical position, end bracket side up.

### NOTE

End bracket side of stator has four mounting bosses.

### NOTE

Later FR11 models use a skewed (slanted) rotor with a straight stator. When replacing either rotor or stator, be sure replacement is the same as the original. Rotor and stator must be of dissimilar styles (skewed rotor with straight stator or straight rotor with skewed stator) for the generator to function properly.

3. Place end bracket on stator, use bolts to align holes. Use a rubber mallet to mount end bracket flush with stator. Figure 6-8.



Figure 6-8. Mounting End Bracket to Stator

### NOTE

End bracket hoisting eye must be opposite of the stator mounting bracket.

4. Install bolts to mount end bracket to stator.
5. Attach hoist hooks to end bracket and suspend stator. Place the adapter on the floor and lower stator to within 1/2-1/4 in. (12.7-6.4 mm) of the adapter lip. Figure 6-9.



Figure 6-9. Aligning Adapter & Stator

6. Align adapter to stator and start bolts and washers. Lower stator onto adapter and finish tightening bolts.

### NOTE

Adapter hoisting eye must be opposite of the stator mounting bracket and directly below end bracket hoisting eye.

7. To install rotor, the generator assembly must be set on the end bracket end. Fasten hoisting hook to end bracket eye, lower generator assembly to a horizontal position.
8. Attach hoisting hooks to adapter as shown in Figure 6-10. Suspend generator assembly. Before lowering generator, place boards along the edge of the end bracket. A one inch (2.54 cm) clearance must be available underneath the center of the end bracket to prevent damage to the photo transistor board and actuator cup when the rotor is installed.

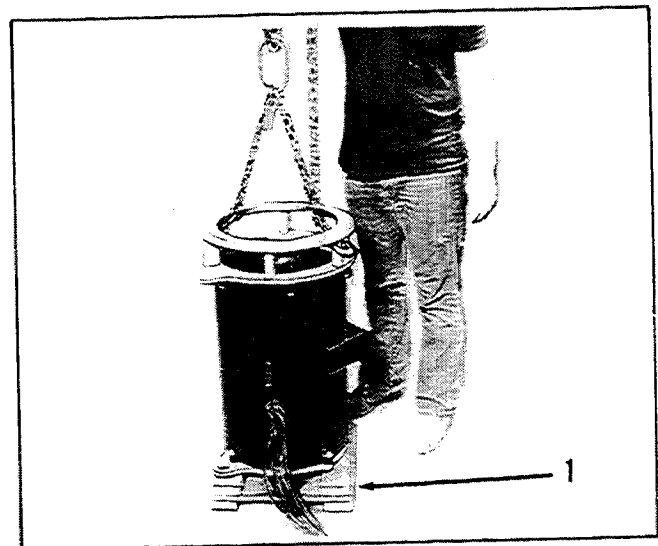
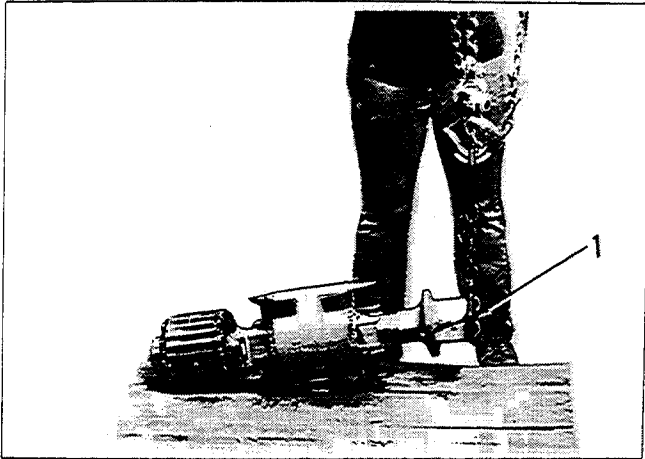


Figure 6-10. Supporting Generator Assembly  
1. Wood Support

## Reassembly – cont'd.

9. Fasten lifting eye and hoist hook to rotor flange. Figure 6-11. Hoist rotor to a vertical position taking care not to damage windings, laminations, or bearing.

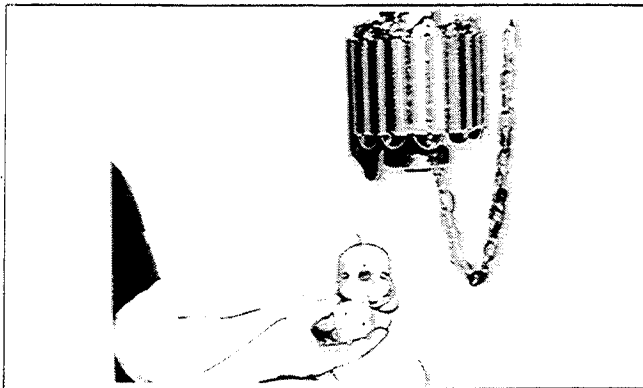


**Figure 6-11. Hoisting Rotor**  
1. Hoist Hook

10. While the rotor is suspended, install the photo transistor board and actuator cup. Place photo transistor board lead through actuator cup as shown in Figure 6-12. Push lead through hole in rotor shaft and then through exciter laminations ending near the FR Activator.

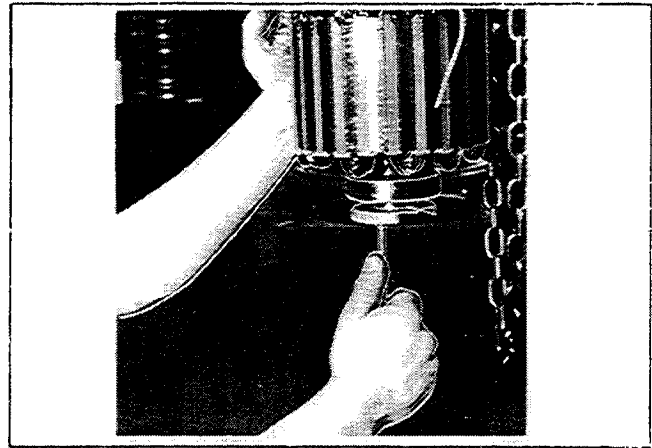
### WARNING

Be sure that foil side of photo transistor board, end of shaft, and threaded holes are clean and free of metal particles and chips. Dangerous HIGH VOLTAGE may result! AC voltmeter must show proper output before generator may be reconnected to load!



**Figure 6-12. Installing Photo Transistor Board**

11. Attach photo transistor board and actuator cup to end of rotor shaft with two mounting screws. Figure 6-13. Cut off excess lead wire, leaving enough wire to reach FR Activator. Strip 2-3 in. (5.08-7.62 cm) of gray insulator jacket from lead. Cut off all exposed uninsulated wire. Strip about 1/4 in. (.635 cm) of insulation on red and black leads crimp on 3/16 in. (.476 cm) female push on terminals (part no. X-431-19). Before connecting to FR Activator terminals, cable tie leads together to better secure leads. Reconnect red lead to "C" terminal and black lead to "E" terminal on FR Activator.



**Figure 6-13. Mounting Photo Transistor Board & Actuator Cup**

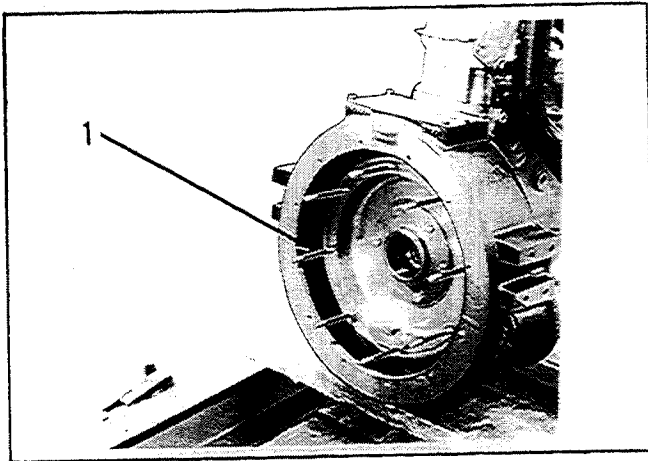
12. Suspend rotor over generator assembly. Lower rotor field into stator. Take care not to damage the exciter armature, field magnets, stator windings or rotor laminations while lowering rotor. Figure 6-14. Carefully align rotor bearing into end bracket tolerance ring. Check for an outer race measurement of 1/4" from bracket-to-bearing. Make sure the photo transistor board and actuator cup have clearance below the end bracket.



**Figure 6-14. Installing Rotor**

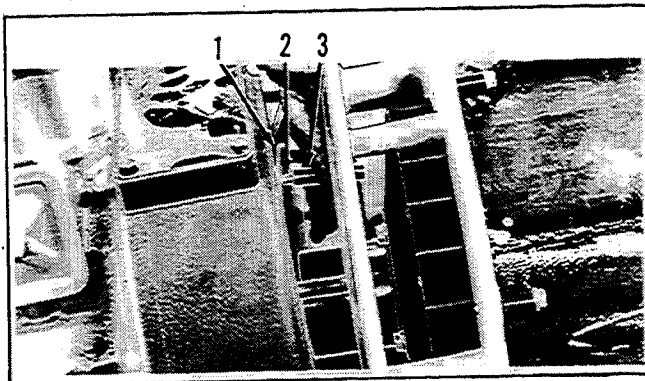
13. Place fan over rotor flange and torque bolts to 260 in. lbs. (29.4 Nm).  
14. Fasten drive discs to end of rotor shaft. Torque drive disc mounting bolts to 50 ft. lbs. (108.48 Nm).  
15. Attach hoist to adapter eye and place generator assembly in a horizontal position. Take care not to damage rotor or stator. Hoisting eyes of generator should be to the top.

16. Thread studs into flywheel as shown in Figure 6-15.



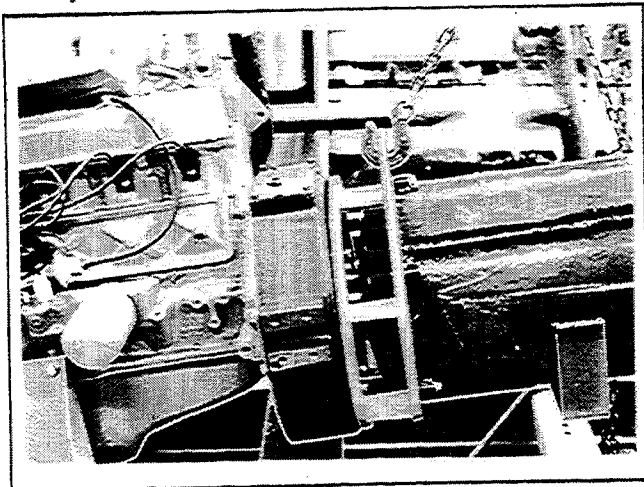
**Figure 6-15. Flywheel Studs**  
1. Flywheel Studs

17. Place hoist hooks into end bracket and adapter eye. Raise generator assembly and align studs with drive discs by turning the flywheel. Move generator as necessary to work drive discs over studs. When drive discs are about 1 in. (2.54 cm) over studs, install spacers. Figure 6-16.



**Figure 6-16. Installing Spacers**  
1. Drive Discs 3. Spacers  
2. Studs

18. Move generator as necessary to align adapter and flywheel housing. Fasten and final tighten adapter to flywheel housing bolts and lockwashers. Figure 6-17.

