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**Onan**

**Service  
Manual**

**20 kW**

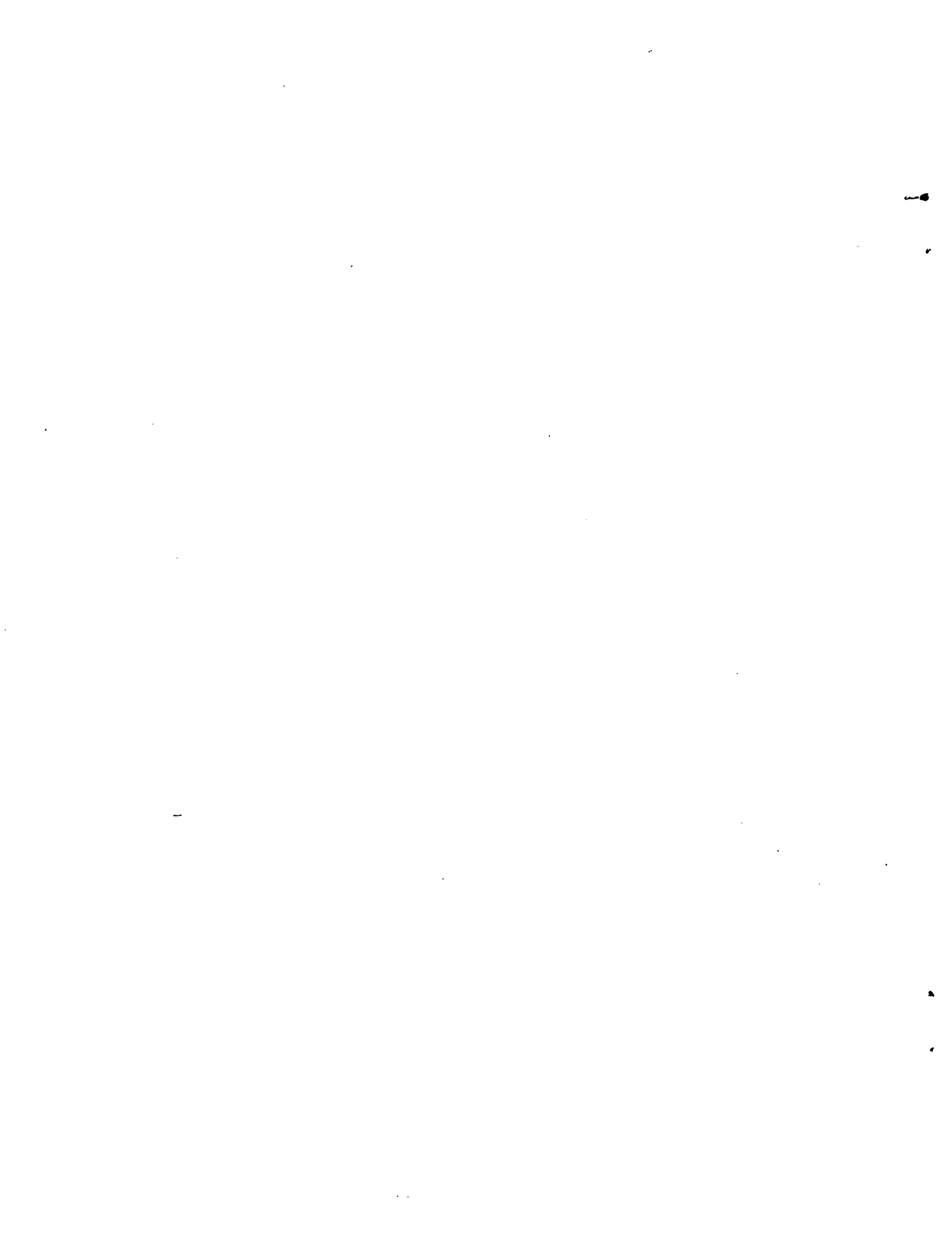
**ES**

**Generator and  
Controls**

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**900-0335**

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**Supplement 928-1014**

**Date: 11-92**

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**This supplement includes information on electric governor adjustments which should be added to *Governor Adjustment* section of above listed Service Manual.**

## ELECTRIC GOVERNOR

### Electric Governor Adjustments: Beginning Spec F

If necessary, adjust the linkage according to Figure 2 and wire the controller according to Figure 1. Then adjust the governor controller as follows.

1. Initially set the switches as follows (see Figure 1):

#### SW1

**ADJ1/ADJ2** - Down position (**ADJ1**)

**50HZ/60HZ** - Up position (**50HZ**) or down position (**60HZ**).

**4CYL/6CYL** - Up position (**4 CYL**) or down position (**6 CYL**).

#### SW2 (Rotary Switch)

**GAIN** - Position 4.

#### SW3

All positions down.

2. Attach tachometer to engine or frequency meter to generator output leads if control panel does not come equipped with one of these meters.

**Prior to adjusting governor control, make sure that governor control terminals 5 and 6 are jumpered.**

3. Start the set. Hold throttle linkage so that engine will not overspeed, should the governor control be out of adjustment.

If the engine overspeeds, shut down the set. Turn the **GAIN** switch to the next higher position and restart the set.

4. Warm up the set under at least 1/4 load until it is up to normal operating temperature and then disconnect the load.

5. If the engine has a consistent hunt at approximately 1 to 2 Hz, adjust **GAIN** rotary switch until engine is stable and responsive to governor control (clockwise increases gain, counter-clockwise decreases gain).
6. Manually actuate governor linkage several times to ensure correct gain adjustment. Unit should respond quickly but should not hunt, use maximum possible gain setting.
7. If the engine has an audibly fast hunt, set **SW3** position 3 to the up position. If no change is seen or heard, return switch to down position.
8. If the engine has an inconsistent slow hunt that is barely audible, set **SW3** position 2 to the up position to reduce integral gain. If no change is seen or heard, return switch to down position.
9. If the engine has a very slow hunt at approximately 0.5 Hz, set **SW1** position 1 up to add friction compensation to the controller. If no effect is seen or heard, return switch to down position and check for linkage binding and repair as necessary.
10. Check for stability (no audible hunting) under a range of loads from no-load to full-load.
11. If engine has significant undershoot on load acceptance, turn **GAIN** rotary switch clockwise. Repeat Steps 6 and 11 to achieve overall stability between no-load and full-load conditions.
12. If engine has significant overshoot on load acceptance after the initial drop in engine speed, move **SW3** position 2 to the down position if it was moved to the up position in Step 8. Return switch to the up position if no change is seen or heard.
13. Shut down engine. Restart engine to make sure that unit does not overspeed.
14. Shut down engine and remove tachometer or frequency meter previously attached.
15. Engine is now ready for service.



## Linkage Adjustments: Beginning Spec F

Figure 2 illustrates the arrangement of the electric governor components and how to adjust the linkage of the electric governor. The following should be noted:

1. Assemble the governor linkage as shown in Figure 2. Thread each female component at least three to four turns onto each male component and set the lock nuts.

2. Thread the assembled governor linkage three or four turns onto the actuator shaft.

3. Snap the ball joint of the governor linkage onto the ball stud of the throttle lever.

4. Loosen the throttle lever screw.

5. Rotate the throttle linkage to the full speed stop and extend the actuator shaft to its end of travel.

6. Tighten the throttle lever screw.

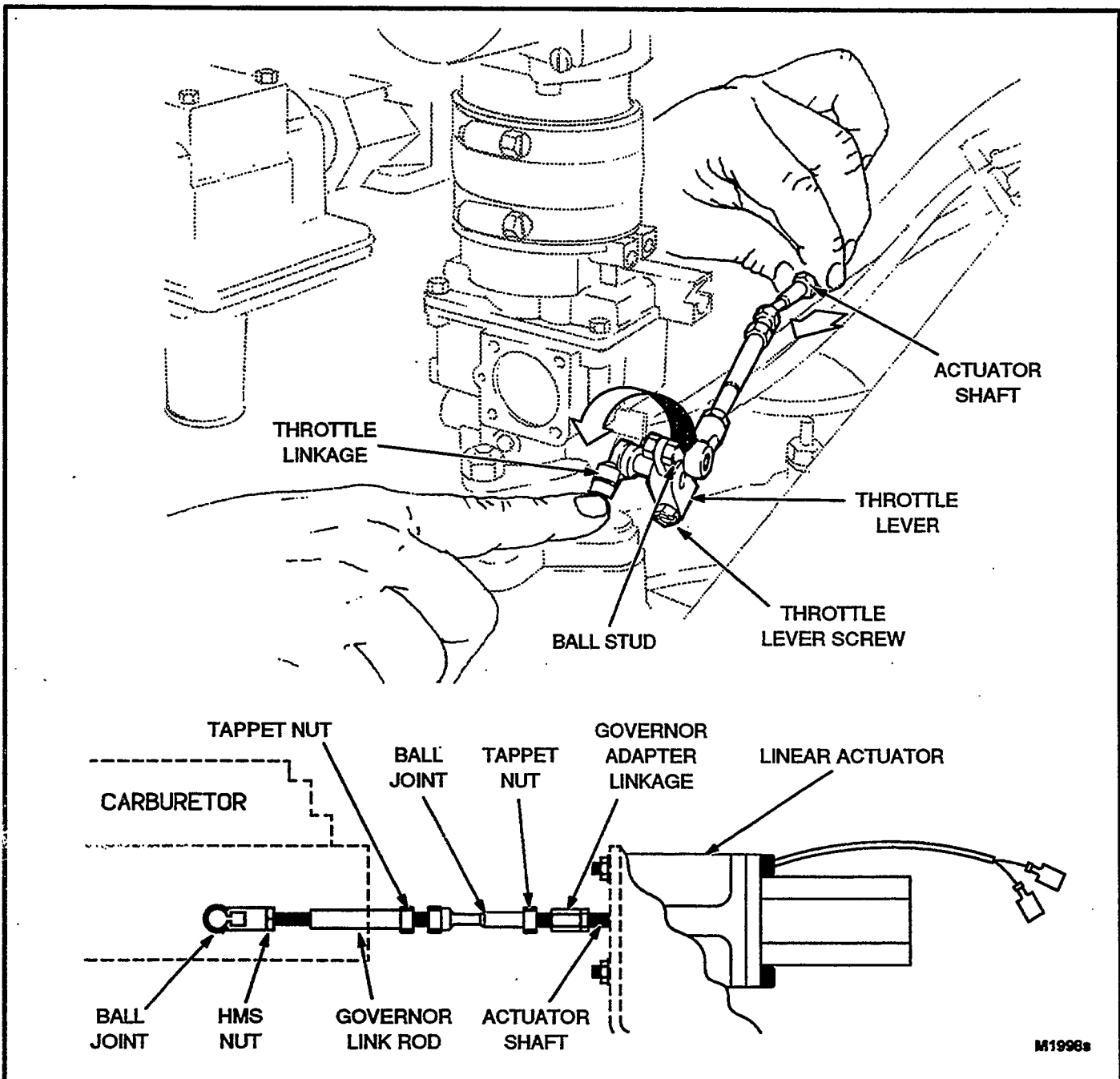


FIGURE 2. ELECTRIC GOVERNOR LINKAGE

# Safety Precautions

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The following symbols in this manual highlight conditions potentially dangerous to service personnel, or equipment. Read this manual carefully. Know when these conditions can exist. Then take necessary steps to protect personnel as well as equipment.

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

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

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

## PROTECT AGAINST MOVING PARTS

Avoid moving parts of the unit. Avoid use of loose jackets, shirts or sleeves due to danger of becoming caught in moving parts.

Make sure all nuts and bolts are secure. Keep power shields and guards in position.

If you must make adjustments while the unit is running, use extreme caution around hot manifolds,

moving parts, etc.

Do not work on this equipment when mentally or physically fatigued.

## GUARD AGAINST ELECTRIC SHOCK

Disconnect electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.

Disconnect batteries to prevent accidental engine start. Jewelry is a good conductor of electricity and should be removed before working on electrical equipment.

Use extreme caution when working on electrical components. High voltages cause injury or death.

Follow all state and local codes. To avoid possible personal injury or equipment damage, a qualified electrician or an authorized service representative must perform installation and all service.

**▲ WARNING**

## EXHAUST GAS IS DEADLY!

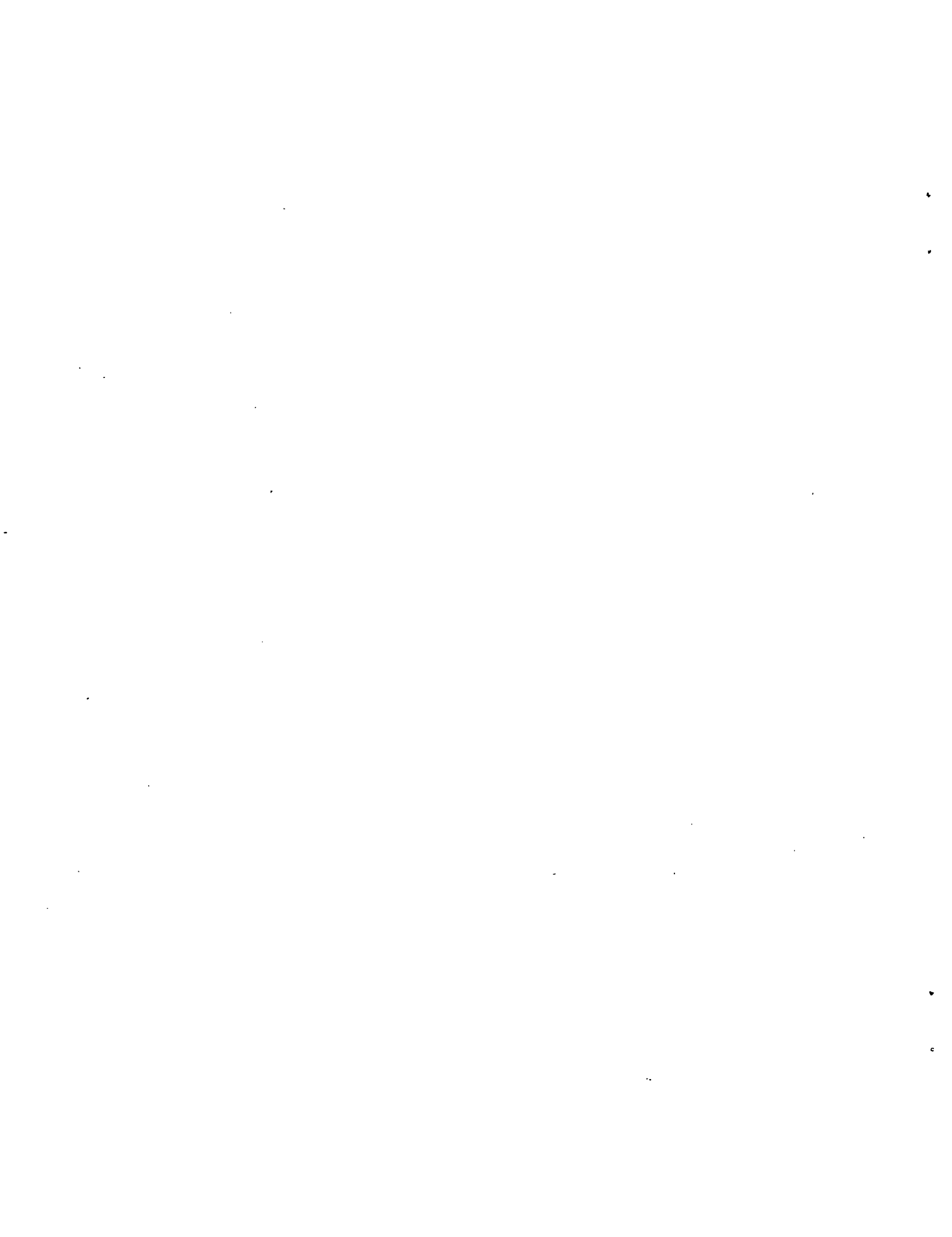
*Exhaust gases contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:*

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

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

**Protection against carbon monoxide inhalation includes proper installation and regular, frequent visual and audible inspections of the complete exhaust system.**





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**▲WARNING**

**INCORRECT SERVICE OR REPLACEMENT OF PARTS MIGHT RESULT IN SEVERE PERSONAL INJURY AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.**



A ball bearing in the end bell supports the outer end of the rotor shaft. The end bell and generator stator housing are attached by four-through-studs which pass through the stator assembly to the engine-generator adapter. The brushless exciter stator mounts in the end bell while the exciter rotor and its rotating rectifier assemblies mount on the generator rotor shaft.