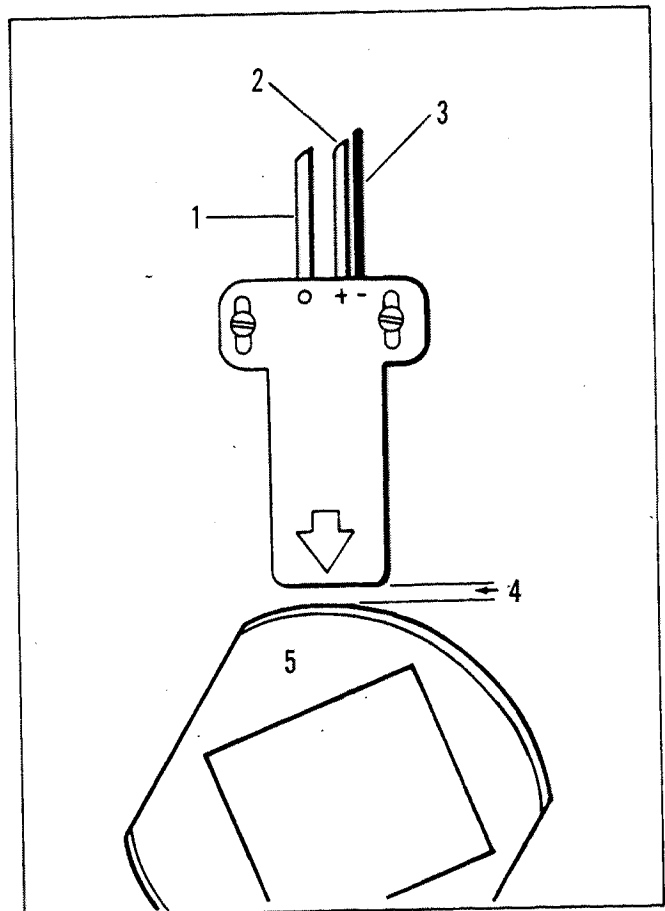


**Figure 6-17. Aligning Adapter and Flywheel Housing**

19. Install nuts on studs.
20. Hoist generator and engine slightly to remove wood block(s) from under flywheel housing. Align generator assembly and vibro mounts. Lower generator. Tighten vibro mount mounting bolts.
21. Remove chains or slings used to suspend generator. Final tighten drive discs to flywheel.
22. Install fan guard.
23. Reinstall junction box and controller. Reconnect all controller-to-engine and engine-to-generator harnesses and wiring. Refer to Section 7, Wiring Diagrams.
24. Reconnect fuel, cooling and exhaust systems that were disconnected during disassembly. Reconnect output leads or load circuit cables at generator. Open fuel supply valve.
25. Reconnect starting batteries and connect any AC accessories, such as battery charger, block heater and fuel transfer pump.

**NOTE**

Set speed sensor gap at 0.020 in. (0.508 mm) when remounting. Figure 6-18.



**Figure 6-18. Speed Sensor Air Gap**

- |                     |                            |
|---------------------|----------------------------|
| 1. White-Clear (16) | 4. .020 in. (0.508 mm) Gap |
| 2. Red (24)         | 5. Actuator Cup            |
| 3. Black (2)        |                            |

## NOTES

## Section 7

### WIRING DIAGRAMS

#### Engine-Generator Interconnections

- Figure 7-1. Perkins/TK-4.154 Diesel, 1-Phase/3-Phase
- Figure 7-2. Ford LSG-423 Gas/Gasoline, 1-Phase/3-Phase
- Figure 7-3. Ford CSG-649 Gas/Gasoline w/Breaker Ignition, 1-Phase/3-Phase
- Figure 7-4. Ford CSG-649 Gas/Gasoline w/Breaker Ignition, 600-Volt
- Figure 7-5. Ford CSG-649 Gas/Gasoline w/Electronic Ignition, 1-Phase/3-Phase
- Figure 7-6. Ford CSG-649 Gas/Gasoline w/Electronic Ignition, 600-Volt
- Figure 7-7. Ford LSG-875 Gas/Gasoline w/Breaker Ignition, 1-Phase/3-Phase
- Figure 7-8. Ford LSG-875 Gas/Gasoline w/Electronic Ignition, 1-Phase/3-Phase
- Figure 7-9. Cummins 4B, 6B Diesel, 1-Phase/3-Phase
- Figure 7-10. Cummins 4B, 6B Diesel, 600-Volt

#### Controllers

- Figure 7-11. Relay, Without Meters, 1-Phase/3-Phase
- Figure 7-12. Relay, With Meters, 1-Phase/3-Phase
- Figure 7-13. Relay, With Meters, 600-Volt
- Figure 7-14. Microcomputer, 1-Phase/3-Phase, Early Model
- Figure 7-15. Microcomputer, 1-Phase/3-Phase, Later Model
- Figure 7-16. Microcomputer, 600-Volt, Early Model
- Figure 7-17. Microcomputer, 600-Volt, Later Model

# Section 7 WIRING DIAGRAMS

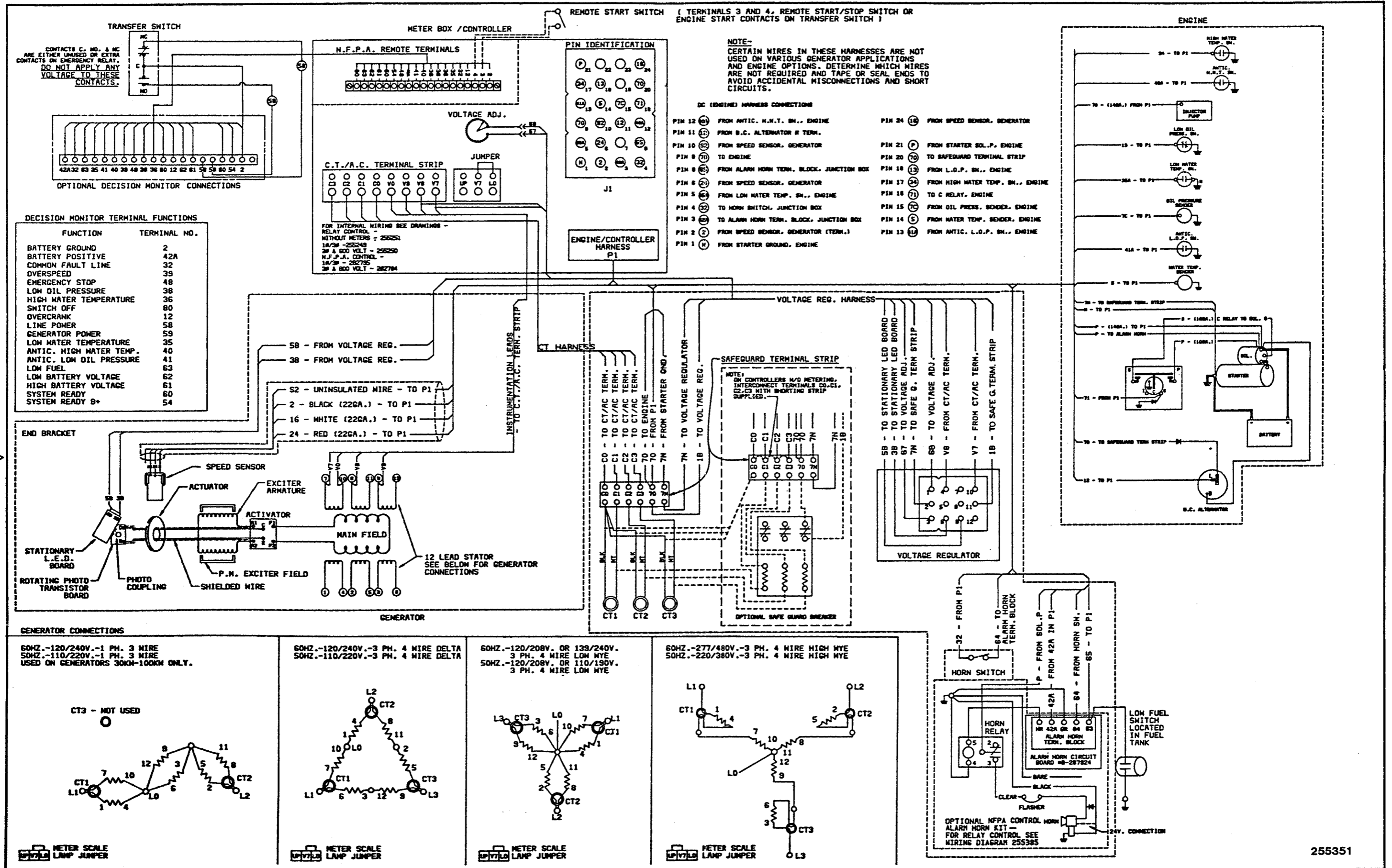


Figure 7-1. Perkins/TK-4.154 Diesel, 1-Phase/3-Phase

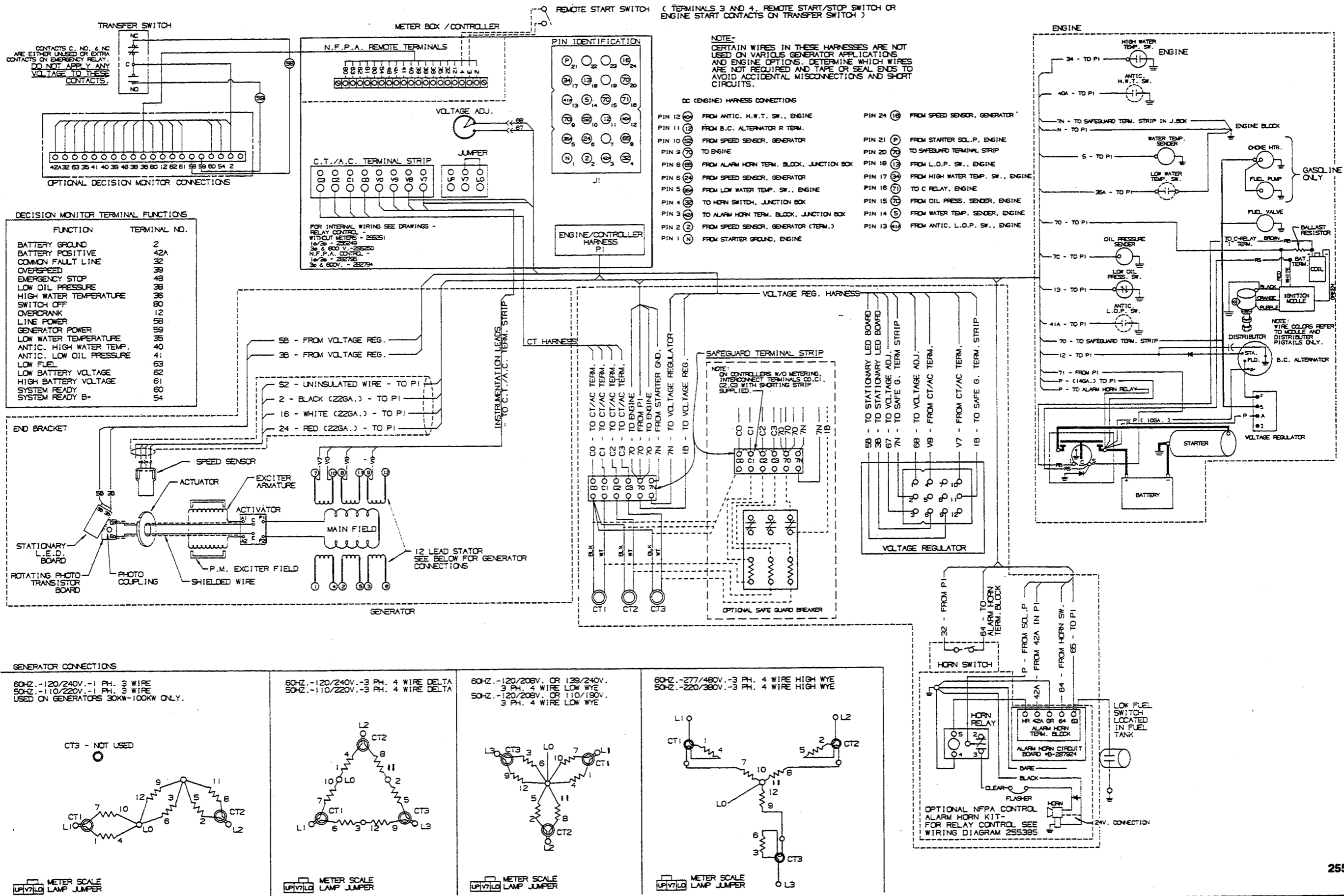


Figure 7-2. Ford LSG-423 Gas/Gasoline, 1-Phase/3-Phase

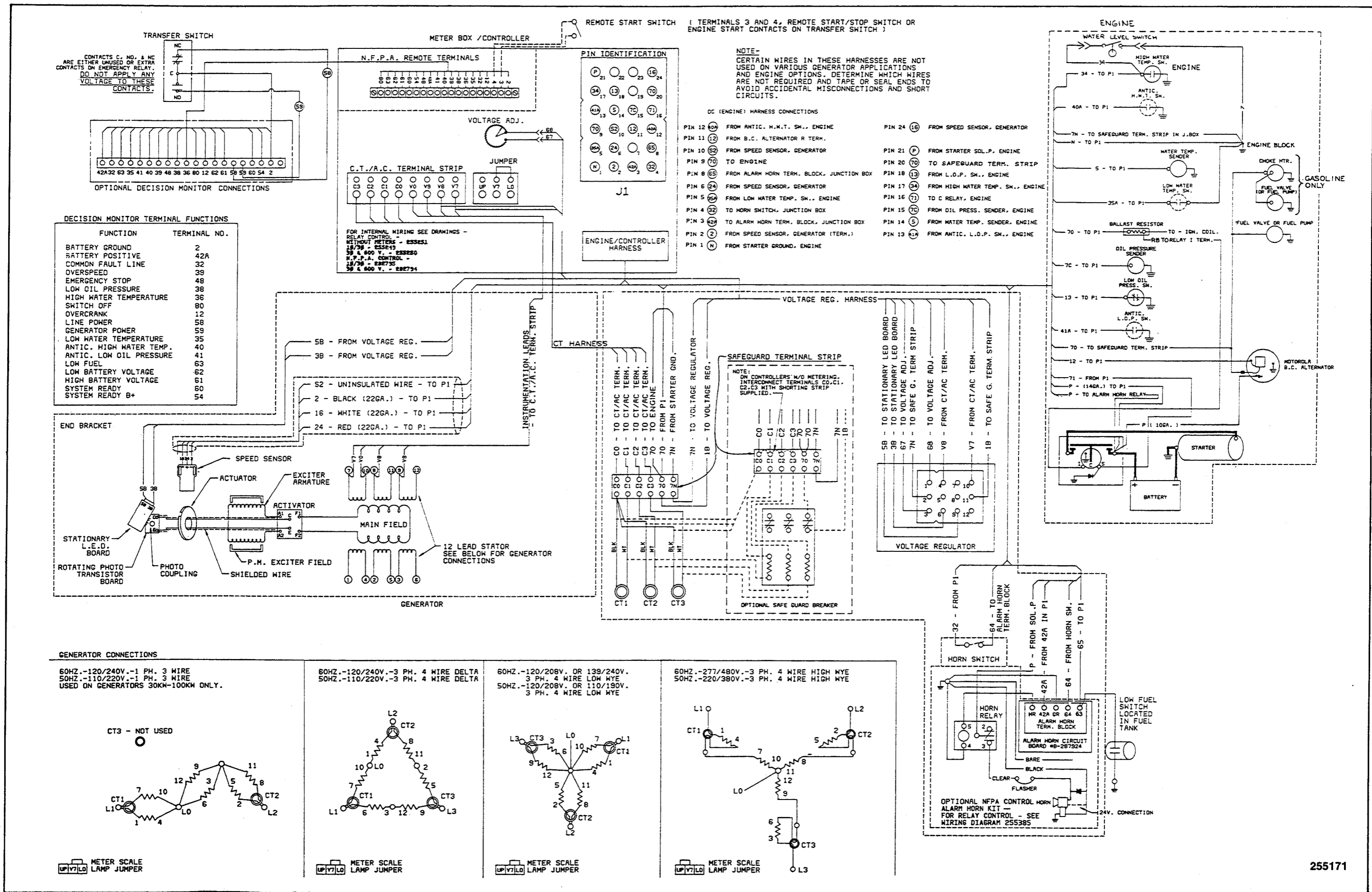


Figure 7-3. Ford CSG-649 Gas/Gasoline w/Breaker Ignition, 1-Phase/3-Phase

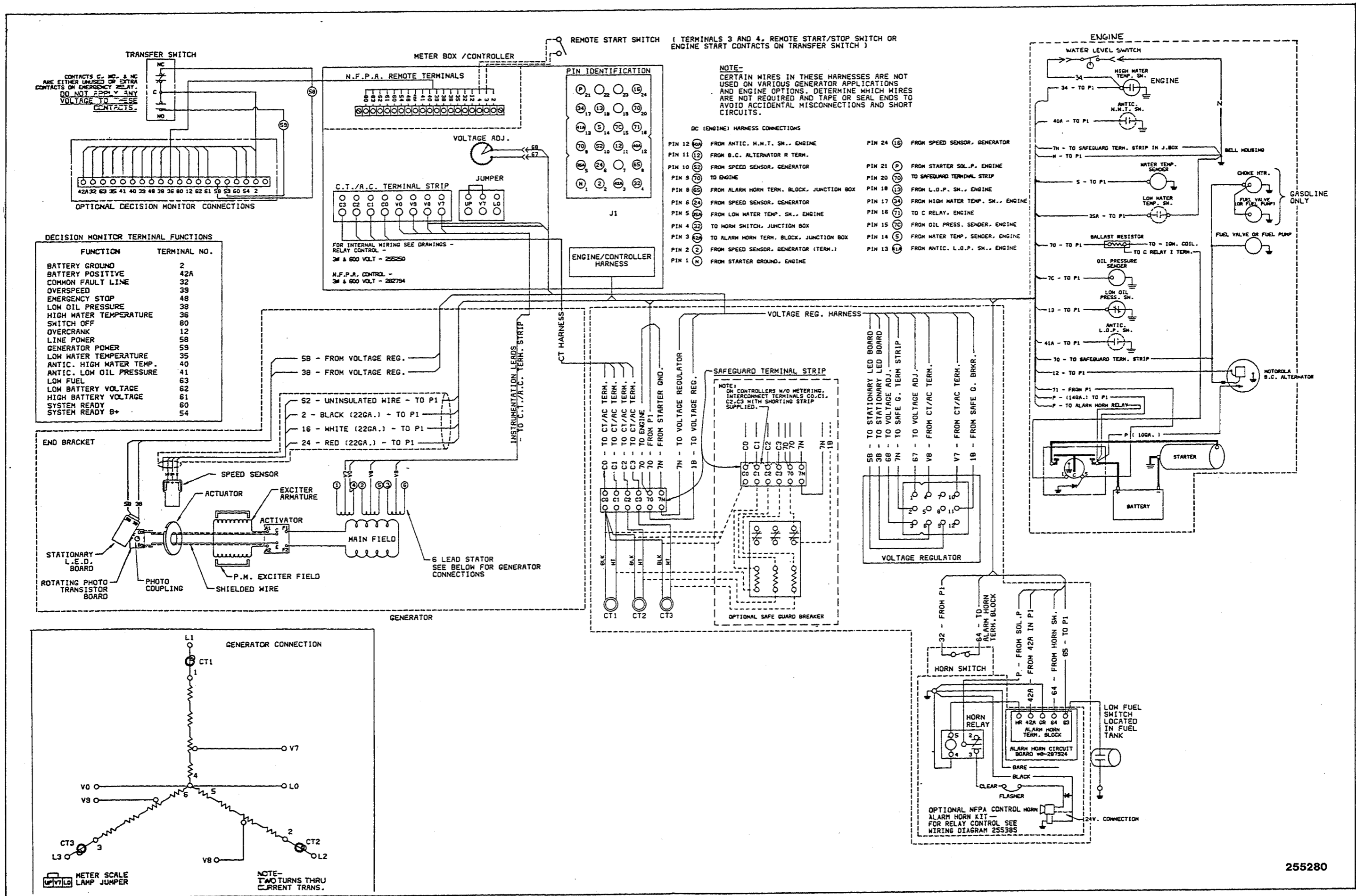