All generators have four wires extending from the stator housing in addition to the AC output leads, Figure 2. Lead F1<sup>+</sup> and F2<sup>-</sup> are from the exciter field winding and are connected to the output terminals of the voltage regulator. Leads 1 and 2 are connected to the stator windings and provide reference voltage and input power to the voltage regulator. These four leads are connected at the factory.

Figure 2 is a composite illustration showing four output leads for single phase units, 12 output leads for 3 phase broad range units, and four output leads for code 9X, 3 phase 347/600 volt generators.

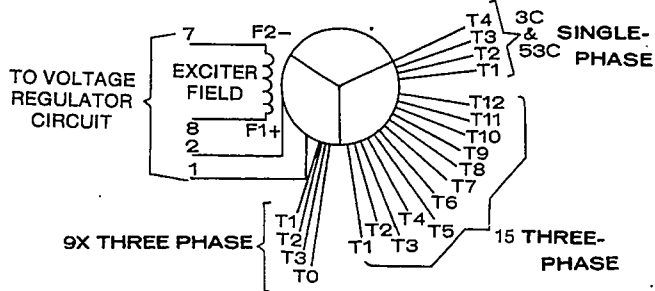


FIGURE 2. SINGLE AND THREE PHASE GENERATOR SCHEMATIC (COMPOSITE)

## GENERATOR OPERATION

Operation of the generator involves the stator, voltage regulator, exciter field and armature, a full wave bridge rectifier, and the generator rotor, Figure 3. Residual magnetism in the generator rotor and a permanent magnet embedded in one exciter field pole begin the voltage build-up process as the generator set starts. Single-phase AC voltage, taken from one of the stator windings, is fed to the voltage regulator as a reference for maintaining the generator output voltage. AC voltage is converted to DC by a silicon controlled rectifier bridge on the voltage regulator printed circuit board and fed into the exciter field windings. The exciter armature produces three-phase AC voltage that is converted to DC by the rotating rectifier assembly. The resultant DC voltage excites the generator rotor winding to produce the stator output voltage for the AC load.

Generator sets without a control panel or switchboard containing AC instruments such as voltmeters, ammeters, running time meter, frequency meters, and line circuit breakers are shipped from the factory with the AC output leads separated in the output box. On generator sets with switchboards containing AC instruments, the AC output leads are wired as specified on the customer's purchase order to deliver only the voltage specified.

## VOLTAGE RECONNECTION WITH OPTIONAL INSTRUMENTS

The optional AC instruments on the control panel (such as voltmeters, ammeters, transformers, and running time meters) are intended for use with specific nameplate voltages. Control components may have to be changed to match new current ratings when field reconnection for other voltage codes or voltages are made.

**CAUTION** To prevent instrument damage contact the Onan factory for required instrument changes, new wiring diagrams, new nameplate with proper specification number and voltage before attempting to reconnect a generator with instruments on the control panel.

Do not connect the generator in any other manner than shown in the applicable wiring and reconnection diagrams.

Severe damage will result if leads are incorrectly connected or improperly insulated. Use extreme care in checking leads to assure proper connections.

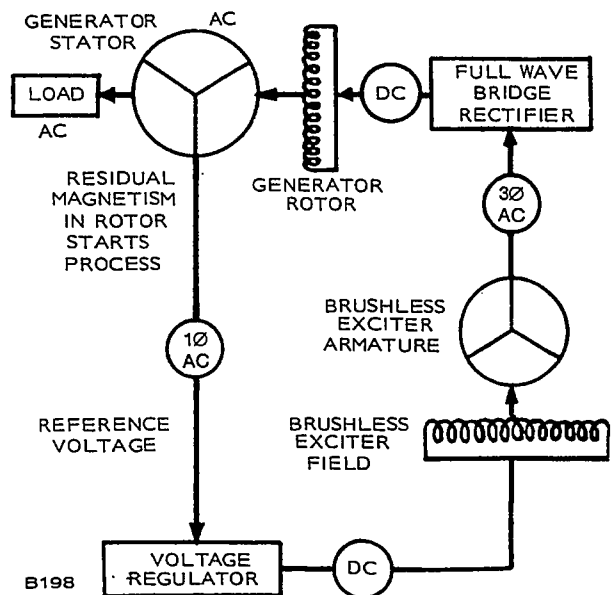


FIGURE 3. EXCITATION BLOCK DIAGRAM

# Generator Troubleshooting

## PREPARATION

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

- Check all modifications, repairs, replacements performed since last satisfactory operation of set to ensure that connection of generator leads are correct. A loose wire connection, overlooked when installing a replacement part could cause problems. An incorrect connection, an opened circuit breaker, or a loose connection on printed circuit board are all potential malfunction areas to be eliminated by a visual check.
- Unless absolutely sure that panel instruments are accurate, use portable test meters for troubleshooting.
- Visually inspect components on VR21. Look for dirt, dust, or moisture and cracks in the printed solder conductors. Burned resistors, arcing tracks are all identifiable. Do not mark on printed circuit boards with a pencil. Graphite lines are conductive and can cause leakage or short circuits between components.

## TROUBLESHOOTING PROCEDURES (STANDARD YD GENERATOR AND REGULATOR)

The information in this section is divided into Flow Charts A, B, C, D, and E as follows:

- NO AC OUTPUT VOLTAGE AT RATED ENGINE RPM.
- UNSTABLE OUTPUT VOLTAGE, ENGINE SPEED STABLE 1800 RPM.
- OUTPUT VOLTAGE TOO HIGH OR LOW.
- EXCITER FIELD BREAKER TRIPS.
- UNBALANCED GENERATOR OUTPUT VOLTAGE.

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

Referenced components in the Flow Charts and Adjustments and Test procedures can be found on the electrical schematic Figure 4, and on assembly drawings and wiring diagrams on pages 18-19.

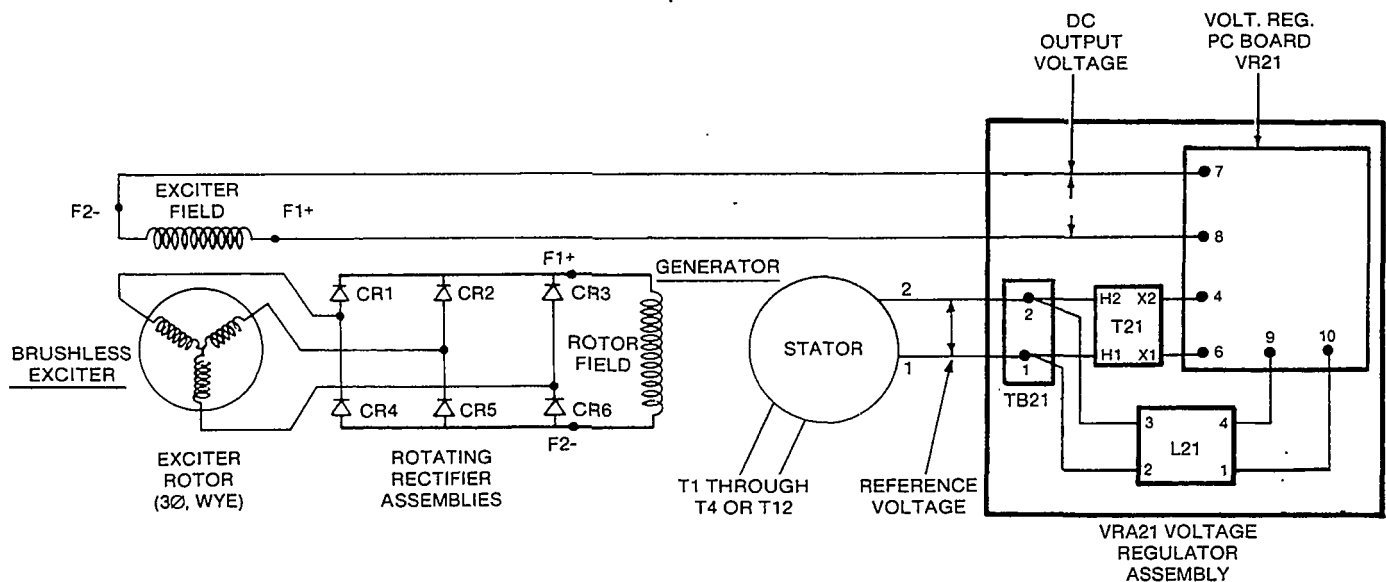
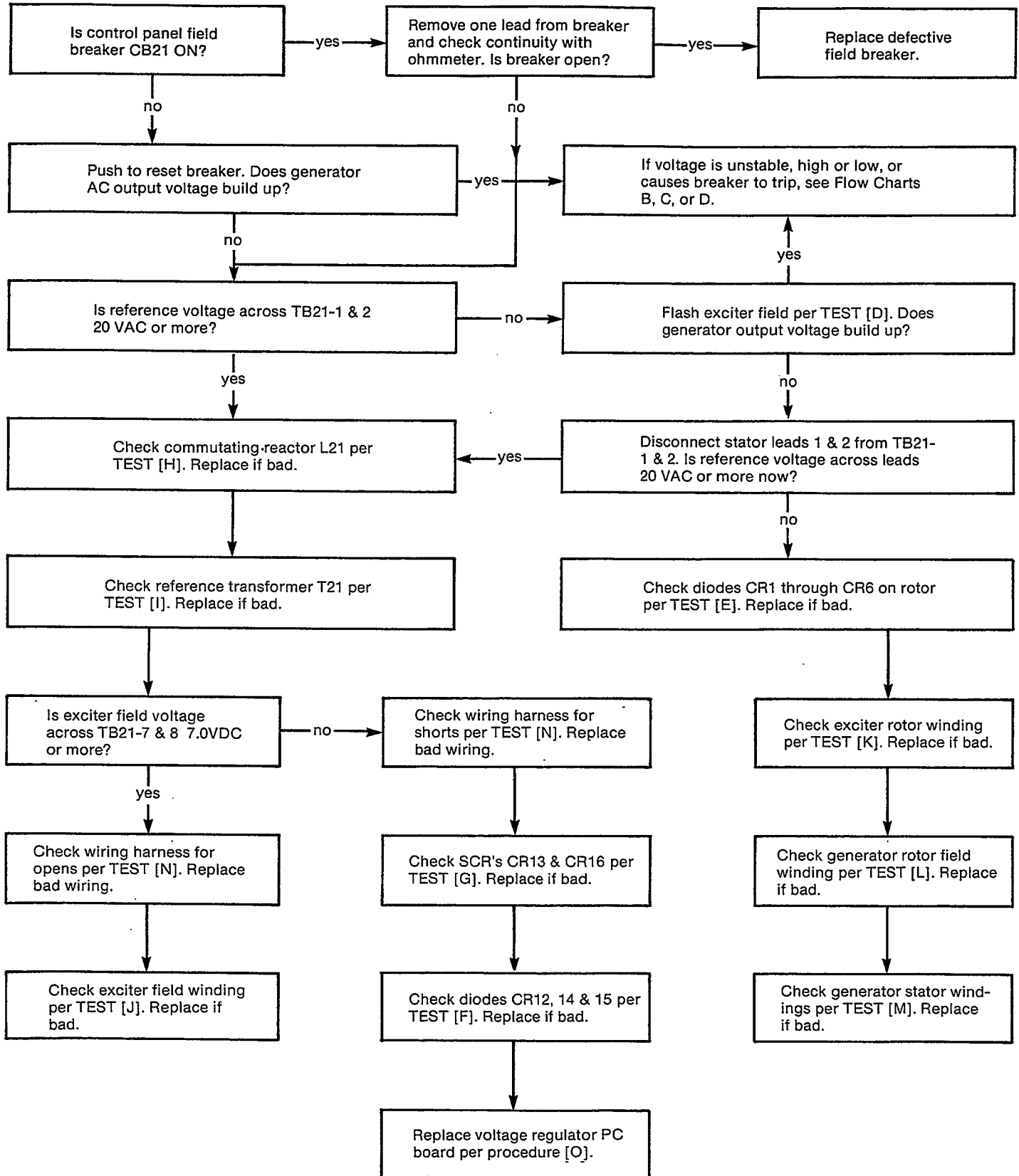


FIGURE 4. ELECTRICAL SCHEMATIC, STANDARD YD GENERATOR AND REGULATOR

## FLOW CHART A. NO BUILD UP OF AC OUTPUT VOLTAGE

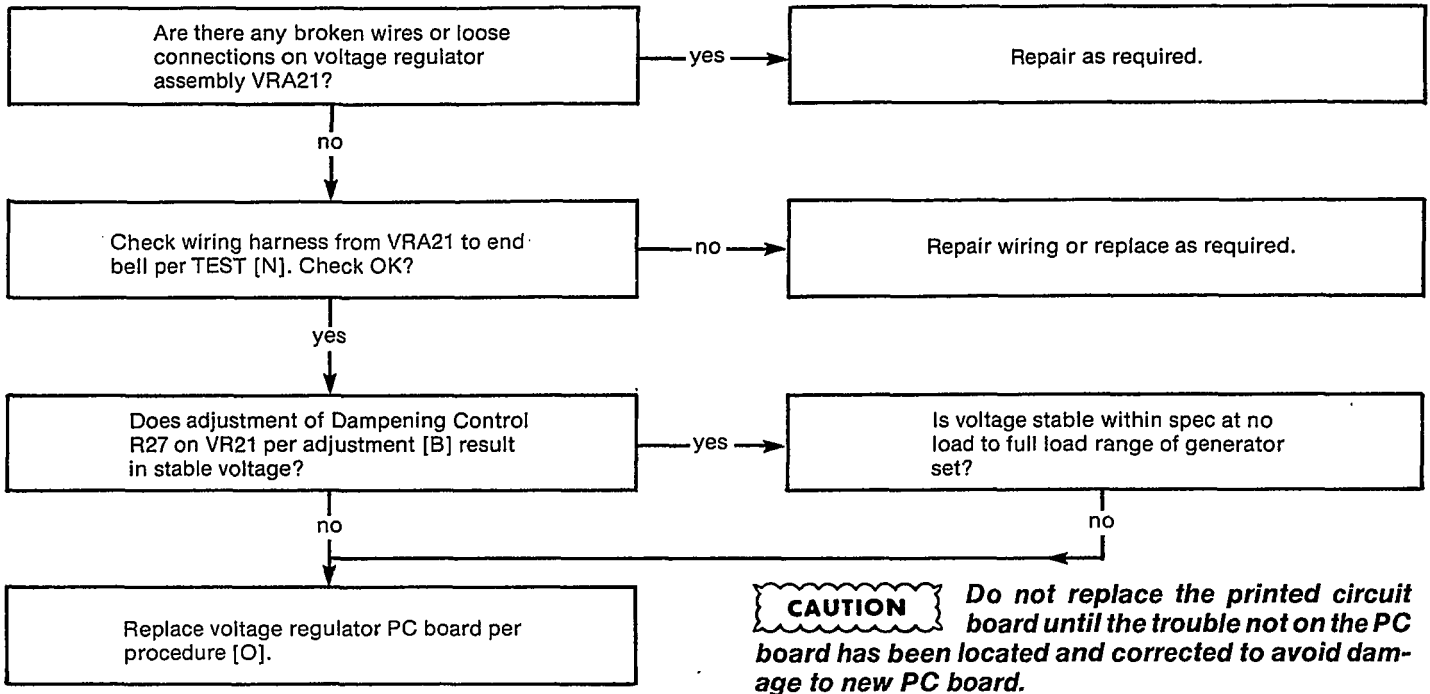
START



**CAUTION** Do not replace the printed circuit board until the trouble not on the PC board has been located and corrected to avoid damage to new PC board.