Figure 7-4. Ford CSG-649 Gas/Gasoline w/Breaker Ignition, 600-Volt



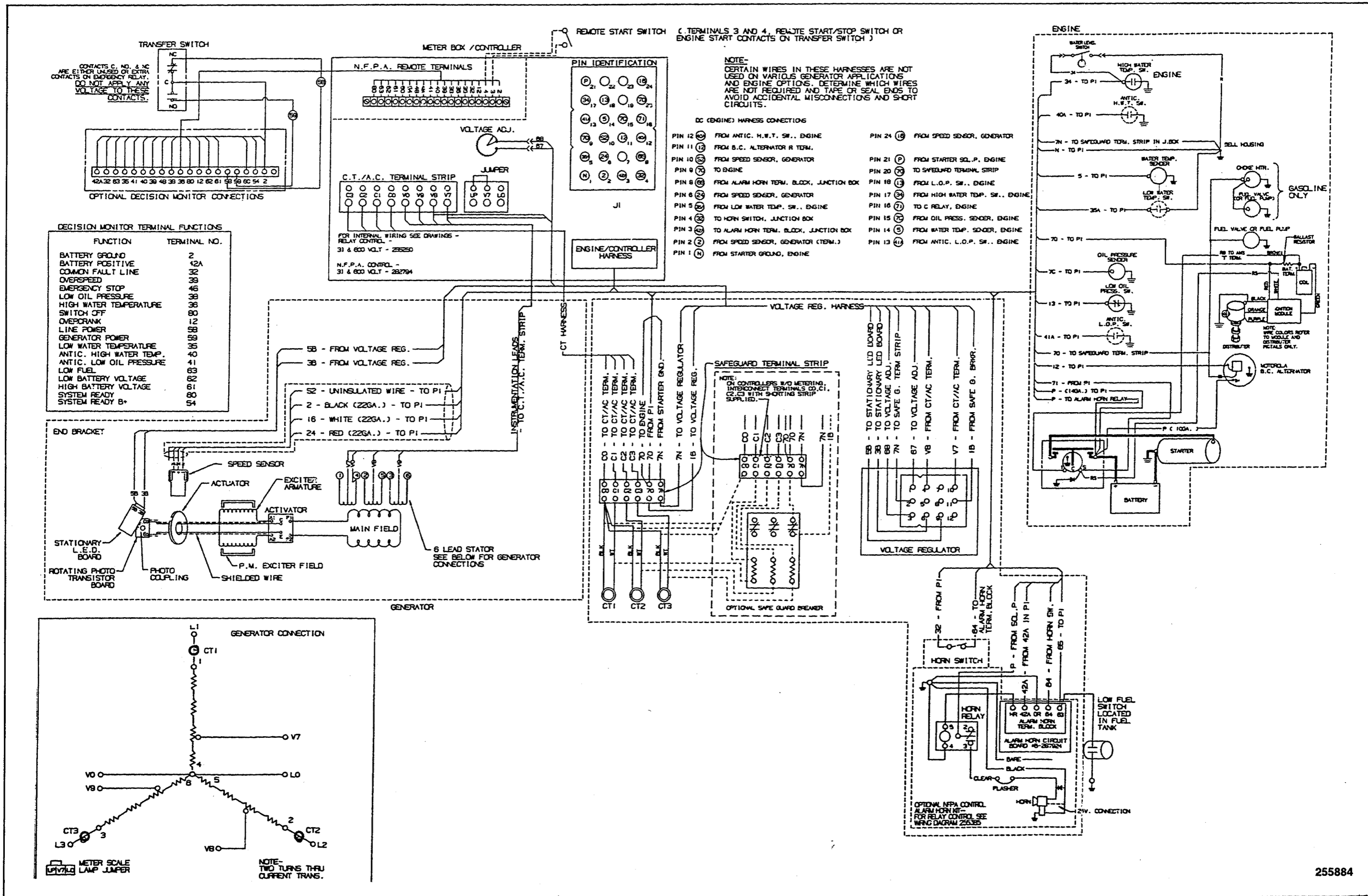


Figure 7-6. Ford CSG-649 Gas/Gasoline w/Electronic Ignition, 600-Volt

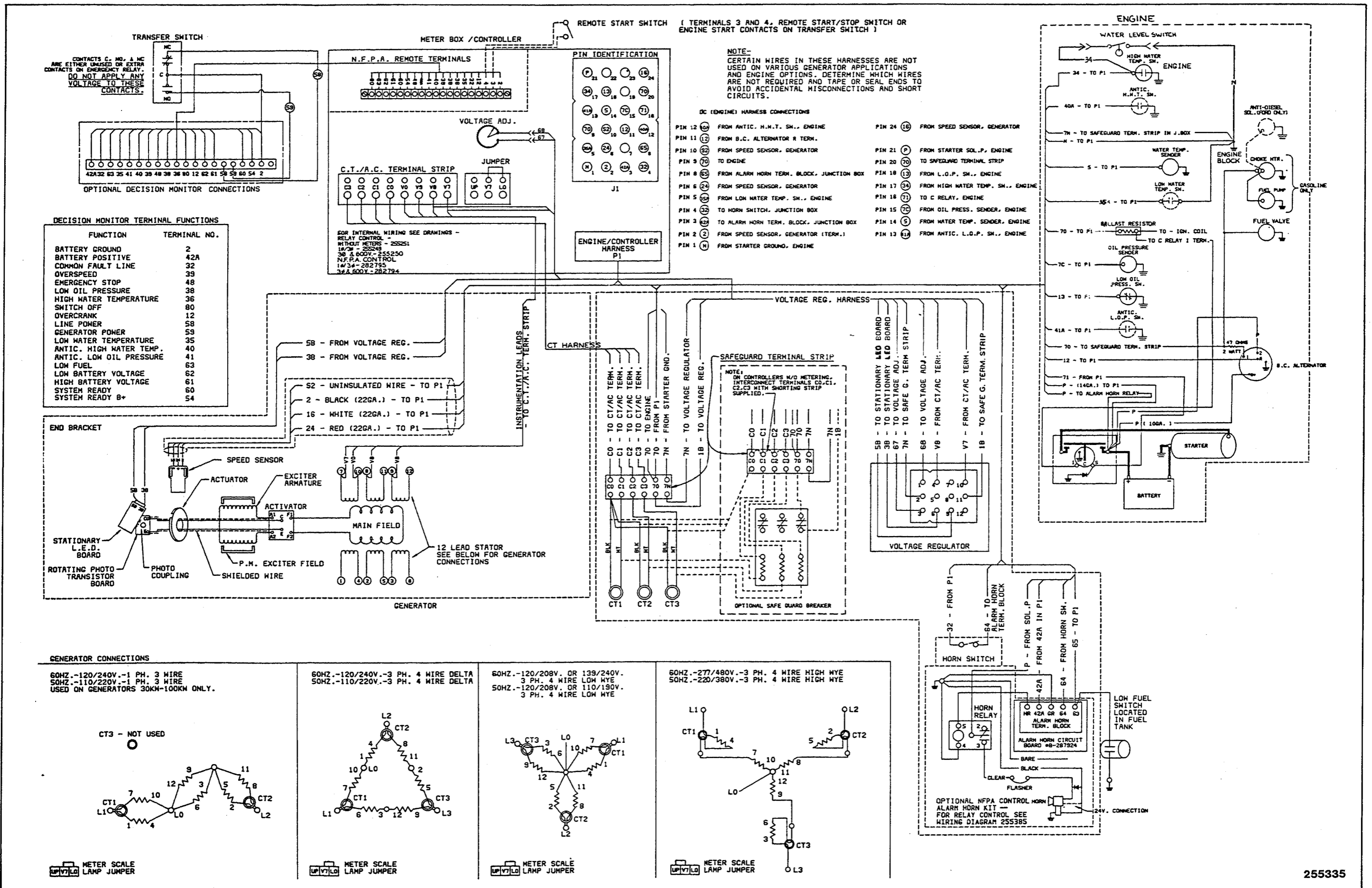


Figure 7-7. Ford LSG-875 Gas/Gasoline w/Breaker Ignition, 1-Phase/3-Phase

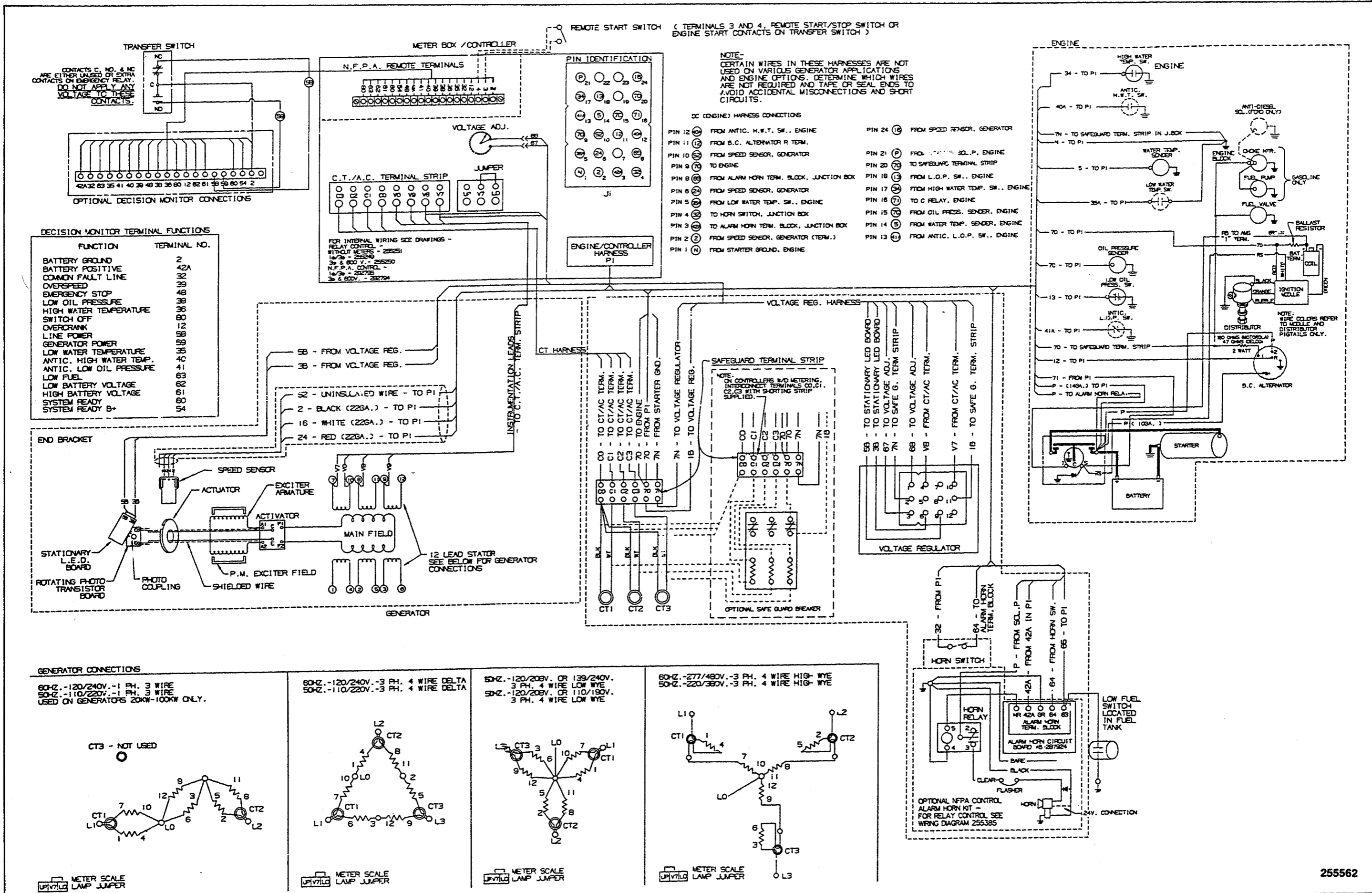