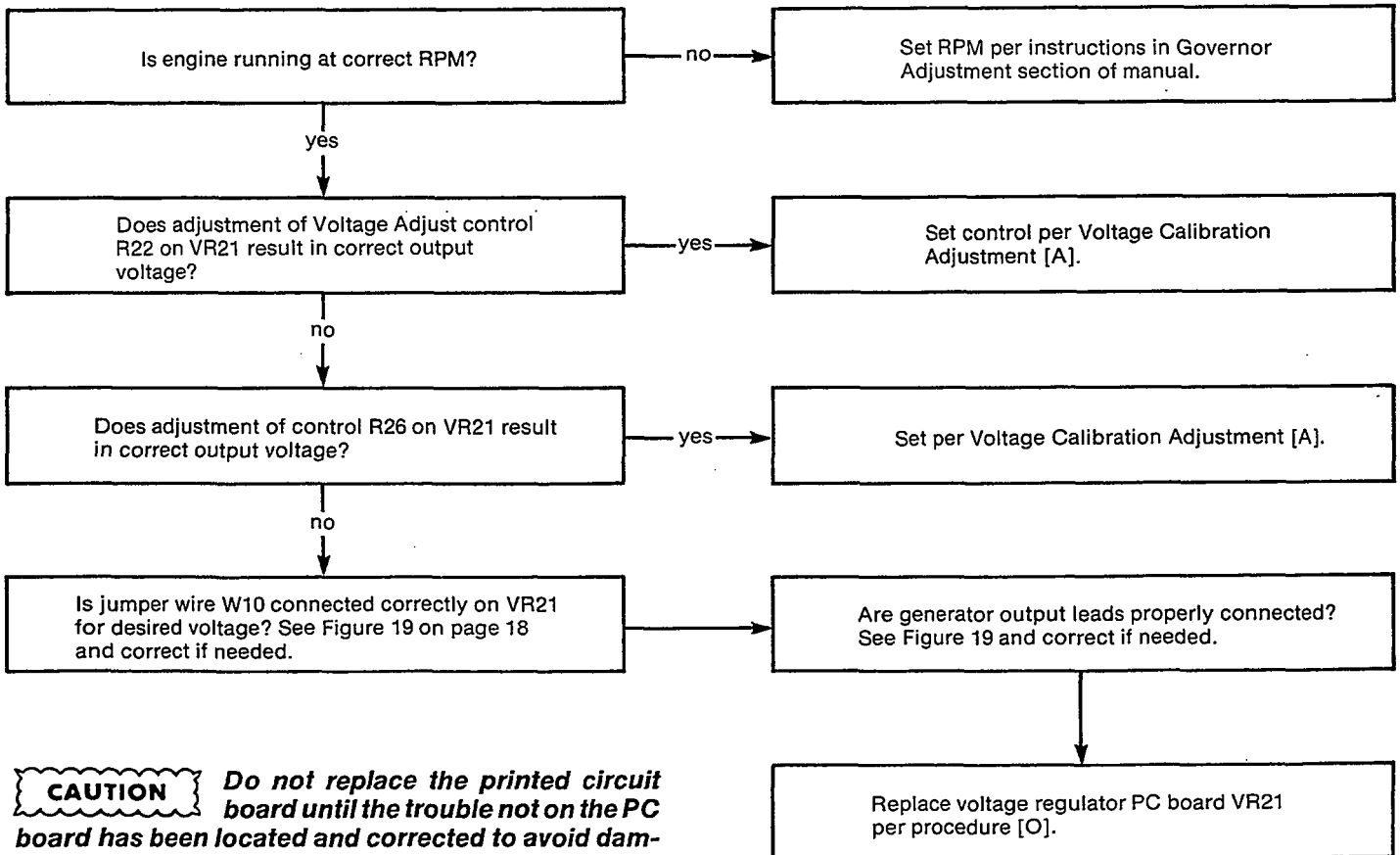
## FLOW CHART B. AC OUTPUT VOLTAGE BUILDS UP, BUT IS UNSTABLE

START



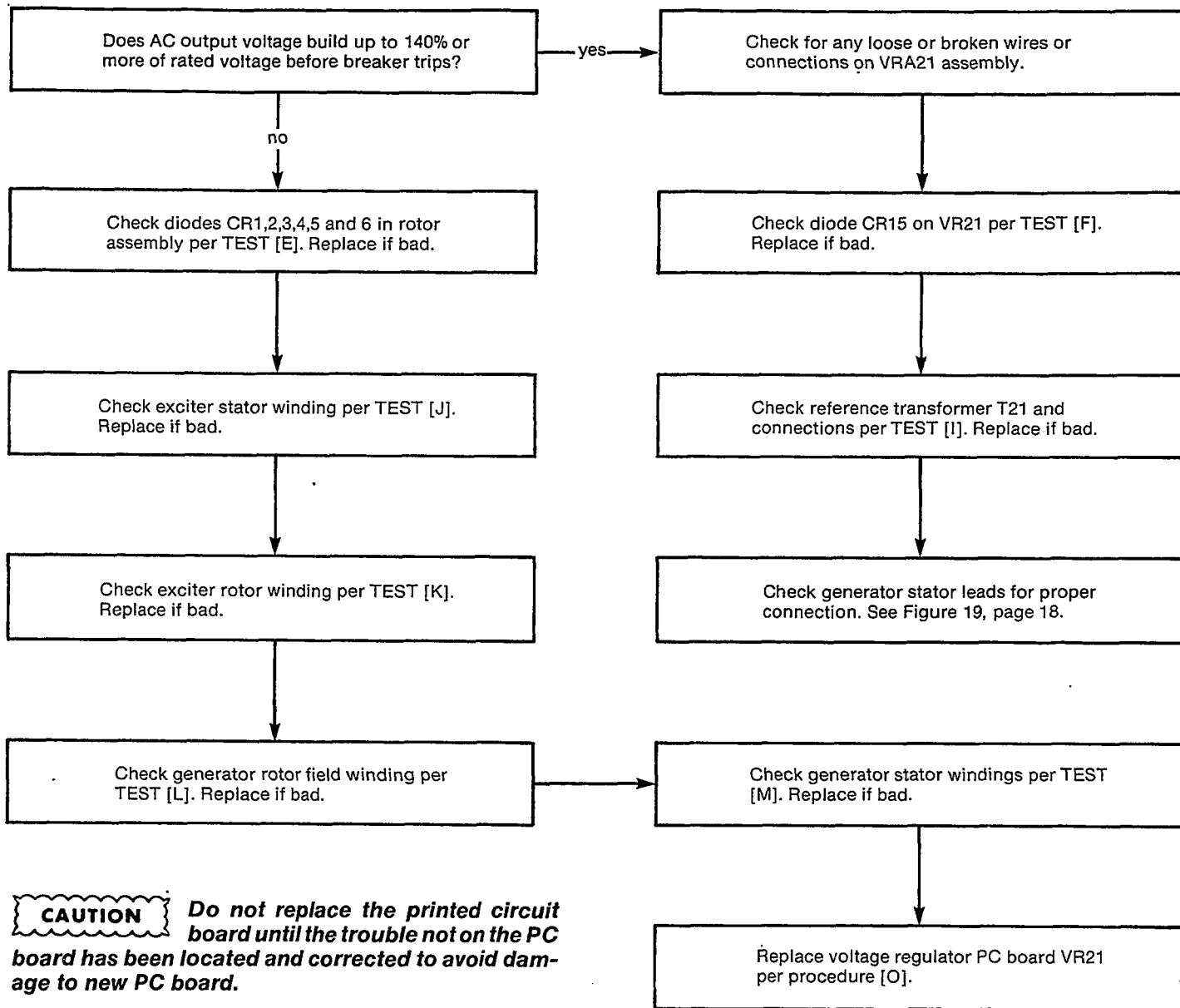
## FLOW CHART C. AC OUTPUT VOLTAGE BUILDS UP, BUT IS HIGH OR LOW

START



# FLOW CHART D. AC OUTPUT VOLTAGE BUILDS UP, BUT FIELD BREAKER TRIPS

START

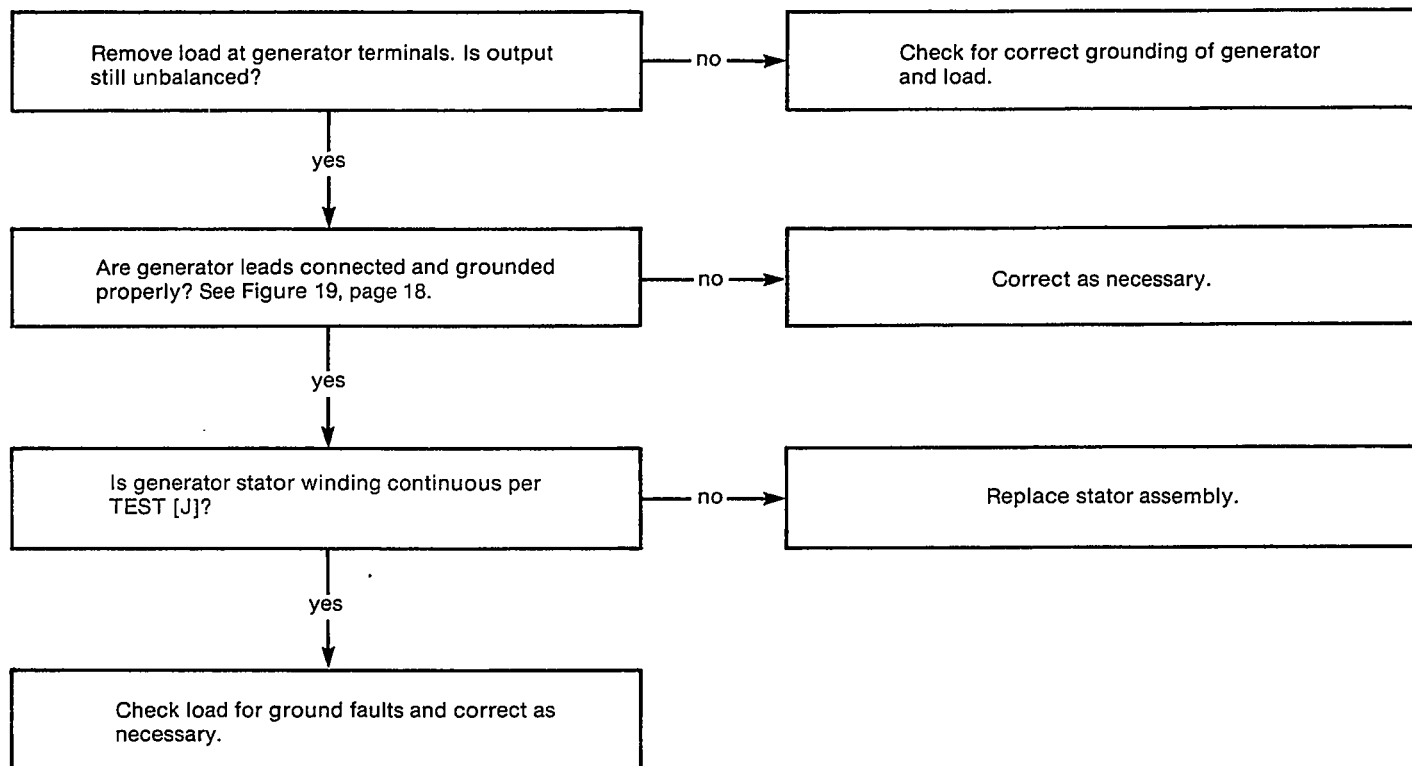


**CAUTION** Do not replace the printed circuit board until the trouble not on the PC board has been located and corrected to avoid damage to new PC board.



## FLOW CHART E. UNBALANCED GENERATOR OUTPUT VOLTAGE

START



# Adjustments and Tests

## GENERAL

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

### [A]

#### VOLTAGE CALIBRATION ADJUSTMENT

The calibration adjustment is made using an accurate AC voltmeter to observe generator output voltage and to set the correct no load voltage. If voltage regulator VR21 printed circuit board has been replaced, it may be necessary to make a calibration adjustment. To obtain the correct output voltage, proceed as follows:

1. If set has a voltage adjust potentiometer (R22) on the meter panel, set pointer halfway between minimum and maximum positions.
2. With unit running at no load, turn generator voltage potentiometer R26 on VR21 (Figure 5) clockwise to increase output voltage; turn R26 counterclockwise to decrease output voltage.

### [B]

#### VOLTAGE STABILITY ADJUSTMENT

Voltage stability is set at the factory, but if printed circuit board VR21 has been replaced or if damping potentiometer R27 has been unnecessarily adjusted it may be necessary to reset stability. Set stability as follows:

1. With generator set running at no load, turn potentiometer R27 (Figure 5) to a position where voltage tends to be unstable or hunt.
2. Turn R27 clockwise slowly until voltage first stabilizes. This setting will result in stable voltage under all conditions in maximum voltage regulator response time.

### [C]

#### VOLTAGE REGULATOR CHECKOUT

The solid state voltage regulators (VR21) can be checked out on the bench for proper operation or location of faulty components. The following test equipment (one-each) is required for a proper checkout.

REF. DESIGNATION	TEST EQUIPMENT
S	Switch
L21	Reactor
F	Fuse, 5 Amps
T1	Transformer, Variable 2 Amp 0-150V
V2	Voltmeter, DC $\pm 2\%$ of Full Scale 3, Scale 0-50 and 0-150V and 0-10V
V1	Voltmeter, AC $\pm 2\%$ @ 10VAC, 1% @ 150V
R1	Resistor, 100-Ohm 400 W
T21	Transformer, Input 315-0386

Transformer T21 and reactor L21 are a part of the voltage regulator assembly (VRA21); these are the only parts obtainable with an Onan part number. The big 100 ohm 400 watt resistor (R1) serves as the field during checkout.

#### Bench Check:

1. Remove voltage regulator from unit according to procedure given for voltage regulator replacement.
2. Referring to Figure 5 and Table 1, connect test equipment to the printed circuit board VR21 terminals as follows:

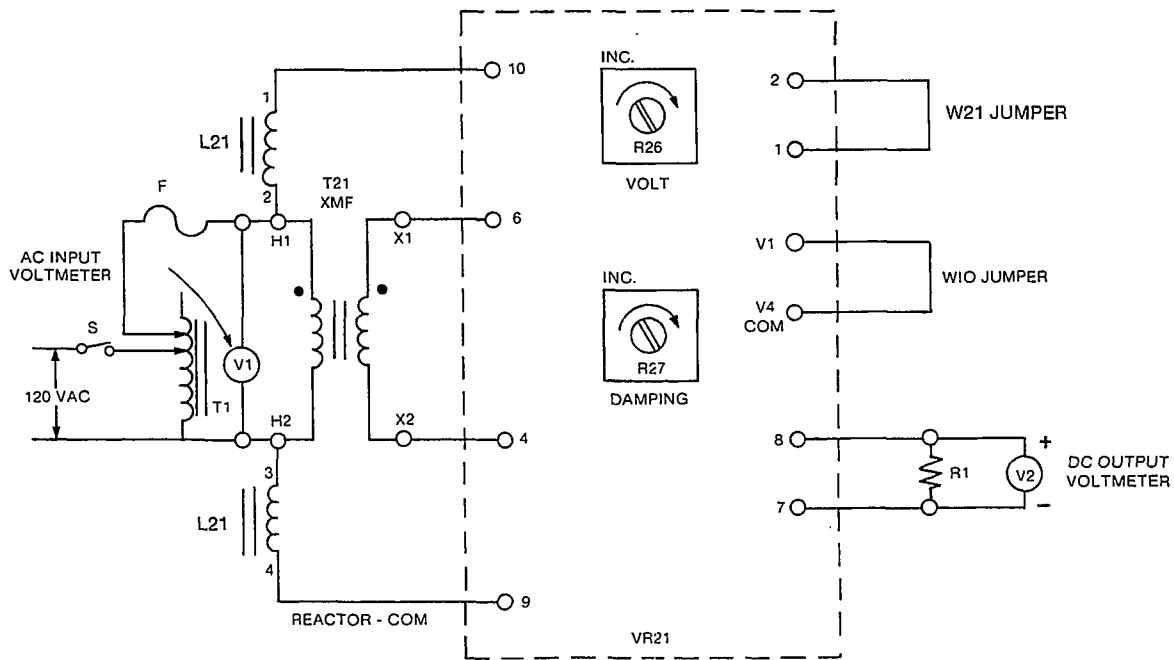
CONNECT	FROM	TO
Jumper	VR21-V1	VR21-V4
Jumper	VR21-1	VR21-2
Lead	L21-1	VR21-10
Lead	L21-4	VR21-9
Lead	T21-X1	VR21-6
Lead	T21-X2	VR21-4
AC Voltmeter	Across	T21-H1 & H2
DC Voltmeter	Across	VR21-7 & 8
VARIAC	Across	T21-H1 (fused) and H2
R1	Across	VR21-7 & 8

3. Open switch in 120 VAC supply to VARIAC.
4. Plug VARIAC into 120 VAC source.
5. Proceed with checkout according to steps in Table 1.

**TABLE 1. VOLTAGE REGULATOR CHECKOUT**

$V_1$  AC INPUT VOLTAGE  
 (< = LESS THAN)  $V_2$  DC OUTPUT VOLTAGE (> = MORE THAN)

STEP NO.	TEST NAME	PROCEDURE	REQUIREMENTS
1	Build Up	Set $V_1$ to 25 VAC	$V_2$ Shall Be > 12 VDC
2	Calibration	Set $V_1$ to 120 VAC	Set POT R26 to Hold $V_2$ Between 50-70 VDC
3	Range	A. Set $V_1$ to 123 VAC B. Set $V_1$ to 125 VAC	$V_2$ Shall be < 30 VDC $V_2$ Shall be < 10 VDC
4	Range	A. Set $V_1$ to 115 VAC B. Set $V_1$ to 117 VAC	$V_2$ Shall be > 85 VDC $V_2$ Shall be > 80 VDC
5	Max Voltage	Set $V_1$ to 150 V	$V_2$ < 10 Volts
6	Damping	Set $V_1$ to 120 VAC. Decrease R27 until Instability in $V_1$ and $V_2$ Occurs. Increase R27 to Stability in $V_1$ and $V_2$ .	$V_1$ and $V_2$ Shall Remain Stable after Application and Removal of Generator Load.



**FIGURE 5. VOLTAGE REGULATOR CHECKOUT TEST EQUIPMENT CONNECTIONS**

**[D]**

**FLASHING THE FIELD**

The following procedure is used for momentarily flashing the exciter field with a low voltage which restores the residual magnetism in the alternator rotor. Flashing the field is usually necessary when

installing a new brushless exciter stator wound assembly, but seldom is necessary under other circumstances. Always check generator residual voltage at terminals 1 and 2 to be certain whether or not flashing the field is necessary. Generator residual

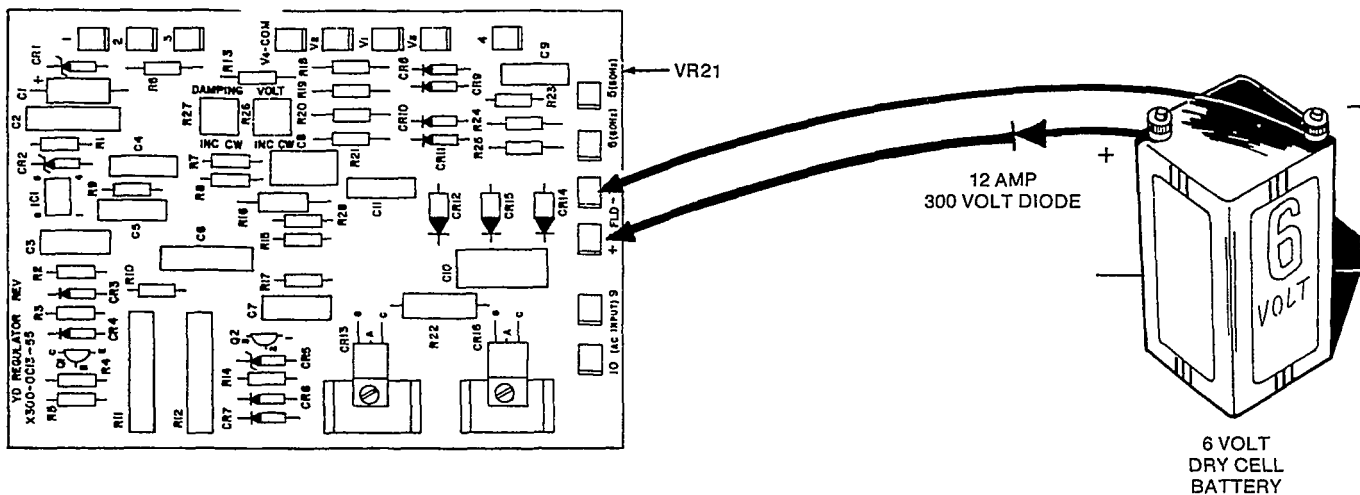


FIGURE 6. FLASHING THE FIELD

voltage should be at least 20 VAC at rated speed. If residual is too low and the output voltage will not build up, flash the field as follows:

1. Locate terminals 7(-) and 8(+) on voltage regulator printed circuit board (VR21).
2. Use a six volt dry cell battery with two clip leads and a 12 amp, 300 volt diode as shown in Figure 6. If a six volt battery is not available, a 12 volt automotive battery can be used by adding a 20-ohm resistor in series; or a 24 volt automotive battery can be used by increasing the resistance to 40-ohms.
3. After starting engine, touch positive (+) battery lead to the +8, and negative (-) lead to -7 terminals just long enough until voltage starts to build up or damage may occur to exciter-regulator system.

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

**WARNING** Exercise care when working around a generator or associated equipment. An electrical shock from the generator or its associated hardware could cause serious injury or death.

Use 24 lbs-in. (2.7 N•m) torque when tightening nuts on F1+ and F2-, CR1, CR2, CR3, CR4, CR5, and CR6.

## TEST PROCEDURES

All of the following tests can be performed without disassembly of the generator. Use the following test procedures for testing generator components in conjunction with the troubleshooting charts.

### [E]

#### TESTING ROTATING RECTIFIERS

Two different rectifier assemblies make up the rotating rectifier bridge assembly, Figure 7. Using an accurate ohmmeter, test each CR using negative and positive polarities. Test rectifiers as follows:

1. Disconnect all leads from assembly to be tested.

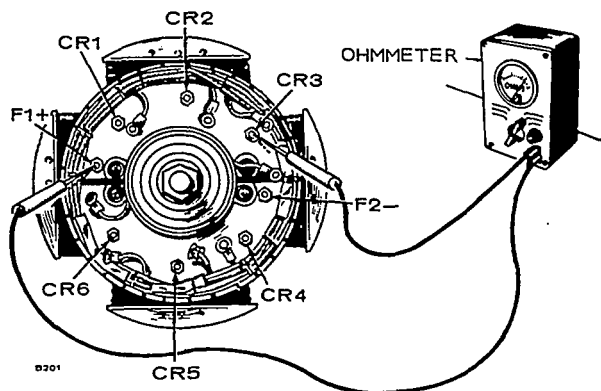


FIGURE 7. TESTING ROTATING RECTIFIERS

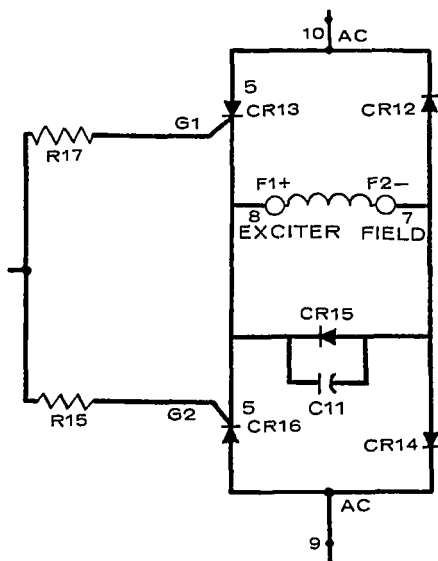


FIGURE 8. SILICON CONTROLLED RECTIFIER BRIDGE

## [F]

### TESTING OUTPUT BRIDGE DIODES

The output bridge rectifier diodes (Figure 8), CR12, CR14, and CR15, are located on the voltage regulator printed circuit board. Using an accurate ohmmeter, test diodes CR12, CR14, and CR15 as follows:

1. Connect one ohmmeter lead to each end of diode and observe resistance reading, Figure 9.
2. Reverse ohmmeter leads and again observe resistance readings.

A good diode has a higher reading in one direction than the other. If both readings are high, or low, diode is defective.

3. Replace defective diodes with new, identical parts.

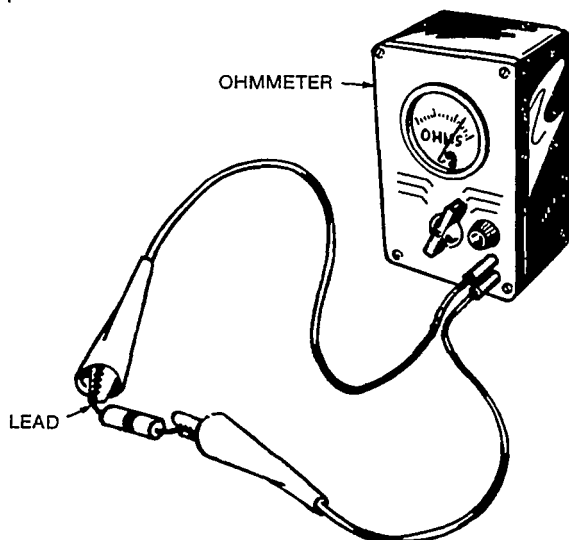


FIGURE 9. TESTING DIODES

## [G]

### TESTING SCR'S

Two identical silicon controlled rectifiers (SCR's), CR13 and CR16, control the DC output voltage to the exciter field. These SCR's are mounted in heat sinks on the voltage regulator and are tested as follows:

1. Using high scale on ohmmeter, connect ohmmeter leads to anode and cathode of the SCR as shown in Figure 10. The resistance reading should be one megohm or greater. Reverse ohmmeter leads to anode and cathode; resistance should again be one megohm or greater.

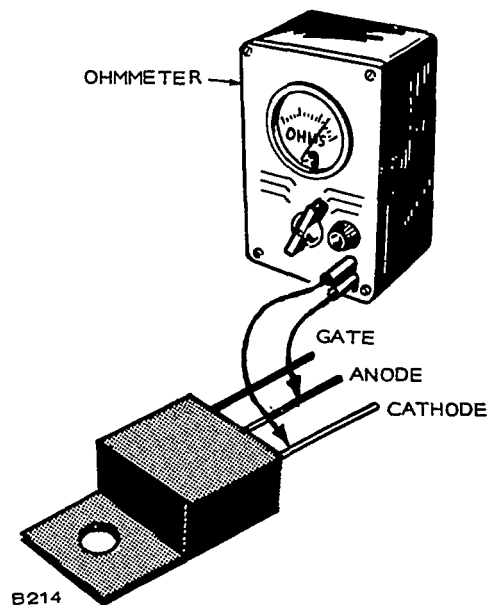


FIGURE 10. SCR RESISTANCE TEST

2. Using a 6 volt dry cell battery and a 200 ohm series resistor, observe correct polarity and connect battery leads to anode and cathode as shown in Figure 11. Observe polarity and connect a DC voltmeter across the 200 ohm resistor. The voltmeter should now read zero. Jumper anode to gate; voltmeter should now read 6 volts. Remove jumper; voltmeter should still read 6 volts because the SCR remains turned on until voltage is removed from anode to cathode.
3. If the SCR does not pass either test, it is defective. Replace defective SCR with a new, identical part.

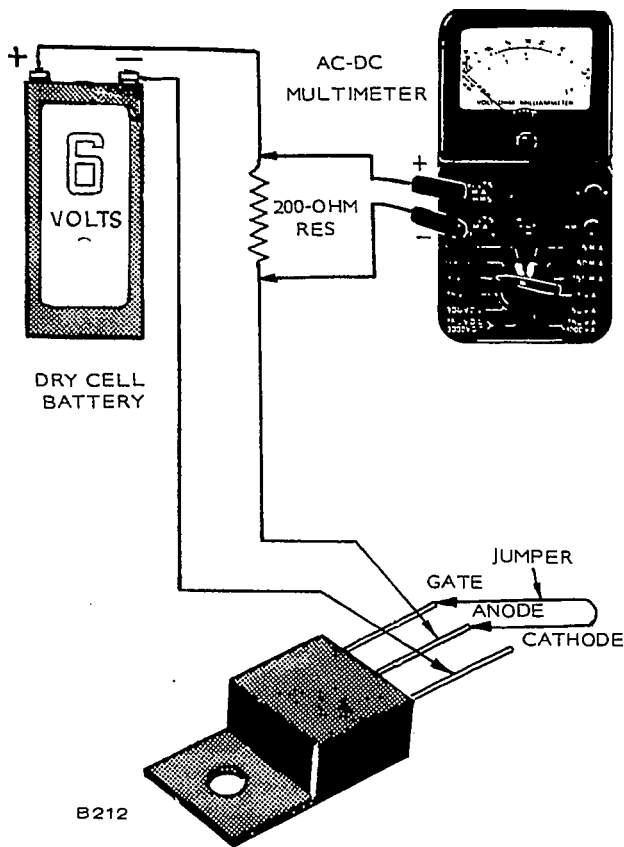
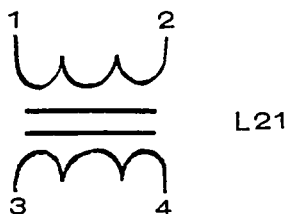


FIGURE 11. SCR VOLTAGE TEST

### [H]

#### TESTING REACTOR

The reactor assembly L21 leads are marked 1,2,3 and 4. Wires 1-2 and 3-4 are wound on the same iron core.