Figure 7-8. Ford LSG-875 Gas/Gasoline w/Electronic Ignition 1-Phase/3-Phase

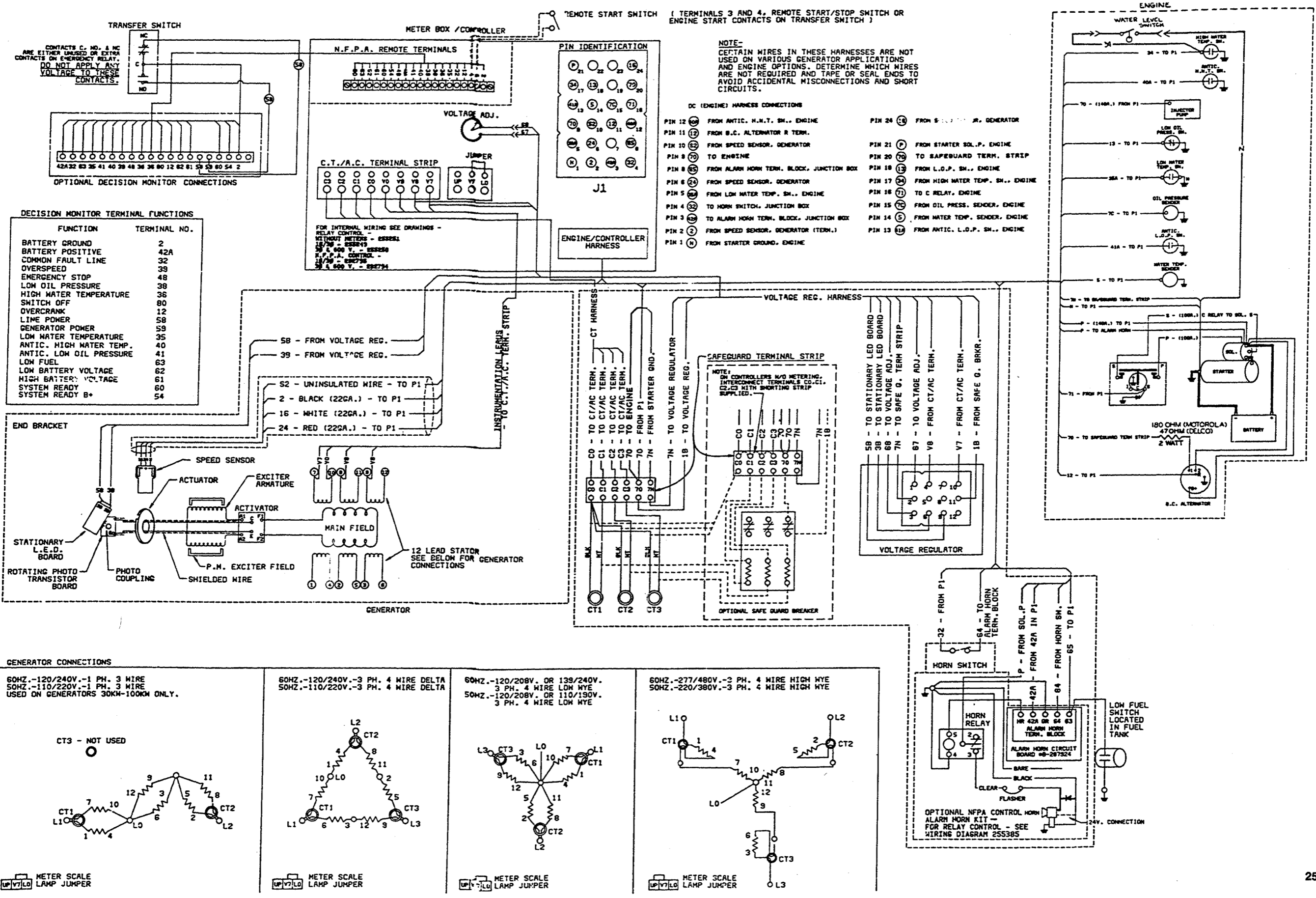


Figure 7-9. Cummins 4B, 6B Diesel, 1-Phase/3-Phase

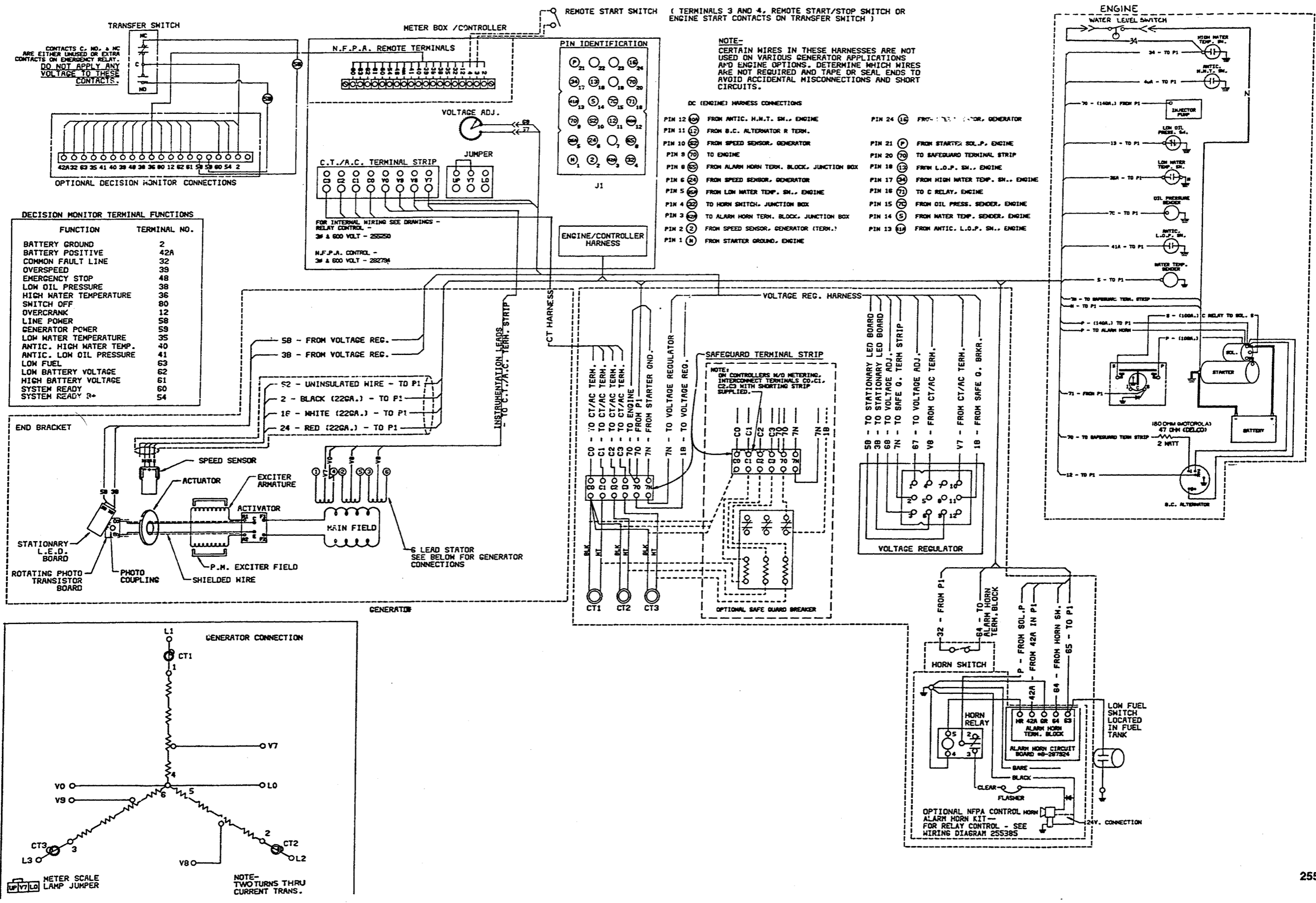


Figure 7-10. Cummins 4B, 6B Diesel, 600-Volt

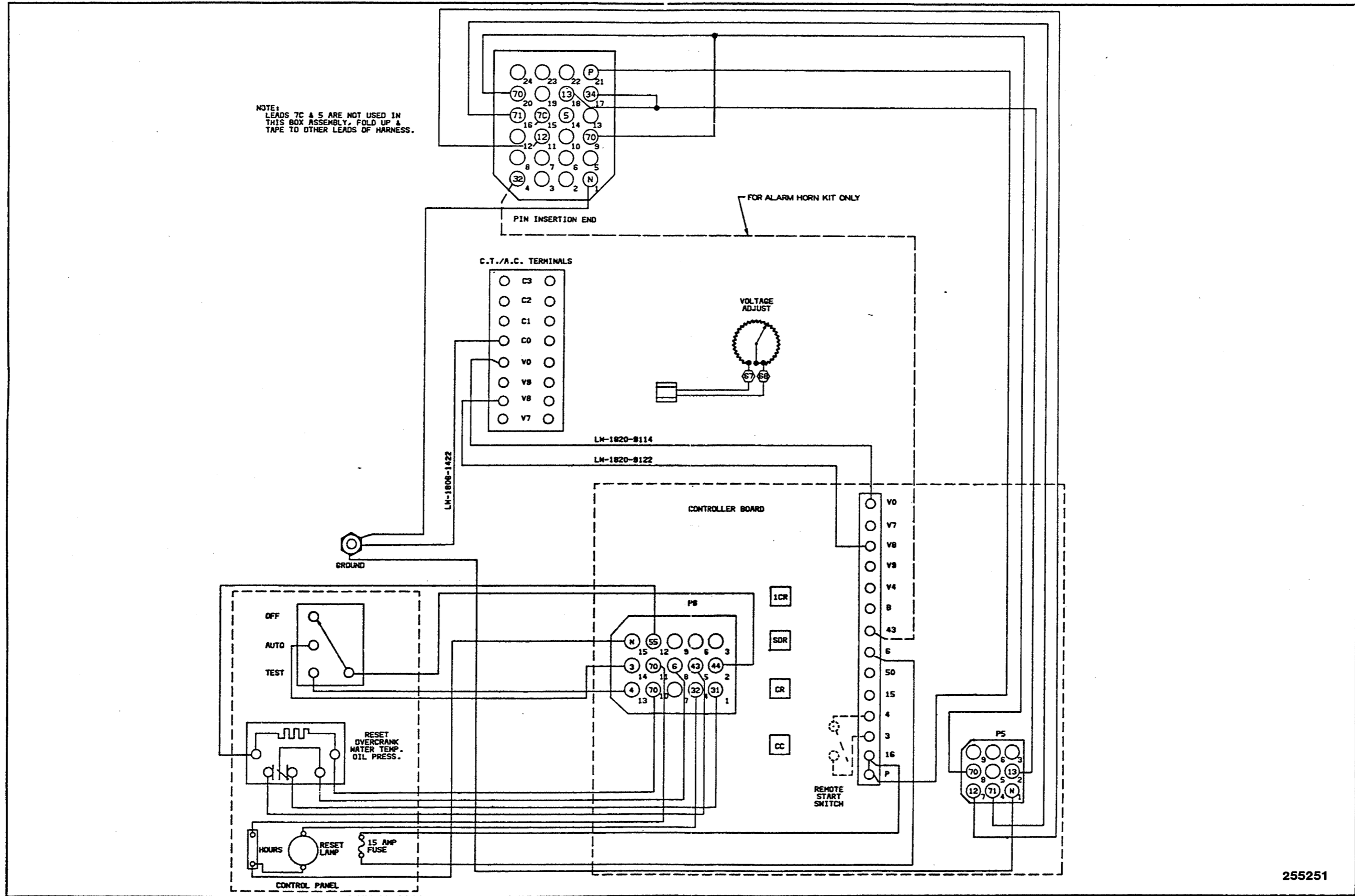
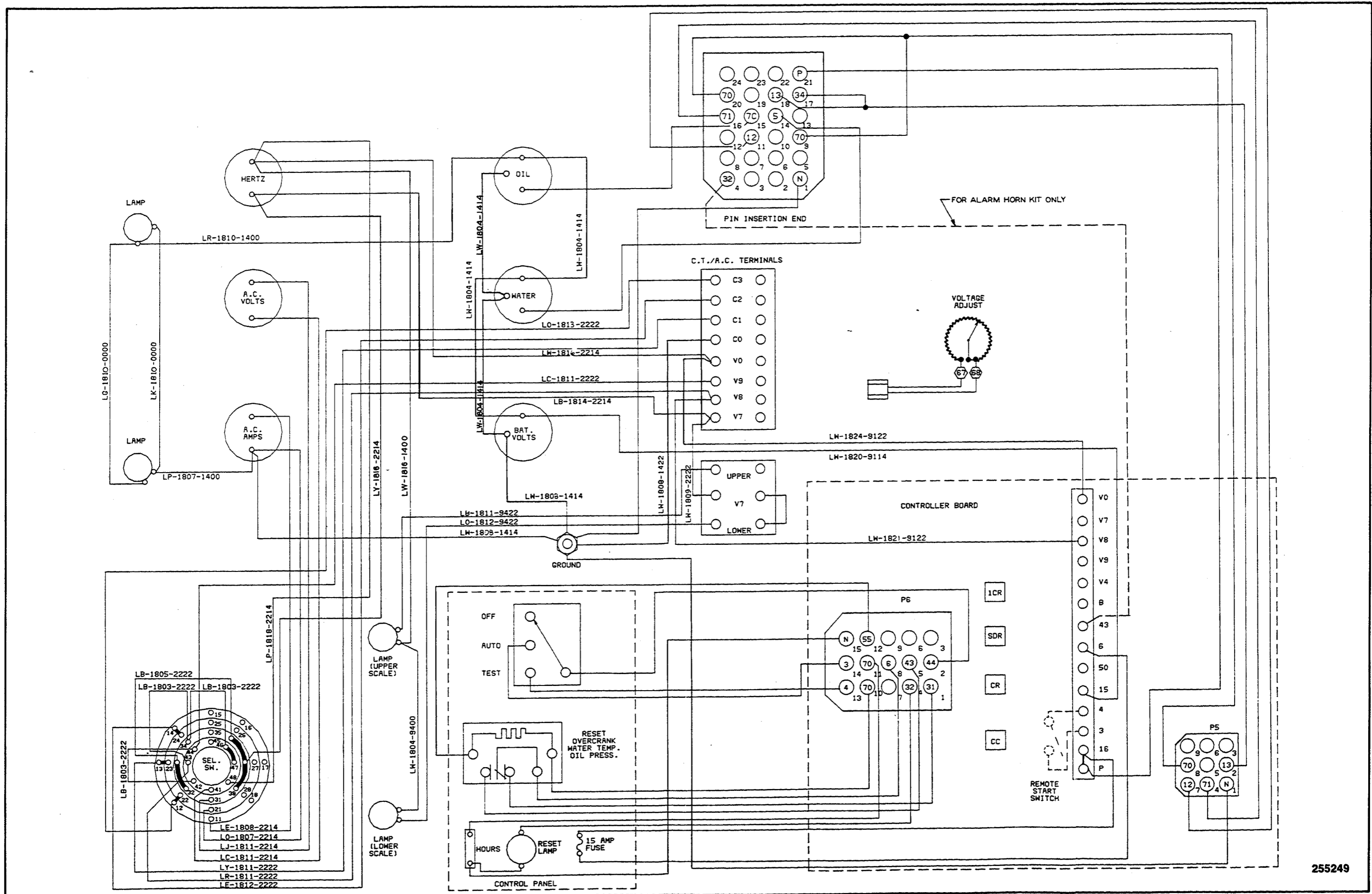
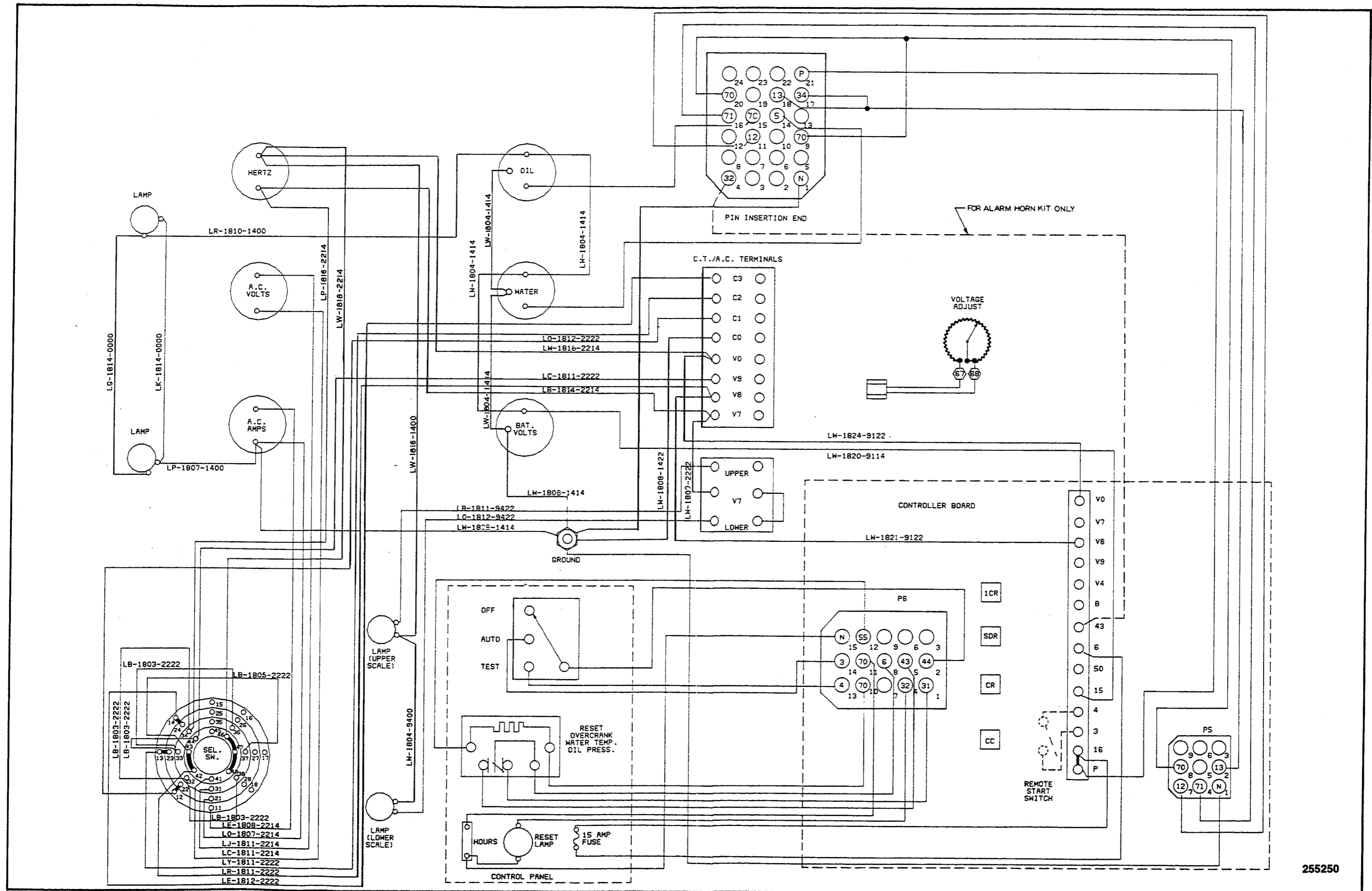