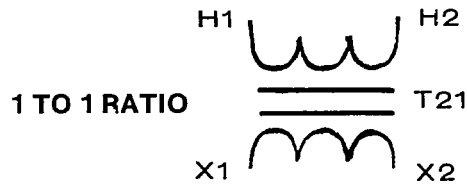
Resistance between 1-2 and 3-4 should be 0.33 to 0.39 ohms and 0.38 to 0.46 ohms respectively at 77°F (25°C). Resistance between coils (e.g. 1-3) and from any terminal to reactor frame should be infinity.

### [I]

#### TESTING REFERENCE TRANSFORMER

The transformer T21 has four leads marked H1, H2,

X1, and X2. H1-H2 are the primary leads. X1-X2 are the secondary leads.



Resistance between H1-H2 should be 113 to 139 ohms, between X1-X2 133 to 163 ohms at 77°F (25°C). Resistance between coils and from any terminal to transformer frame should be infinity.

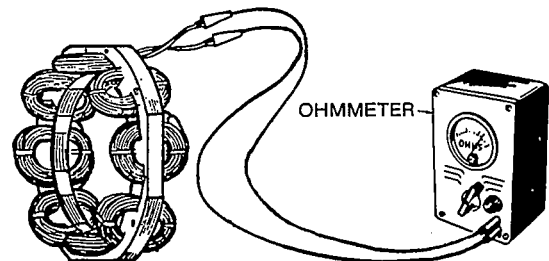
### [J]

#### TESTING BRUSHLESS EXCITER STATOR

Like the generator, the brushless exciter stator (Figure 12) can be tested for open or shorted windings and grounds.

##### Testing for Open or Shorted Windings:

Disconnect F1+ and F2- exciter field leads from terminal block in generator end bell. The resistance between field leads should be 10.98 to 13.42 ohms at 68°F (20°C).



OHMMETER RESISTANCE BETWEEN F1 AND F2 SHOULD BE 10.98 TO 13.42 OHMS

FIGURE 12. TESTING EXCITER FIELD FOR OPEN OR SHORTED WINDINGS

##### Testing for Grounds:

Connect ohmmeter between either field lead and exciter stator laminations. Use ohmmeter set at R x 100 scale. An ohmmeter reading of less than infinity ( $\infty$ ) indicates defective ground insulation.

### [K]

#### TESTING BRUSHLESS EXCITER ROTOR (ARMATURE)

The brushless exciter rotor (Figure 13), can be tested for open or shorted windings, or grounds.

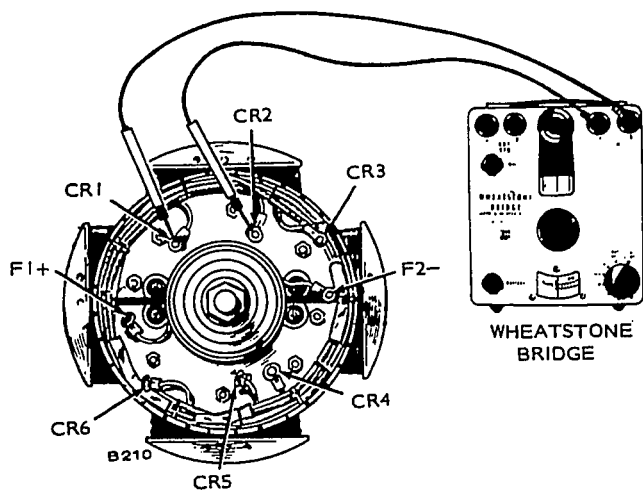


FIGURE 13. TESTING EXCITER ARMATURE

**Testing for Open or Shorted Windings:**

Use a Wheatstone Bridge for this test. Disconnect main rotor field leads which connect to rotating rectifier assemblies at F1+ and F2-. Disconnect lead wires from diodes CR1, CR2, CR3, CR4, CR5 and CR6. Test between exciter lead pairs T1-T2, T2-T3 and T1-T3. Resistance should be 0.5 to 0.6 ohms at 68° F (20° C).

**Testing for Grounds:**

Connect leads of ohmmeter between each CR lead and exciter rotor laminations; use R x 100 scale on ohmmeter. An ohmmeter reading less than infinity (∞) indicates defective ground insulation.

[L]

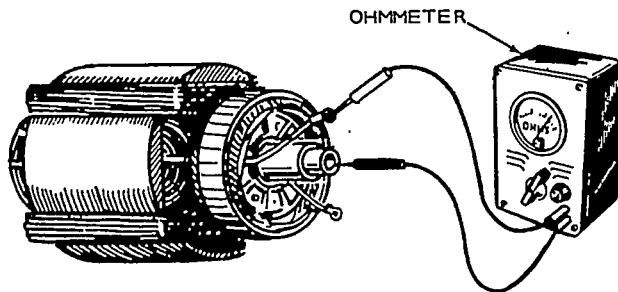
**TESTING GENERATOR ROTOR**

For these tests, use an ohmmeter on R x 100 scale.

**Testing for Grounds:**

On brushless type generators, check for grounds between each rotor lead and the rotor shaft, Figure 14. Perform tests as follows:

1. Remove rotor leads F1+ and F2- from rotating rectifier assemblies.
2. Connect ohmmeter leads between F1+ and rotor shaft and between F2- and rotor shaft. Meter should not register.
3. If meter registers, rotor is grounded.
4. Replace grounded rotor with new, identical part.



CONTACT ONE PROD TO EACH OF THE FIELD LEADS AND OTHER PROD TO ROTOR SHAFT. IF ROTOR IS GOOD, THERE WILL BE NO READING ON OHMMETER.

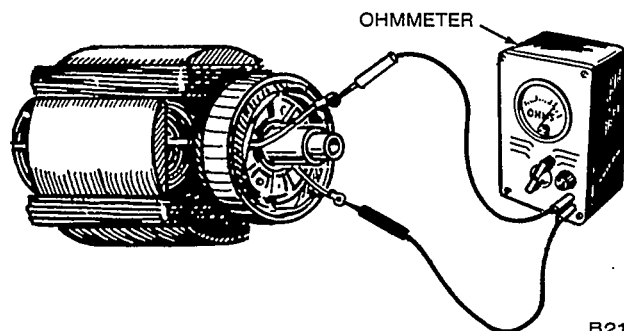
B215

FIGURE 14. TESTING ROTOR FOR GROUNDS

**Testing for Open or Shorted Winding:**

All resistance values should be within ±10% of values specified in Table 2 at 77° F (25° C). Perform tests as follows:

1. Remove rotor leads F1+ and F2- from rotating rectifier assemblies.
2. Using ohmmeter, check resistance between F1 and F2 leads, Figure 15.
3. Replace defective rotor with new, identical part if resistance readings are not within limits shown in Table 2.



B213

CONTACT ONE PROD TO ONE FIELD LEAD AND OTHER PROD TO OTHER FIELD LEAD. RESISTANCE VALUES ARE GIVEN IN TABLE 2.

FIGURE 15. TESTING ROTOR FOR AN OPEN CIRCUIT

TABLE 2. RESISTANCE VALUES FOR ROTORS

ROTOR	ROTOR STACK LENGTH	RESISTANCE
		OHMS @ 25° C (77° F)
201-2984	5.875	2.75
201-2985	7.125	1.80

## [M]

### TESTING GENERATOR STATOR

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

#### Testing for Grounds:

Some generators have ground connections to the frame. Check wiring diagram.

Using an ohmmeter set at R x 100, test each stator winding for shorts to laminations. A reading less than one megohm indicates a ground.

#### Testing for Open or Shorted Windings:

Test for continuity between coil leads shown in Figure 16; all parts should have equal resistance. Use an accurate instrument for this test such as a Kelvin Bridge. The proper resistance values for the ES generator set are given in Table 3. All resistances should be  $\pm 10\%$  of value shown.

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

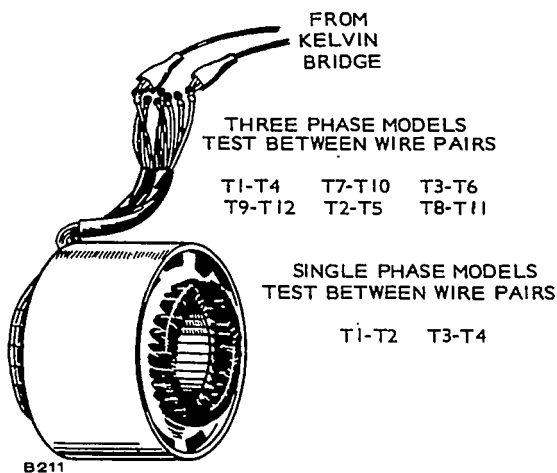


FIGURE 16. TESTING STATOR WINDINGS

## [N]

### WIRING HARNESS CHECK

Carefully check wiring harnesses as follows:

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

## [O]

### VR21 REPLACEMENT

Use the following procedure for replacing the voltage regulator PC board.

1. Stop engine.
2. Disconnect and if necessary, label the following wires: 3, 4, 5 or 6, 7, 8, 9, and 10.
3. Remove four screws at corners.
4. Remove used PC board.
5. Install new PC board; secure with four screws.
6. Reconnect wires removed in step 2 at the proper terminals.
7. Place jumper W10 at proper terminals for your particular voltage code and voltage connection. See Figures 17 and 19.
8. Perform Voltage Calibration and Stability Adjustment procedures [A] and [B] to obtain the correct generator output voltage and stability with new PC board in set.

TABLE 3. RESISTANCE VALUES FOR STATORS

STATOR	PHASE	STATOR STACK LENGTH IN INCHES (mm)	RESISTANCE OHMS @ 20°C (68°F)
220-3691	1Ø	5.75 (146)	.0686 $\pm 10\%$
220-3685	3Ø	5.75 (146)	.127 $\pm 10\%$
220-3686	3Ø	7.00 (178)	.104 $\pm 10\%$



## VOLTAGE REGULATOR

The line-voltage regulator assembly VRA21 for the ES generator set is a solid state device. Basic components are:

- Printed circuit board VR21
- Voltage reference transformer T21
- Commutating reactor L21
- Field circuit breaker CB21
- Voltage adjust rheostat R22 (Optional)

Figure 17 shows the above components for typical control boxes. The electrical schematic and printed circuit board are shown in Figure 18.

The voltage adjust control R22 is optional on the VRA21 voltage regulator. When R22 is used, it is connected between VR21-1 and VR21-3 (Figure 17) and the jumper between VR21-1 and VR21-2 is removed.

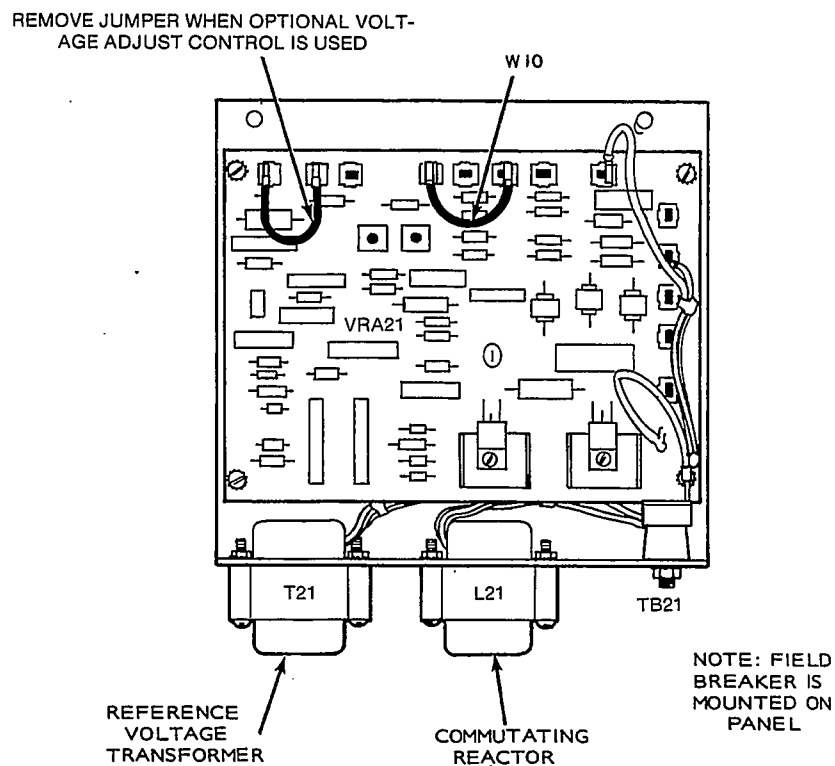
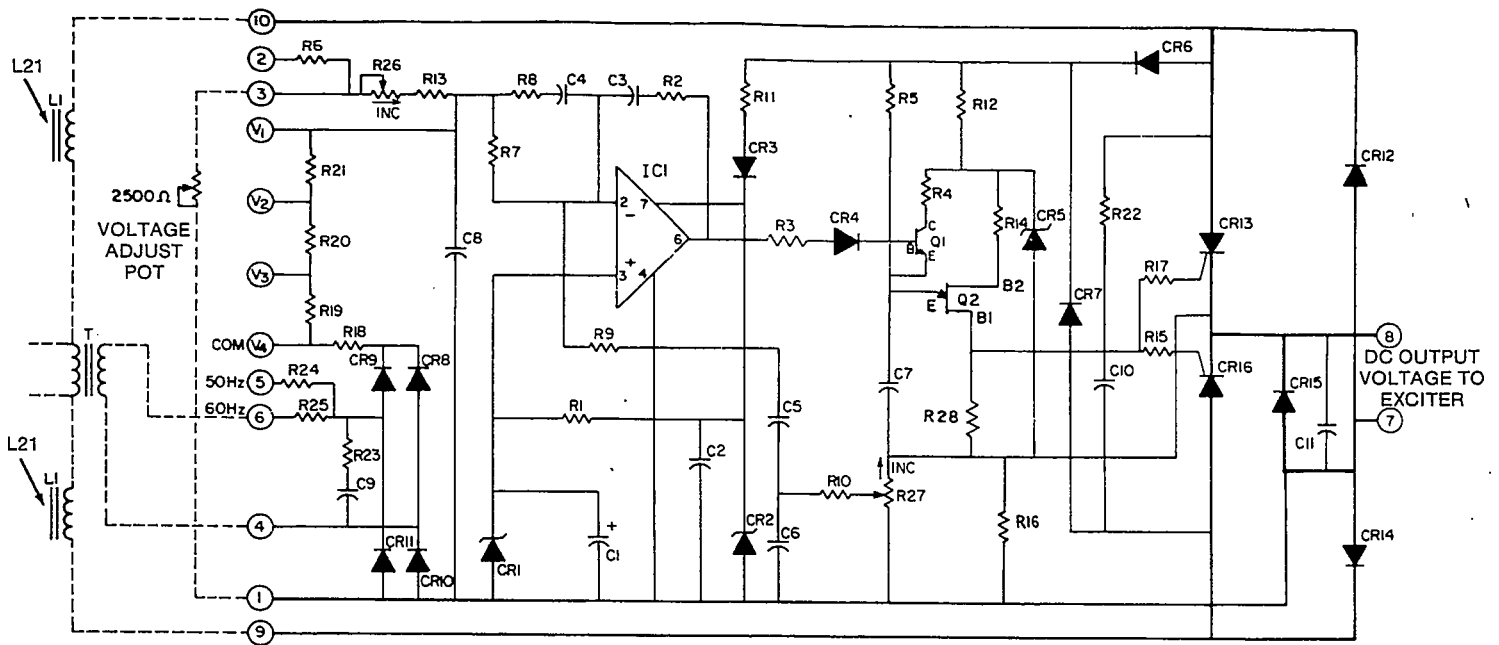
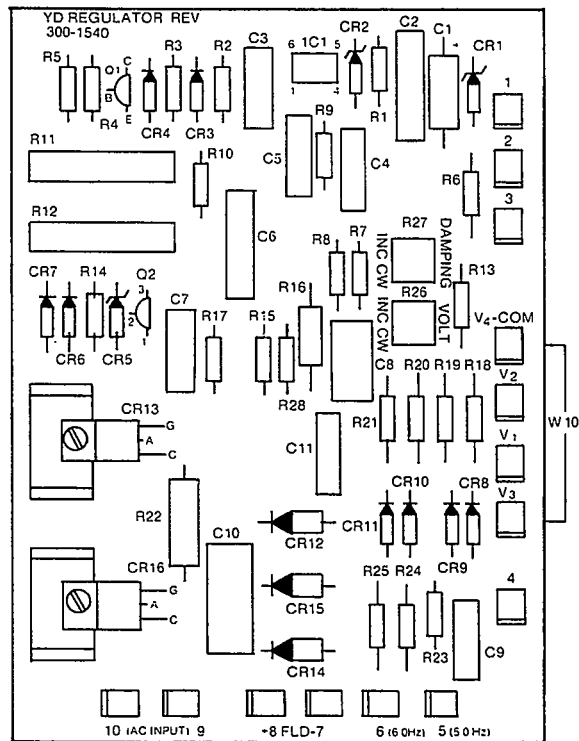