Figure 7-11. Relay, Without Meters, 1-Phase/3-Phase



255249

Figure 7-12. Relay, With Meters, 1-Phase/3-Phase



255250

Figure 7-13. Relay, With Meters, 600-Volt







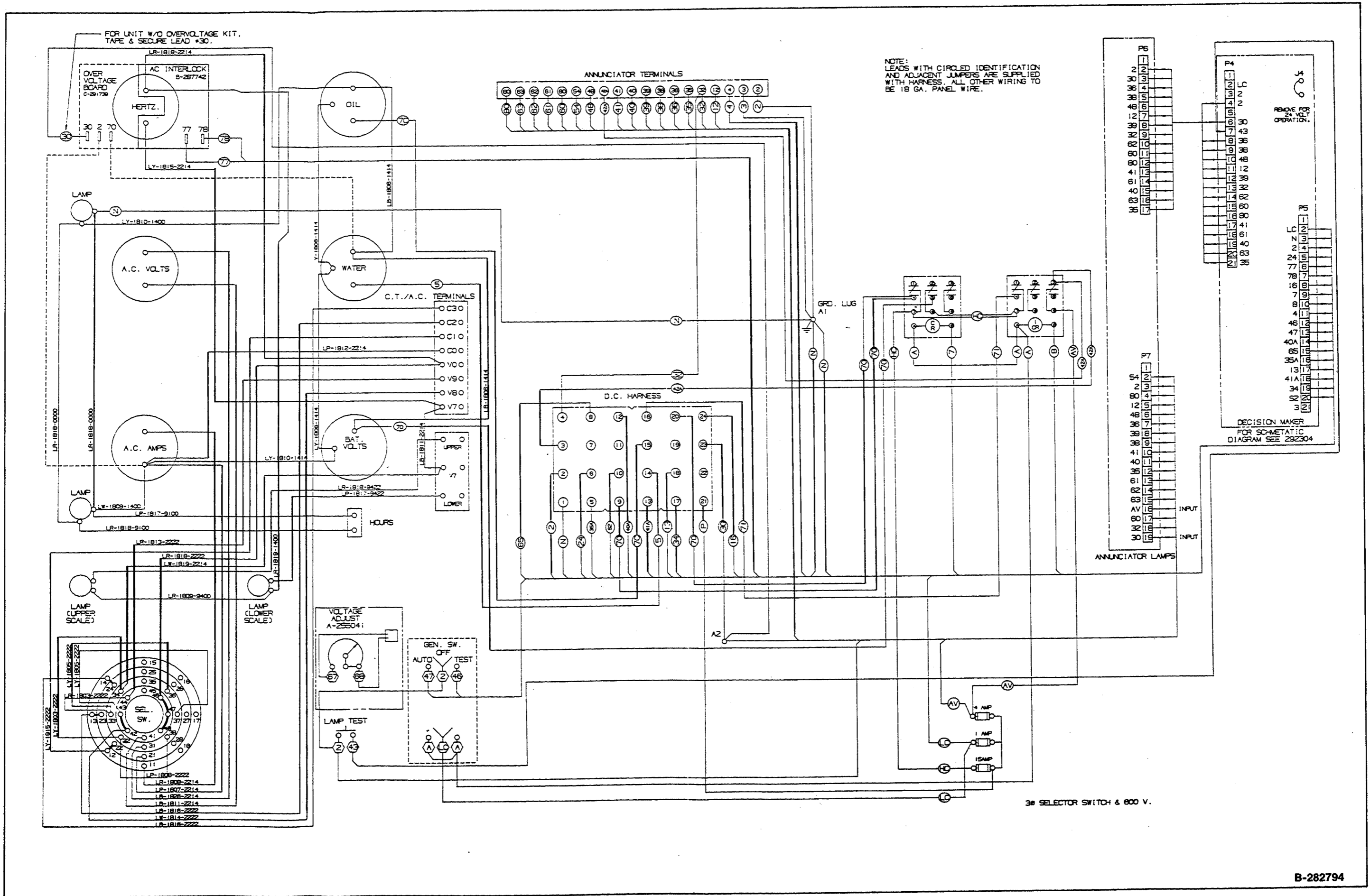


Figure 7-17. Microcomputer, 600-Volt, Later Model

# Appendix A

## GENERATOR FREQUENCY CHANGE AND ADJUSTMENT

### All Models

#### Frequency Change

On Microcomputer equipped generators, the jumper indicated in Figure A1 must be snipped in order to convert from 60 Hz to 50 Hz.

63 Hz for 60 Hz operation and 53 Hz for 50 Hz operation. If your generator is equipped with an isochronous governor, check for 60 and 50 Hz operation at no load. If your controller is not equipped with a frequency meter, connect a meter across V0 and V7 on the control board terminal strip (set must not be running while making connection). Refer to Figure A2.

#### Frequency Adjustment

To check your generator set for proper frequency operation, check the frequency meter for a no load reading of

To adjust governor speed, refer to the governor adjustment section for your specific unit.

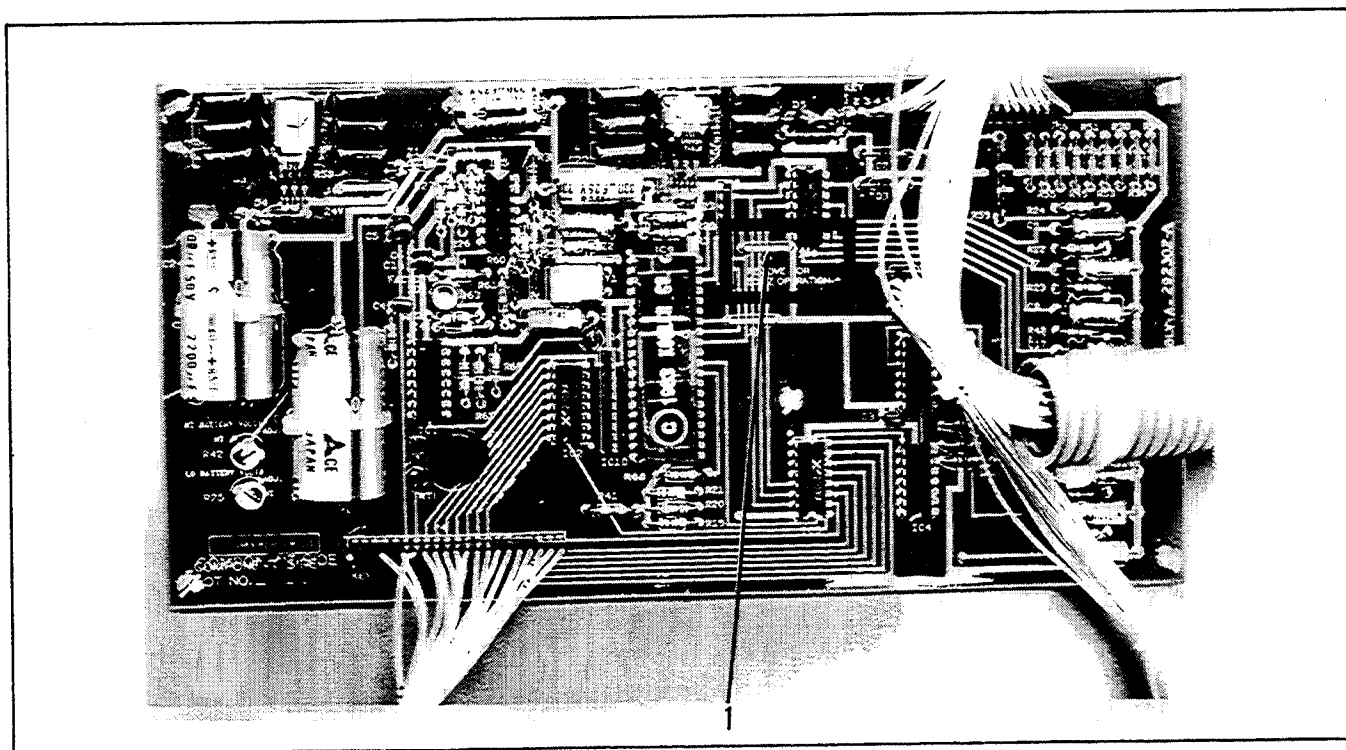


Figure A1. Jumper Location  
1. Jumper (J1) 50/60 Hz Operation

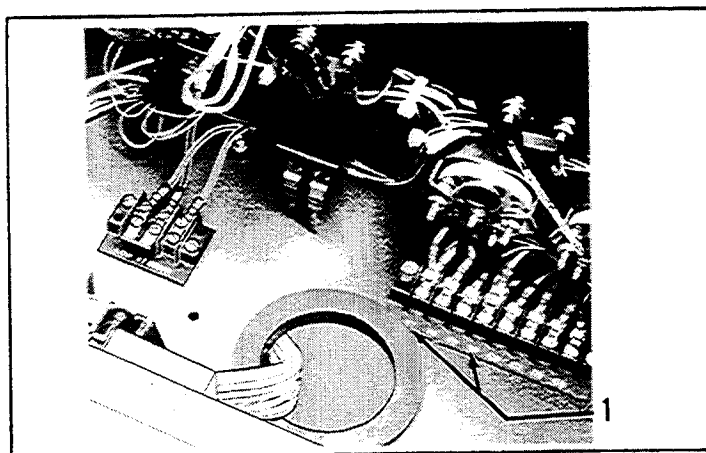


Figure A2. Frequency Meter Connections  
1. Meter Connections

# GOVERNOR ADJUSTMENTS

## Diesel

### Mechanical Governor Adjustments

#### Frequency Adjustment

1. Start the generator set, observe the frequency meter.
2. Loosen the fuel pump high speed screw locknut to make the adjustments. See Figure A-3.
3. To increase or decrease the frequency (at no load), rotate the screw clockwise or counterclockwise respectively. Tighten the locknut.

The loaded droop frequency may alternately be adjusted to the operating frequency at full load. Apply the full load to the generator set by closing the generator circuit breaker and then make adjustments to the fuel pump screw.

The stability of the frequency is not adjustable, it is preset via the fuel pump.