FIGURE 17. STANDARD YD VOLTAGE REGULATOR ASSEMBLY



REGULATOR SCHEMATIC

REF. DES.	DESCRIPTION
T21	Transformer, Ref Voltage
L21	Commutating Reactor
IC1	INTEGRATED CIRCUIT
Q1	TRANSISTOR-NPN
R28	RESISTOR 47Ω 1/2W
R27	POTENTIOMETER 100KΩ
R26	" 5.0KΩ
R25	RESISTOR-FILM 42.2KΩ 1/4W
R24	" 46.4KΩ 1/4W
R23	RESISTOR 10Ω 1/2W
R22	RESISTOR 270Ω 2W
R21	RESISTOR-FILM 2.67KΩ 1/4W
R20	" 1.53KΩ 1/4W
R19	RESISTOR-FILM 3.00KΩ 1/4W
R18	RESISTOR FILM 28.0KΩ 1/4W
R16	RESISTOR 18KΩ 1W
R15 17	" 33Ω 1/2W
R14	RESISTOR 100Ω 1/2W
R13	RESISTOR-FILM 11.0KΩ 1/4W
R11 12	RESISTOR-WIRE WOUND 4KΩ 5W
R9	RESISTOR 1 MEGΩ 1/2W
R8 10	RESISTOR 100KΩ 1/4W
R7	" 270KΩ 1/2W
R6	RESISTOR-FILM 1.24KΩ 1/4W
R5	RESISTOR 2 MEGΩ 1/2W
R4	RESISTOR 3KΩ 1/2W
R3	" 330KΩ 1/2W
R2	" 220KΩ 1/2W
R1	" 33KΩ 1/2W
Q2	TRANSISTOR-UNI-JUNCTION
CR13 16	RECTIFIER-GATE CONT
CR12,14,15	RECTIFIER-DIODE
CR5	DIODE-ZENER 18V
CR3,4,6-11	RECTIFIER-DIODE 1A 400V
CR2	DIODE-ZENER 20V
CR1	" 5.6V
C10	CAPACITOR .47MFD 400V
C9	CAPACITOR .39MFD 250V
C8	" 1MFD 250V
C4,C5 C11	" .1MFD 250V
C3,C7	" .22MFD 250V
C2,C6	CAPACITOR 47MFD 250V
C1	CAPACITOR-ELECTROLYTIC 100MFD 10V



PRINTED CIRCUIT BOARD, VR21

SC-1189

NOTE: The 2500 ohm external voltage adjust potentiometer connects between pin 1 and pin 3. See regulator schematic. If your set does not have an external voltage adjust potentiometer, pin 1 is jumpered to pin 2.

FIGURE 18. STANDARD YD REGULATOR PC BOARD 300-1540

NAMEPLATE VOLTAGE CODE		VOLTAGE	PHASE	FREQUENCY	CONNECT W10 JUMPER WIRE FROM V4 TO	GENERATOR CONNECTION	GENERATOR CONNECTION SCHEMATIC DIAGRAM			LOAD-TO-GENERATOR CONNECTIONS		
							CONNECT X1 TO TERMINAL 5 OF PRINTED CIRCUIT BOARD FOR 50 Hz. TO TERMINAL 6 FOR 60 Hz					
3C	120/240	1	60	V1								
15	120/240	1	60	V1		DOUBLE DELTA						
15	120/240	3	60	V1		SERIES DELTA						
15	120/208 127/220 139/240	3	60	V1 V2 V4		PARALLEL WYE						
15	240/416 254/440 277/480	3	60	V1 V2 V4		SERIES WYE						
9X	347/600	3	60	V4		WYE						

FIGURE 19. GENERATOR WIRING AND CONNECTION DIAGRAMS

# DC Control

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## GENERAL

The descriptions in this section are limited to the exterior and interior DC components of the control panel.

Refer to the Operator's Manual 928-0122 for installation, engine operation and general maintenance data.

Refer to engine manufacturer's manual for engine repair and servicing information.

## CONTROL PANEL

The following is a brief description of the standard and optional controls and instruments located on the face of the panel. See Figures 20 and 21.

### Gauges/Meters and Switches

**Oil Pressure Gauge:** Indicates engine lubricating oil pressure. The gauge has a range of 0 to 100 psi (0 to 700 kPa).

**Water Temperature Gauge:** Indicates engine coolant temperature. The gauge is wired to a sensor unit on the engine and has a range of 100° to 250°F (40° to 121°C).

**Battery Charge Rate DC Ammeter:** Indicates battery charging current. Meter range is  $\pm 30$  amperes.

**Running Time Meter:** Registers the total number of hours that the unit has run. Use it to keep a record for periodic servicing. Time is cumulative; meter cannot be reset.

**Frequency Meter (Optional):** Indicates generator output frequency in hertz. It can be used to check engine speed. (Each hertz equals 30 r/min.)

**AC Voltmeter (Optional):** Dual range instrument indicating AC generator voltage.

**AC Ammeter (Optional):** Dual range instrument indicating AC generator line current.

**Start-Stop-Remote Switch:** Starts and stops the unit locally, or from a remote location wired to the control panel.

**Fuel Select Switch (Optional):** Enables operator to select between any two of the following fuels: Gasoline, propane or natural gas for engine operation.

**Reset Switch:** Resets engine monitor circuits after an emergency shutdown. On the optional control panel the switch is also utilized to verify that the nine lamps are functioning properly.

**Line Selector Switch (Optional):** Selects phase of generator to be measured by AC voltmeter and ammeter.

**Voltage Adjustment (Optional):** Provides approximately plus or minus 5 percent adjustment of the rated voltage.

## Circuit Breakers

**Field Breaker:** A 5 ampere breaker provides generator protection from overheating during certain voltage regulator failures.

**Control Breaker:** A 7 ampere breaker provides protection to the control box wiring from a short circuit or overload.

**Remote Breaker:** A 7 ampere breaker protects accessory remote controls and wiring from a short circuit or overload.

**Auxiliary Breaker:** A 15 ampere breaker protects the governor control, ignition system and the switched B+ on terminal 26.

## Indicator Lights

The two indicator lights are described as follows:

- Run (green)
- Fault (red)

The green Run light comes on as soon as the starter circuit is opened after unit starting. The red light indicates an emergency shutdown of the generator set. How the lights are actuated is discussed under the heading Engine Sensors.

The optional panel nine indicator lights from top to bottom are as follows:

- Run (green)
- Pre Hi Eng Temp (amber)
- Pre Low Oil Pres (amber)
- Lo Eng Temp (red)
- Hi Eng Temp (red)
- Overcrank (red)
- Overspeed (red)
- Lo Oil Pres (red)
- Switch Off (flashing red)

High and Low Indicator Lights are activated with the line selector switch and indicate which scale to use on the AC voltmeter and ammeter.

## CONTROL PANEL INTERIOR

The following discussion gives the operator basic information regarding the operation of control box internal components.

### WARNING

**To avoid possible personal injury or equipment damage, have all adjustments and service performed by a qualified electrician or an authorized service representative.**

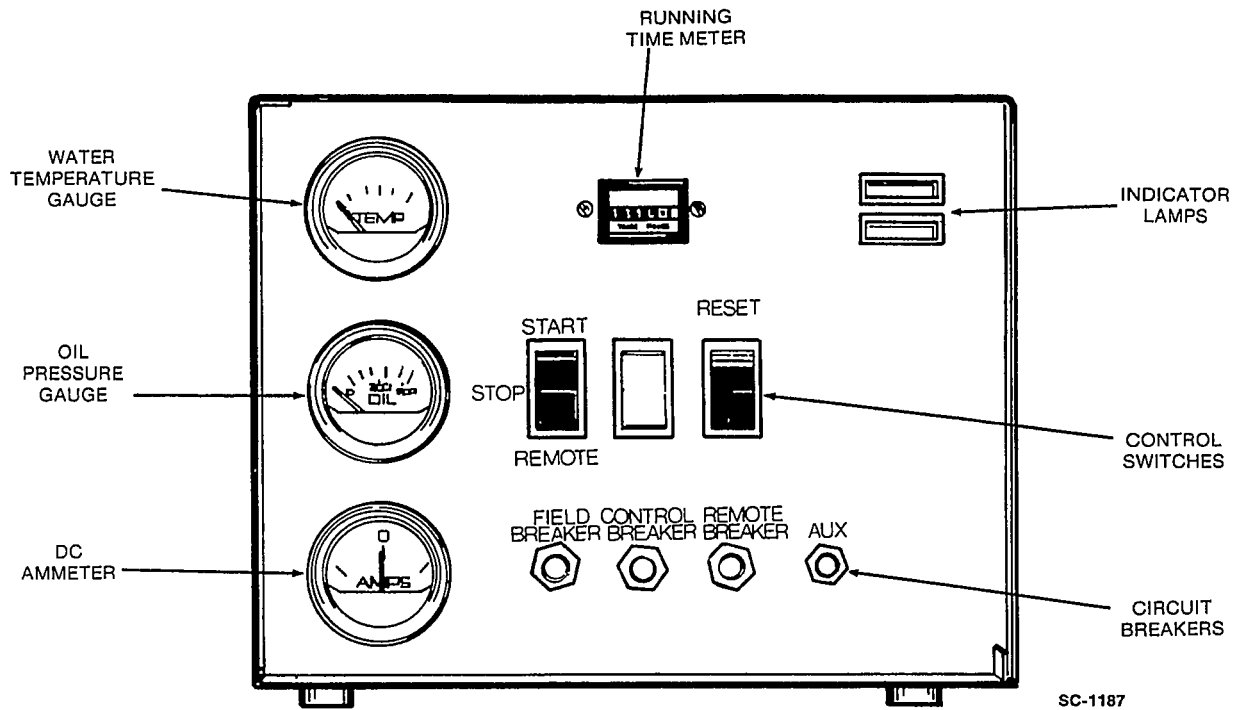


FIGURE 20. STANDARD PANEL

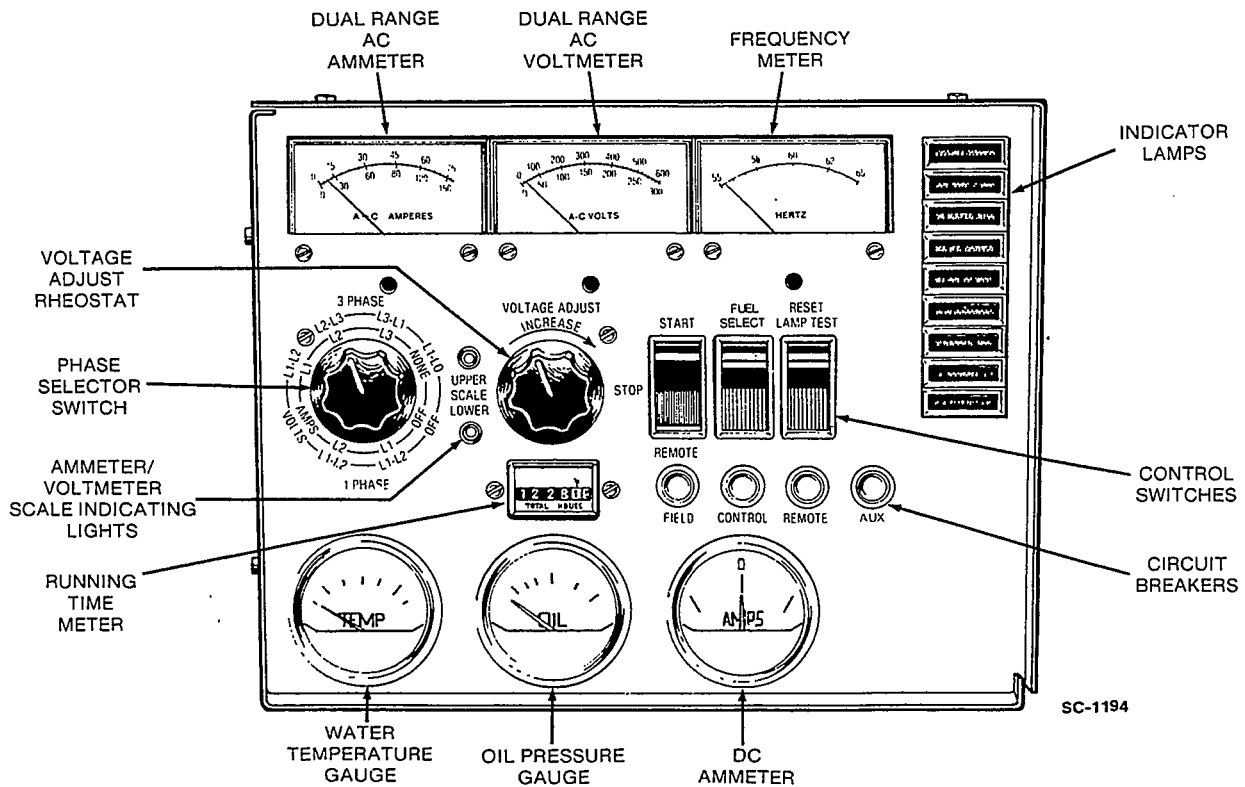


FIGURE 21. OPTIONAL PANEL

**Ignition Resistor Bypass Relay** when energized (during cranking), provides full battery voltage to the electronic ignition.

**Start Disconnect Relay** disconnects the cranking circuit when the engine starts. The relay, energized by output voltage from the auxiliary terminal of the belt driven alternator, also turns the green Run indicator lamp on.

**Fault Relay**, when energized, turns the engine off and prevents a restart until the fault condition is corrected and the Reset switch pressed. The relay can also operate a remote DC alarm (5 ampere maximum) connected to the Fault terminal of the Engine Monitor Circuit Board (Figure 22).

**Overcranking Circuit**, a solid state circuit on the engine Monitor Circuit Board, limits engine cranking time from 45 to 75 seconds. If the engine does not start within this time span, the Fault Relay energizes to stop cranking. The red overcrank indicator lamp (optional) and common fault alarm are turned on.

**Voltage Regulator Assembly (Generator AC)** controls AC generator output voltage at a predetermined level within load limits. Regulation is plus or minus 1 percent from no load to full load with isochronous governing.

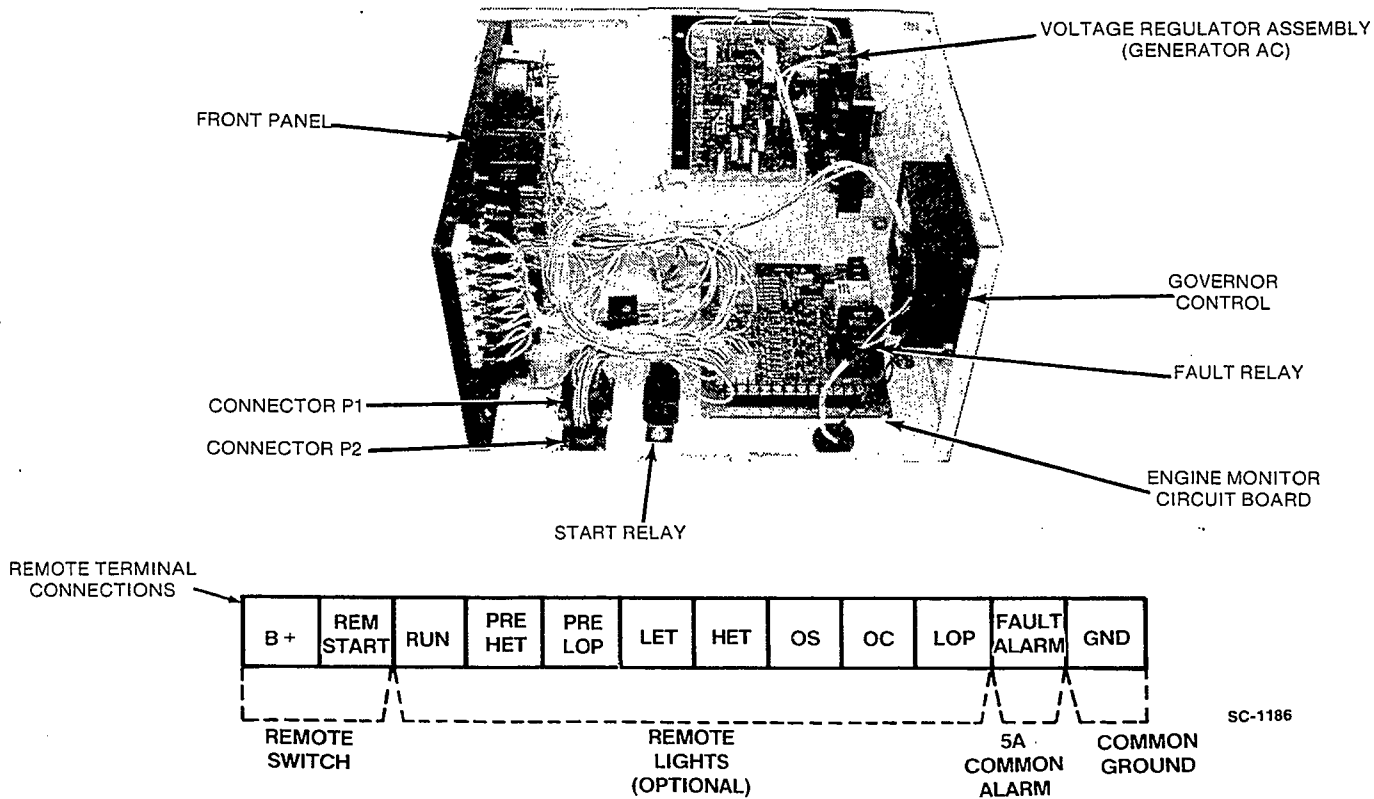


FIGURE 22. CONTROL PANEL INTERIOR COMPONENTS AND REMOTE CONNECTIONS

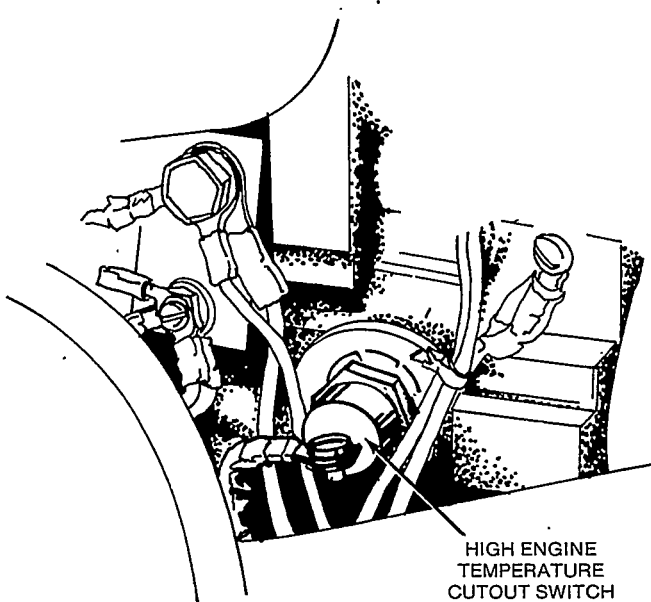
## ENGINE SENSORS

The following briefly describes the engine mounted sensors and switches, and how they protect the engine from unfavorable operating conditions.

All cut-off switches close if abnormal operating conditions exist and energize the Fault Relay to stop the engine. The respective control panel red lamp (optional) lights to indicate cause of the shutdown. The red Switch Off lamp (optional) flashes ON and OFF if the Start Switch is left in the stop position (preventing automatic starting of set).

The optional remote fault alarm can be connected to the terminal shown in Figure 22. Current limitations for optional equipment not supplied by ONAN are 100 milli-amperes for each indicator lamp and 5 amperes for the fault alarm.

**CAUTION** Control components can be damaged if these current limits are exceeded for the optional equipment.



CS-1190

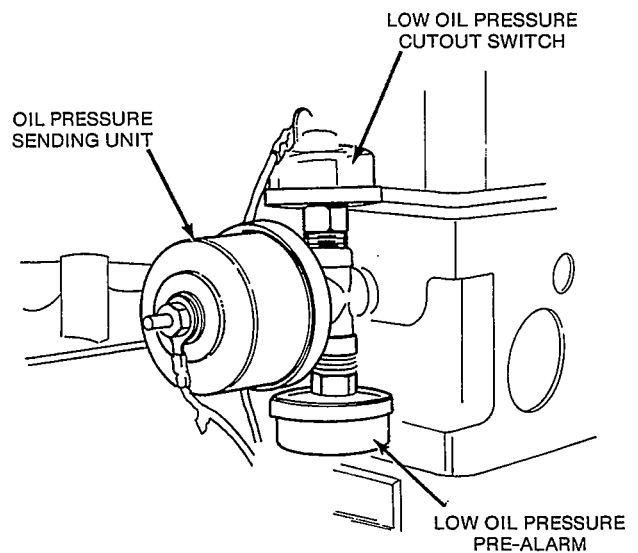
FIGURE 22. ENGINE TEMPERATURE CUTOUT SWITCH

Resistance units and switches in the monitoring and shutdown systems are sealed units and not repairable. When replacing a sensor, do not use a substitute item since resistance units are matched to the gauge they supply. Cutoff switches are close tolerance actuation parts made for a specific application.

## Oil Pressure Monitors

The oil pressure sender (Figure 23) resistance changes with oil pressure and results in a reading on the oil pressure meter. The meter range is 0 to 100 psi (0 to 700 kPa). The low oil pressure switch closes if pressure drops to 14 psi (97 kPa), stopping the engine and activating the optional low oil pressure fault lamp.

The optional pre-low oil pressure switch closes at 20 psi (138 kPa) and turns on the amber Pre Lo Oil Pres lamp. The engine does not shut down, but the warning lamp remains on until the Reset switch is pressed (ensure condition is corrected).



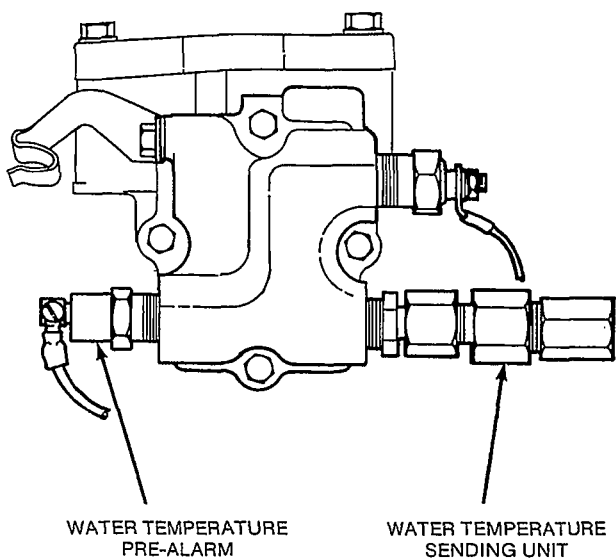
LS-1091

FIGURE 23. OIL PRESSURE MONITORS

## Engine Temperature Monitors

The resistance of the temperature sender unit (Figure 24) changes with the engine coolant temperature and causes a reading on the Water Temp meter. The meter range is 100° to 250°F (40° to 121°C). If coolant temperature rises to 225°F (107°C), the high engine temperature cut-off switch closes, stops the engine, and lights the (optional) red High Engine Temperature Light.

**CAUTION** *The High Engine Temperature Cutoff will shut down the engine in an overheat condition only if coolant level is sufficiently high to physically contact shutdown switch. Loss of coolant will allow engine to overheat without protection of shutdown devices, thereby causing severe damage to the engine. For this reason, make sure to maintain adequate engine coolant levels to ensure proper operation of the cooling system and engine coolant overheat shutdown protection.*



CS-1189

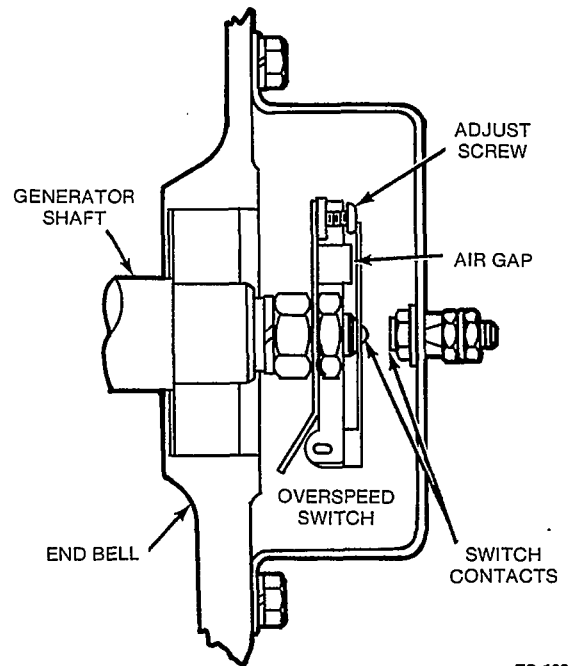
FIGURE 24. ENGINE TEMPERATURE MONITORS

The optional pre-high engine temperature switch closes at a nominal 215°F (102°C) and turns on the amber Pre/Hi Eng Temp lamp. The engine does not shut down, but the warning lamp remains on until the Reset switch is pressed (ensure condition is corrected).

The optional low engine temperature switch closes if coolant temperature drops below 70°F (21°C) to turn on the red Lo Eng Temp light. In locations where ambient temperatures drop below 70°F (21°C), the lamp would indicate malfunction of the optional coolant heater.

## Overspeed Switch

The overspeed switch (Figure 25) is a mechanical switch which grounds the overspeed circuit on the Engine Monitor Circuit Board if an overspeed condition exists causing an engine shutdown and activating the optional overspeed fault lamp. After the problem is corrected, starting will not occur until the Reset switch is pressed.



ES-1298

FIGURE 25. OVERSPEED SWITCH



# Engine Control System Operation

---

## GENERAL

Dependable, trouble-free operation of the control system should be the major concern of any competent generator set service personnel. Service personnel must thoroughly understand how the controls operate, know how to check for troubles, and know how to make the proper adjustments, replacements, or repairs in a reasonable amount of time.

The circuitry, control components, and operating cycles for the ES generator set are described below.

Prior to starting the generator set, check the fuel supply, engine oil level, and all battery connections for loose or broken wires. If an automatic demand control is in use, check for correct connections.

The DC start and run circuits are supplied by the 12 volt battery and charging alternator. The control circuits are completed by returning to ground (negative post of battery).

Figure 26 shows a typical wiring diagram for the ES generator set described in the following Starting, Start-Disconnect and Stopping sequences. Relay contact references normally open (NO) and normally closed (NC) refer to position of contacts with the unit at rest (not energized).

## STARTING SEQUENCE

Depress the Start-Stop switch to the Start position. The engine will start and run. Release the Start-Stop switch when engine starts.

### CAUTION

***Do not hold switch longer than 30 seconds during any attempt to start.***

***Longer periods may damage the starter motor and discharge battery needlessly.***

1. The start circuit is completed by Start-Stop switch S10 at the Start position. This action energizes Relay K2 which supplies B+ to Power Relay K11 Governor Control A12 and ignition by-pass Relay K4.

2. Energizing K11 also energizes fuel solenoid and Starter Relay K1 which energizes Ignition By-pass Relay K4.
3. Energizing K4 supplies B+ to ignition circuit, by-passing the ignition resistor circuit.

## START-DISCONNECT SEQUENCE

When the engine starts, B+ from the auxiliary terminal of the alternator energizes the Start Disconnect Relay K3. Energizing K3 removes the B+ from Start Relay K1 and Ignition By-pass Relay K4.

## STOPPING SEQUENCE

Depressing S10 to Stop position de-energizes K2 and K11 which opens B+ circuit to the ignition system, fuel solenoid and governor control.

## EMERGENCY SHUTDOWN

Fault Relay A11, K1 is directly energized by one of the following fault sensors: S6 low oil pressure switch, S1 high engine temperature switch, S3 overspeed switch, OC (overcrank) Limiter.

When K1 is energized, a NC set of contacts open B+ to the Power Relay K11, and another set closes to connect B+ to an optional fault alarm. The engine sensor causing the fault triggers a solid state circuit that lights up the appropriate fault lamp on the control panel. The engine cannot be started until fault condition is corrected and the Reset Switch S12 pressed.

The Low Oil Pressure Delay circuit is not actuated until the Start-Disconnect Relay is energized. The circuit allows a delay of 7.5 to 12.5 seconds before LOP shutdown and pre-alarm are functional. Following this initial delay, both the LOP shutdown and pre-alarm functions are immediate.