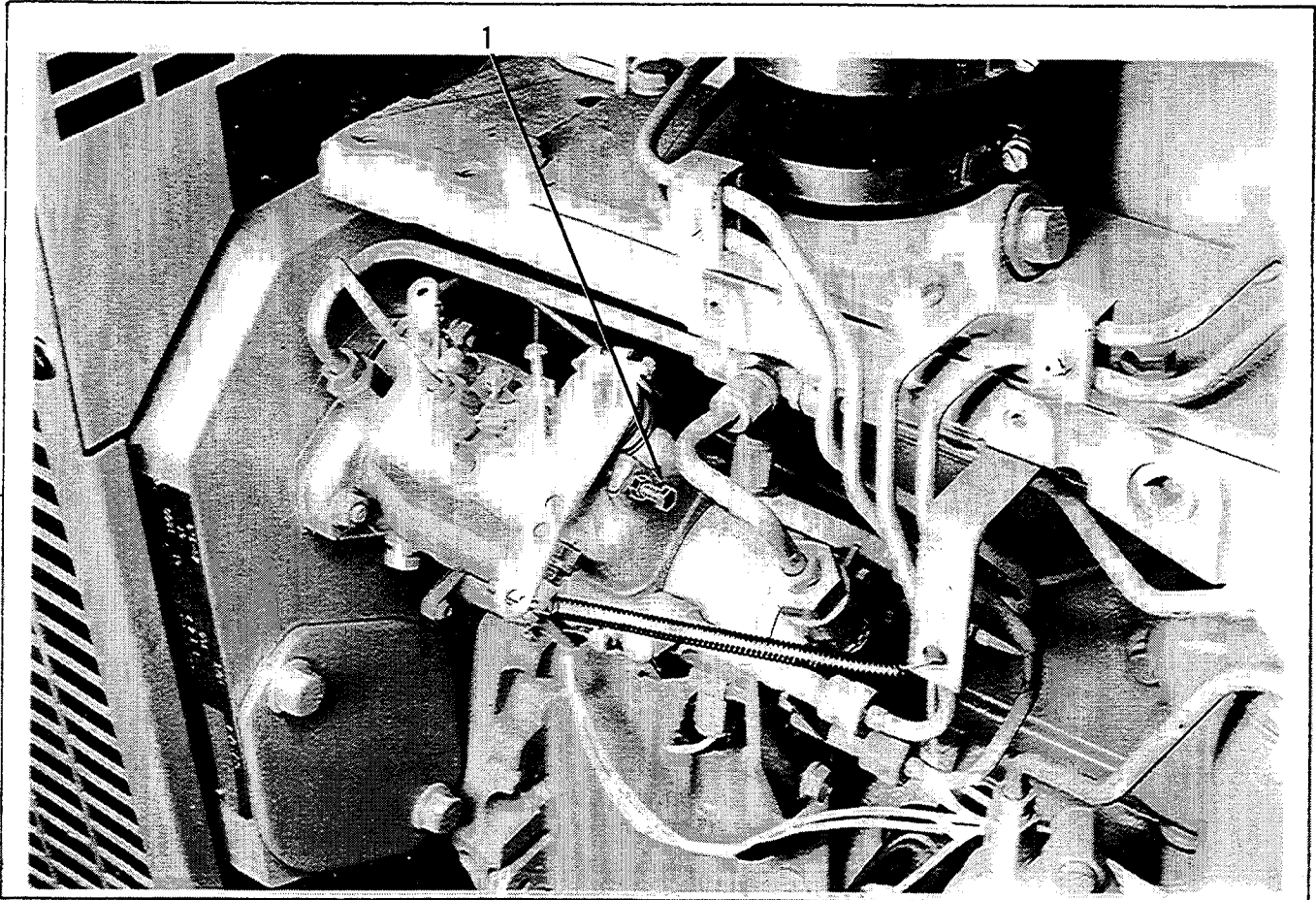


Figure A-3. Fuel Pump High Speed Screw  
1. Adjustment Screw

# Gas/Gasoline Mechanical Governor Adjustments

With the constant speed type governor, the throttle linkage is fixed at a definite length to establish a specific load speed of 1800 rpm (1500 rpm, 50 Hz models). No adjustment should be made to throttle linkage as any variation in speed causes frequency changes in output of the generator – for this reason only slight readjustment of speed is possible. If governor setting is too sensitive, hunting or speed surging will occur with changing load. If a con-

siderable drop in speed is experienced when normal load is applied, the governor should be adjusted for greater sensitivity. If one of the governor settings is readjusted, the other should be readjusted since each has an effect on the other. The governor components and adjustments are shown in Figure A4. With the set running at full or rated load, governed speed, make speed and sensitivity adjustments.

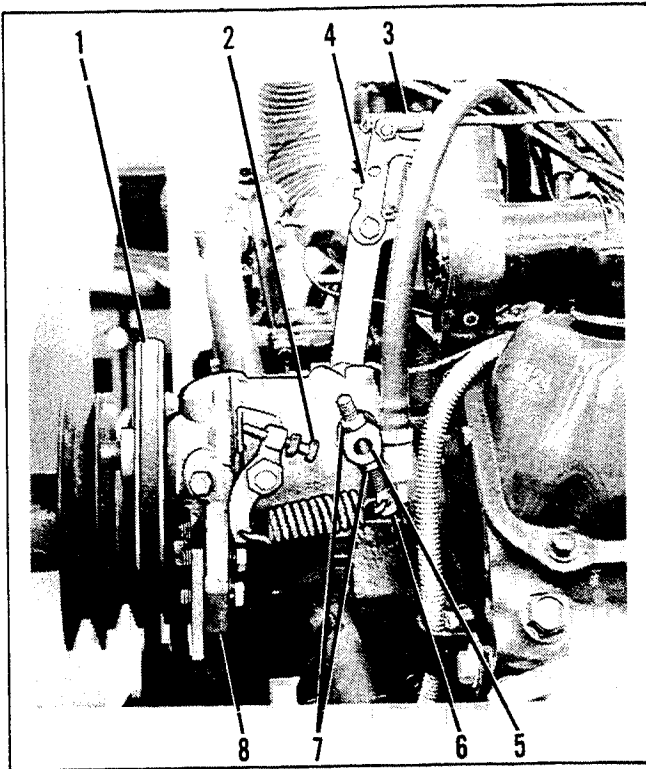


Figure A-4. Governor Components and Adjustments

- |                     |                           |
|---------------------|---------------------------|
| 1. Governor Belt    | 5. Pivot Point            |
| 2. Speed Adjustment | 6. Eyebolt Head           |
| 3. Throttle Linkage | 7. Sensitivity Adjustment |
| 4. Governor Arm     | 8. Governor Mounting      |

## Speed

Check speed with hand tachometer, or frequency meter. Loosen locking nut on speed adjusting screw. Turn screw in clockwise direction to increase speed (and frequency) or in counterclockwise direction to decrease speed. Lock nut at new setting. Follow this adjustment with sensitivity (droop) adjustment.

## Sensitivity

Test under normal load conditions. If readjustment is needed proceed as follows. To make governor control more sensitive, loosen the nut at bottom of adjusting eyebolt and tighten the top nut thereby drawing the head of the eyebolt closer to the governor arm pivot point. To make governor control less sensitive, loosen the top nut and tighten the bottom nut to move the head of the eyebolt away from the pivot point. After sensitivity is correct, tighten the nut that was previously loosened to lock the eyebolt at the new setting. Recheck speed after sensitivity adjustment since changing this will also affect speed.

## NOTE

A speed droop of 3 Hz or 90 rpm between no load and full load is normal.

# Diesel and Gas/Gasoline Bosch Electronic Governor Adjustments

Some sets are equipped with Bosch Electronic Governors. Since the governor is all electric, no mechanical drive or hydraulic connection is required. The system consists of a magnetic pickup (Figure A-5) to sense engine speed, an electronic control unit (Figure A-6) with stability and gain adjustments to control the current input to the throttle actuator and an actuator (Figure A-7) to position the throttle.

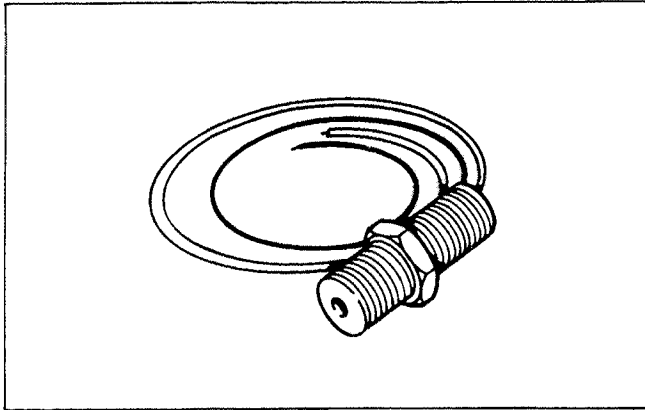


Figure A-5. Magnetic Pickup

## Stability and Gain Adjustments

The stability and gain adjustments are located on the control unit (Figure A-6). To adjust governor proceed as follows:

1. Check that the stability control is in its extreme counterclockwise position.

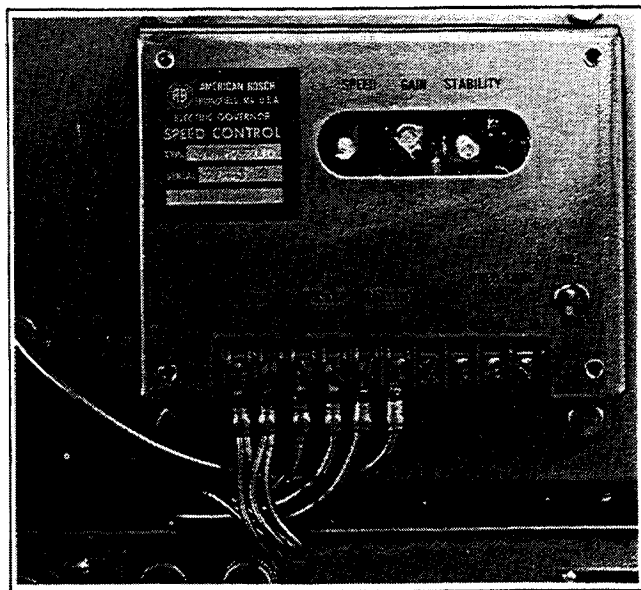


Figure A-6. Control Unit

2. Start engine. While observing normal precautions allow the governor to control the engine. If the engine is unstable, turn the gain control counterclockwise until stability is obtained. Adjust speed screw (Figure A-6) to the proper engine speed.
3. Turn the gain control clockwise until the engine becomes just unstable. Back the gain control slightly counterclockwise until the engine is again stable.
4. Turn the stability control clockwise until the engine becomes just unstable. Back the stability control slightly counterclockwise until the engine is again stable.

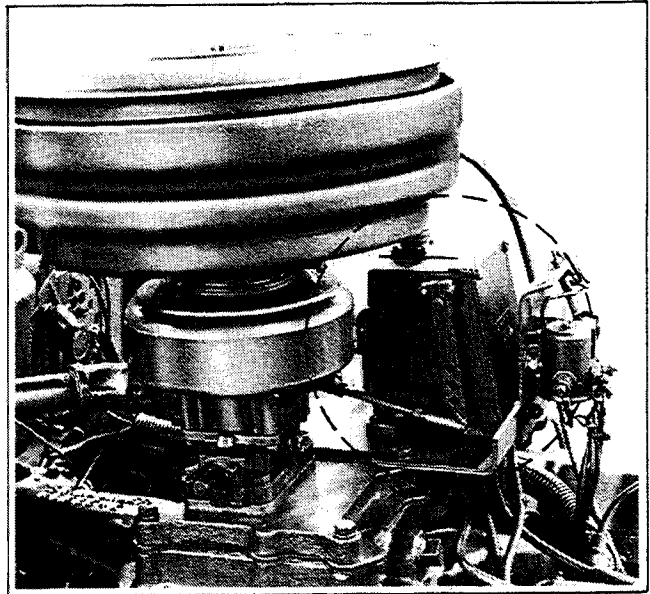


Figure A-7. Throttle Actuator

# Appendix B TABLES AND FORMULAS

**Generator Output  
Three-Phase Amperes — 0.8 Power Factor**

| kW   | kVA  | 208-Volt | 220-Volt | 240-Volt | 380-Volt | 400-Volt | 480-Volt | 600-Volt |
|------|------|----------|----------|----------|----------|----------|----------|----------|
| 5    | 6.3  | 17.5     | 16.5     | 15.2     | 9.6      | 9.1      | 7.6      | 6.1      |
| 7.5  | 9.4  | 26.1     | 24.7     | 22.6     | 14.3     | 13.6     | 11.3     | 9.1      |
| 10   | 12.5 | 34.7     | 33       | 30.1     | 19.2     | 18.2     | 15.1     | 12       |
| 15   | 18.7 | 52       | 49.5     | 45       | 28.8     | 27.3     | 22.5     | 18       |
| 20   | 25   | 69.5     | 66       | 60.2     | 38.4     | 36.4     | 30.1     | 24       |
| 25   | 31.3 | 87       | 82.5     | 75.5     | 48       | 45.5     | 37.8     | 30       |
| 30   | 37.5 | 104      | 99       | 90.3     | 57.6     | 54.6     | 45.2     | 36       |
| 40   | 50   | 139      | 132      | 120      | 77       | 73       | 60       | 48       |
| 50   | 62.5 | 173      | 165      | 152      | 96       | 91       | 76       | 61       |
| 60   | 75   | 208      | 198      | 181      | 115      | 109      | 91       | 72       |
| 75   | 93.8 | 261      | 247      | 226      | 143      | 136      | 113      | 90       |
| 80   | 100  | 278      | 264      | 240      | 154      | 146      | 120      | 96       |
| 100  | 125  | 347      | 330      | 301      | 192      | 182      | 150      | 120      |
| 125  | 156  | 433      | 413      | 375      | 240      | 228      | 188      | 150      |
| 150  | 187  | 520      | 495      | 450      | 288      | 273      | 225      | 180      |
| 175  | 219  | 608      | 577      | 527      | 335      | 318      | 264      | 211      |
| 200  | 250  | 694      | 660      | 601      | 384      | 364      | 301      | 241      |
| 250  | 312  | 866      | 825      | 751      | 480      | 455      | 376      | 300      |
| 300  | 375  | 1040     | 990      | 903      | 576      | 546      | 451      | 361      |
| 350  | 438  | 1220     | 1155     | 1053     | 672      | 637      | 527      | 422      |
| 400  | 500  | 1390     | 1320     | 1203     | 770      | 730      | 602      | 481      |
| 500  | 625  | 1735     | 1650     | 1504     | 960      | 910      | 752      | 602      |
| 600  | 750  | 2080     | 1980     | 1803     | 1150     | 1090     | 902      | 721      |
| 700  | 875  | 2430     | 2310     | 2104     | 1344     | 1274     | 1052     | 842      |
| 800  | 1000 | 2780     | 2640     | 2405     | 1540     | 1460     | 1203     | 962      |
| 900  | 1125 | 3120     | 2970     | 2709     | 1730     | 1640     | 1354     | 1082     |
| 1000 | 1250 | 3470     | 3300     | 3009     | 1920     | 1820     | 1504     | 1202     |

**Miscellaneous Electrical Formulae:**

**Power — A.C. Circuits:**

$$\text{Power Factor} = \frac{\text{Watts}}{\text{Volts x Amperes}}$$

$$\text{Three-Phase Kilowatts} = \frac{\text{Volts x Amperes x Power factor x } \sqrt{3}}{1000}$$

$$\text{Three-Phase Volt Amperes} = \text{Volts x Amperes x } \sqrt{3}$$

$$\text{Three-Phase Amperes} = \frac{746 \times \text{Horsepower}}{\sqrt{3} \times \text{Volts x Efficiency x Power Factor}}$$

$$\text{Single-Phase Kilowatts} = \frac{\text{Volts x Amperes x Power Factor}}{1000}$$

$$\text{Single-Phase Amperes} = \frac{746 \times \text{Horsepower}}{\text{Volts x Efficiency x Power Factor}}$$

# Appendix C

## ISOLATED ALARM CONTACT KIT

(No. A-282927 (12 Volt) for use with "R" Series Units with NFPA Option and FRII Units.)  
(No. A-282928 (24 Volt) for use with FRII Units.)

### FUNCTION

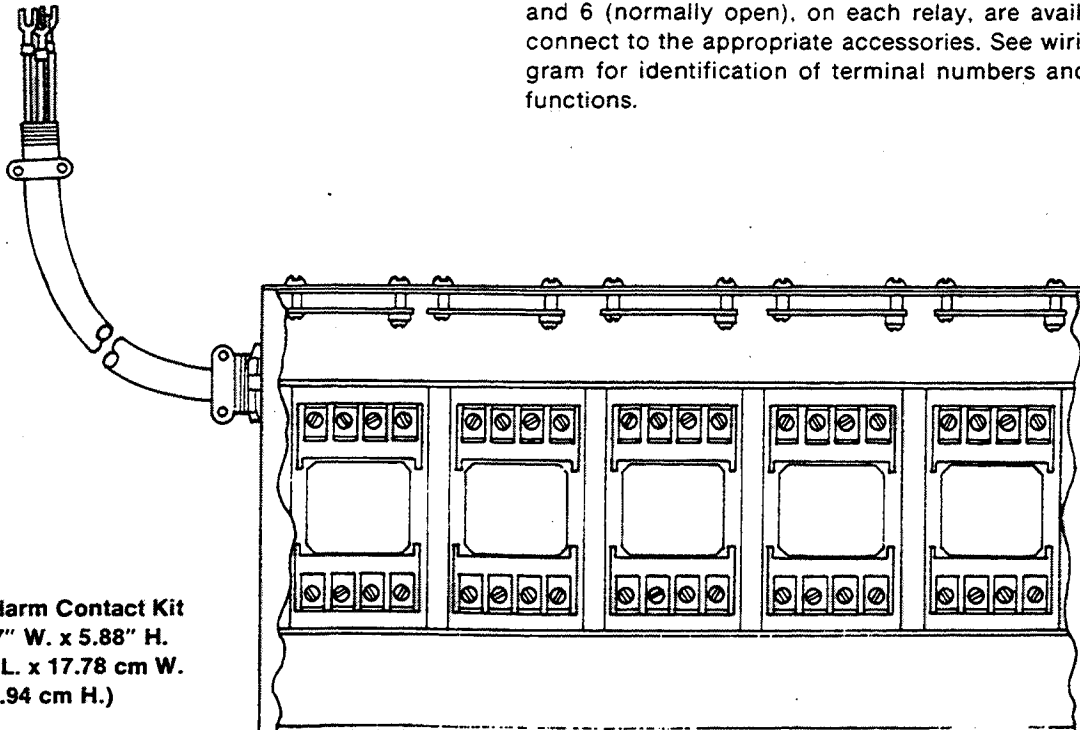
The Kohler Isolated Alarm Contact Kit can be used to activate indicating lamps, audible alarms or any accessory the customer deems necessary from up to five generator functions. This allows monitoring of the standby power system and/or the ability to activate accessories from a station remote from the generator set.

### MOUNTING

The Kohler Isolated Alarm Contact Kit can be mounted in any location including on the generator set, see illustration below. More than one Isolated Alarm Contact Kit can be connected to the terminal strip in controller if desired. The Contact Kit can be used as an alternate or in conjunction with the Decision Monitor annunciator panel.

### NOTE

A total of three Kohler Isolated Alarm Contact Kits and/or Kohler Annunciator Panels can be used together. When three monitors are used, the 3-A fuse in the back of the controller must be replaced with a 5-A fuse.



Isolated Alarm Contact Kit  
12" L. x 7" W. x 5.88" H.  
(30.48 cm L. x 17.78 cm W.  
x 14.94 cm H.)

### WARNING

**UNIT STARTS WITHOUT NOTICE!** Units with Automatic Transfer Switches start automatically. Turn Generator Main Switch on controller to OFF position, and remove battery cables to disable generator set before working on any equipment connected to generator. When removing and connecting battery cables disconnect ground lead first, and reconnect it last to avoid electrical shock or sparks igniting explosive battery gases.

### CONNECTION REQUIREMENTS

Connection of terminals 2 and 42A from annunciator terminal strip in controller to the Isolated Alarm Contact Kit must be made to provide an electrical source. The customer then has the choice of up to five functions (terminal 64 on each relay) to activate the appropriate accessories. The standard connections are shown on the wiring diagram. Terminals 7 and 9 on each relay are the common terminals. Terminals 1 and 3 (normally closed) and terminals 4 and 6 (normally open), on each relay, are available to connect to the appropriate accessories. See wiring diagram for identification of terminal numbers and alarm functions.

**JUNCTION BOX TERMINAL FUNCTIONS**

| Function                | Terminal No. |
|-------------------------|--------------|
| Battery Ground          | 2 )          |
| Battery Positive        | 42A )        |
| Common Fault Line       | 32 )         |
| Overspeed               | 39 )         |
| Emergency Stop          | 48 )         |
| Low Oil Pressure        | 38. )        |
| High Water Temperature  | 36 )         |
| Switch Off              | 80 )         |
| Overcrank               | 12 )         |
| Line Power              | 58 )         |
| Generator Power         | 59 )         |
| Low Water Temperature   | 35 )         |
| Antic. High Water Temp. | 40 )         |
| Antic. Low Oil Pressure | 41 )         |
| Low Fuel                | 63 )         |
| Low Battery Voltage     | 62 )         |
| High Battery Voltage    | 61 )         |
| System Ready            | 60 )         |
| System Ready -- B+      | 54 )         |

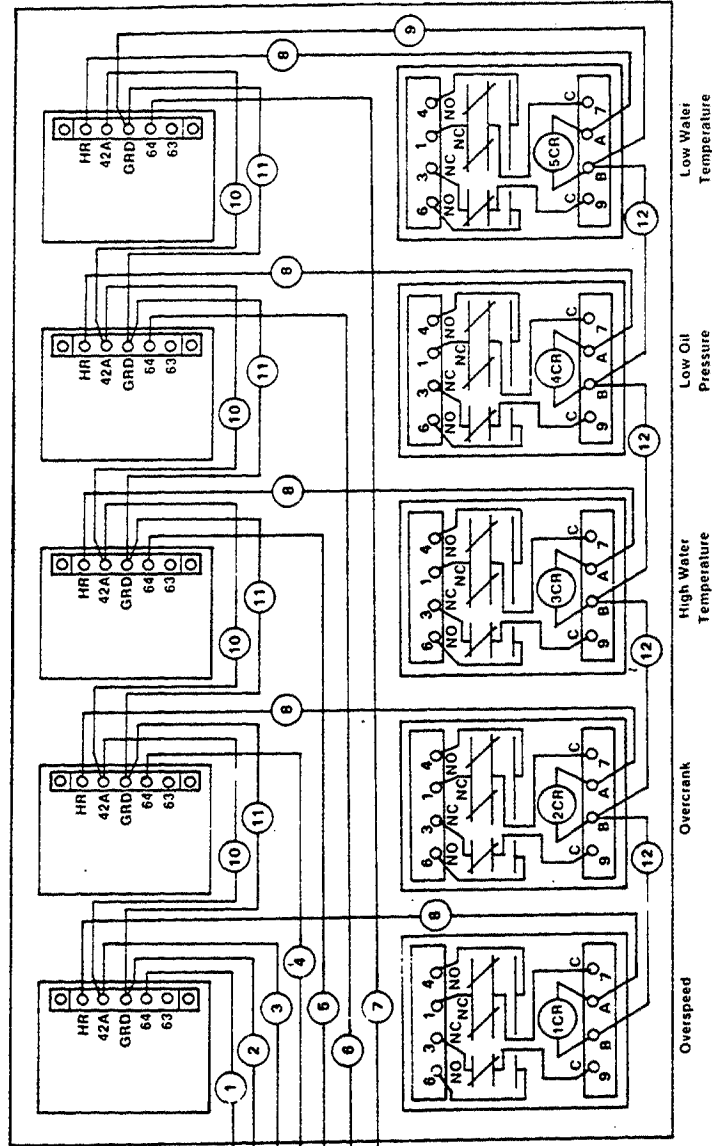
-- Standard Controller

-- Anticipatory Function Option Additions

-- NFPA Option Additions

**Parts List for A-282927 and A-282928**

| Qty. | Part No.  | Description             |
|------|-----------|-------------------------|
| 2    | X-252-2   | Connector, Conduit 1/2" |
| 1    | X-6003-21 | Conduit                 |
| 1    | X-6008-3  | Mounting Track          |
| 5    | 241600    | Relay (12 Volt)         |
| 5    | 291309    | Relay (24 Volt)         |
| 1    | 282885    | Panel                   |
| 1    | 282886    | Panel                   |
| 1    | 282887    | Box, Junction           |
| 5    | A-287924  | Board Assembly, Circuit |
| 5    | 291273    | Socket Assembly         |



**Isolated Alarm Contact Kit Terminal Identifications**

# NOTES



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