# Engine Control Troubleshooting

## GENERAL

The data in this section is divided into three flow charts, and information on troubleshooting the ES solid-state control (page 28). The flow charts consist of:

- A. Engine does not crank.
- B. Engine cranks but does not start.
- C. Engine starts but stops when start switch is released.

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

- Check all modifications, repairs, replacements performed since last satisfactory operation of set. A loose wire connection overlooked when instal-

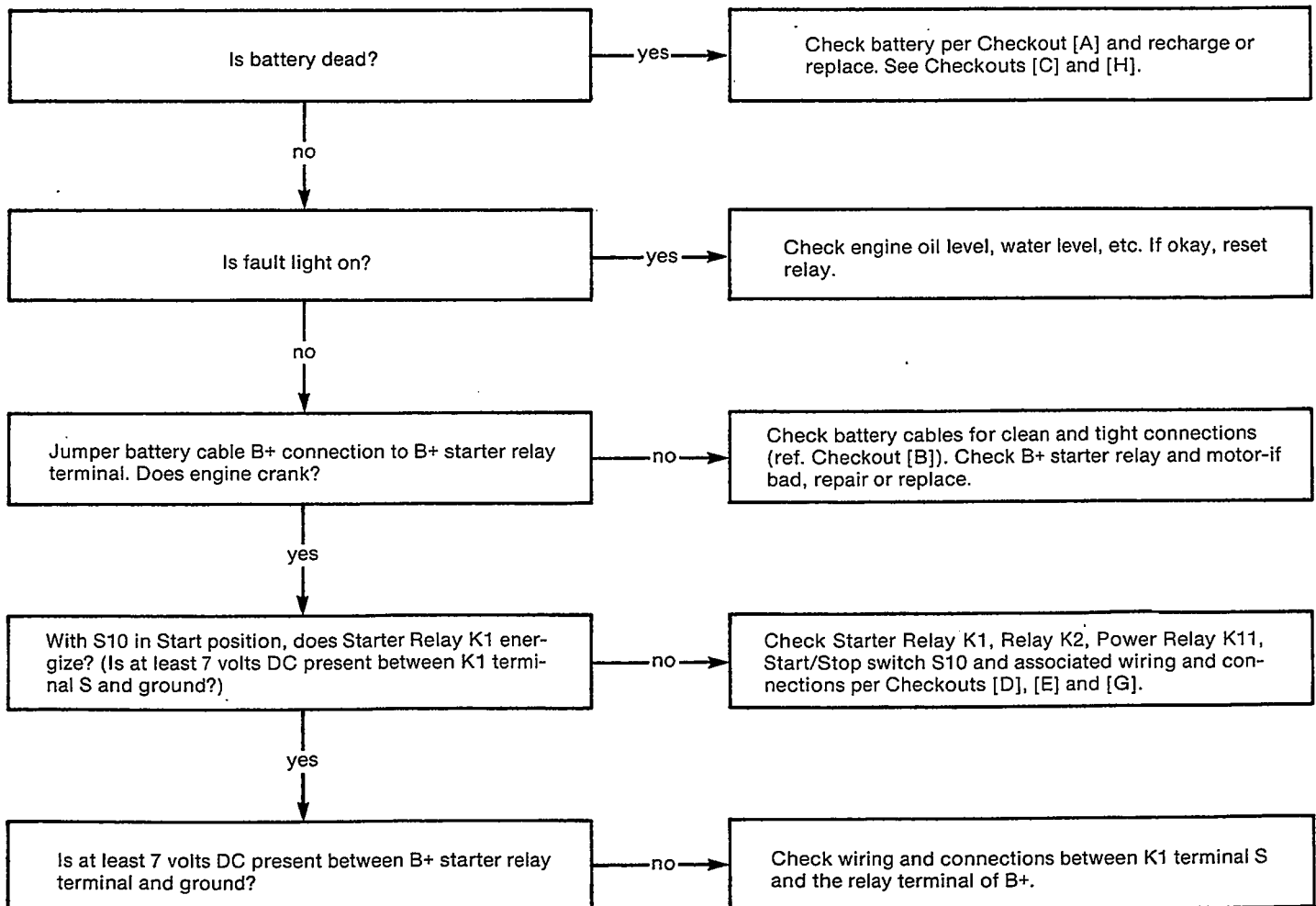
ling a replacement part could cause problems. An incorrect connection, an opened switch or circuit breaker, or a loose plug-in are all potential problems that can be eliminated by a visual check.

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

To troubleshoot a problem, start at the upper-left corner of chart and answer all questions either YES or NO. Follow the chart until the problem is found, performing referenced Control Component Checkout procedures on page 30. Refer to typical wiring diagram in Figure 26 for locating control component leads, terminals and other check points.

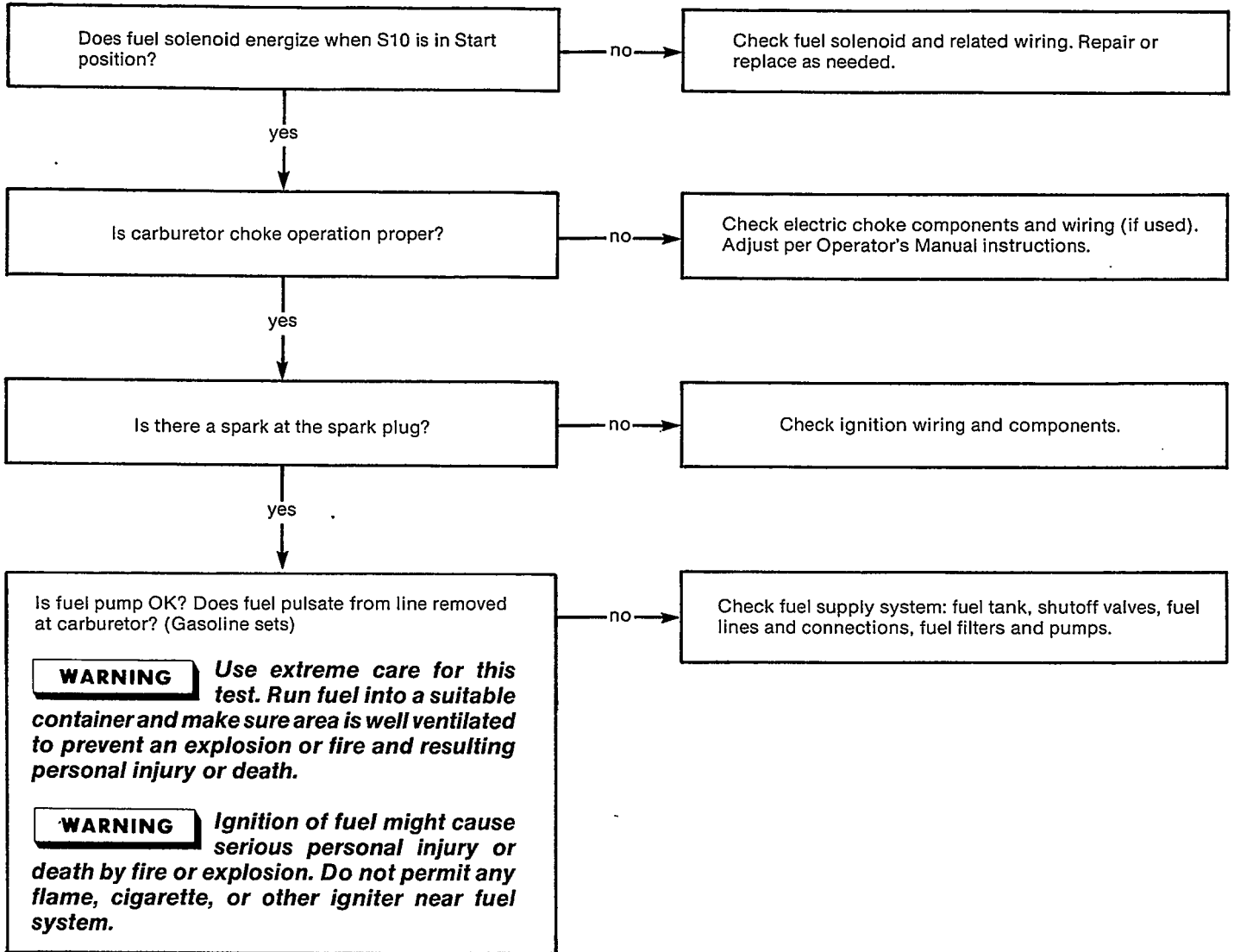
## FLOW CHART A. ENGINE DOES NOT CRANK

START



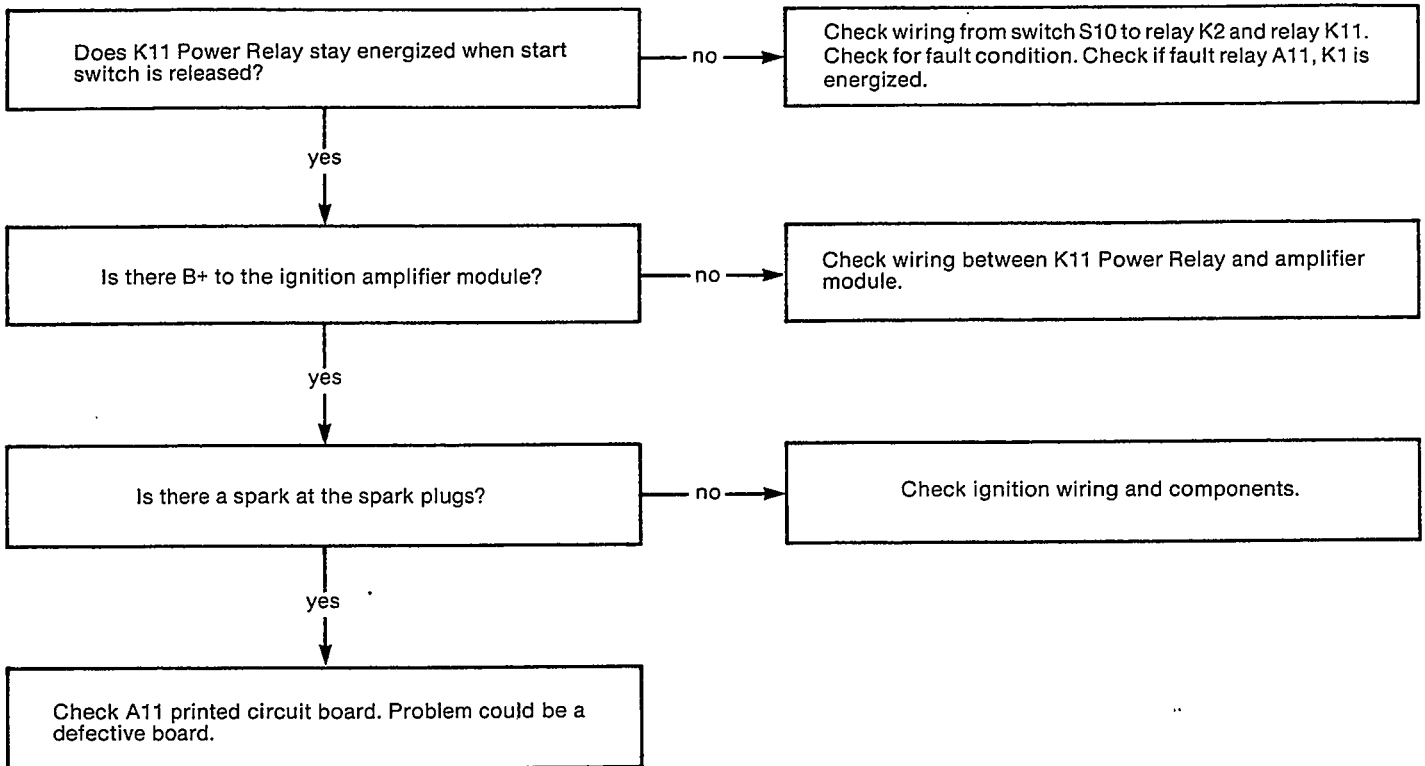
## FLOW CHART B. ENGINE CRANKS BUT DOES NOT START

START



## FLOW CHART C. ENGINE STARTS BUT STOPS WHEN START SWITCH IS RELEASED

START



## TROUBLESHOOTING ENGINE CONTROL

Refer to Control Operation and the schematic in Figure 28 when troubleshooting this control. Repair information is not extensive since the solid-state printed circuit board lends itself more to replacement than repair. External components such as leads, switches, indicator lights, relays, gauge senders, circuit breakers, DC voltage regulator, etc., plug into the board.

If an external component is suspected of causing a problem, disconnect its associated jack (J1, J2 or J3) from the board (Figure 27) and check continuity of wiring and the component. Note some switches are NC and some NO with unit at rest. Individual components can be checked out similarly as referenced in "Control Component Checkout" on page 30.

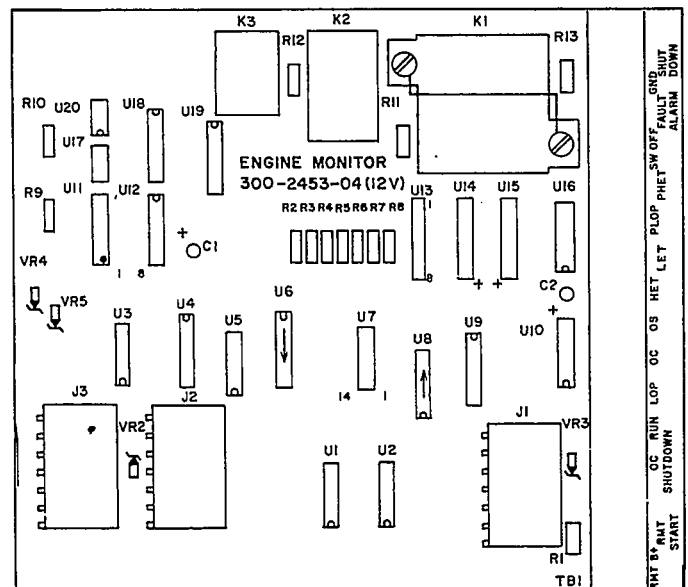


FIGURE 27. LOCATION OF JACKS AND RELAYS ON ENGINE MONITOR BOARD 300-2453

44	RESISTOR (10K, 1/2W, 5%)
43	CAPACITOR (4.7µF, 35V)
42	DIODE-ZENER
41	DIODE-ZENER
40	IC-TIMER
39	IC-1µF CERAMIC CAP.
38	IC-6.8µF TANTALUM CAP.
37	IC-100Ω RES NETWORK
36	IC-PROGRAMMABLE TIMER
35	IC-100K RES NETWORK
34	IC-QUAD PNP XSTR
33	IC-10KΩ RES NETWORK
32	IC-DRIVER ARRAY
31	
30	IC-8 DIODE COM ANODE
29	IC-8 DIODE IN LINE
28	IC-16 DIODE ARRAY
27	IC-QUAD XSTR ARRAY
26	TERMINAL BLOCK-PC BD
25	TERMINAL BLOCK-PC BD
24	RESISTOR (1Ω, 1/2W, 10%)
23	RESISTOR (1.2KΩ, 1W, 5%)
22	RESISTOR (200Ω, 1/2W, 5%)
21	RESISTOR (10Ω, 1/2W, 10%)
20	RESISTOR (22KΩ, 1/2W, 5%)
19	RESISTOR (680Ω, 1/2W, 5%)
18	RESISTOR (4.7KΩ, 1/2W, 10%)
17	RELAY-PC SPDT
16	RELAY-PC SPST
15	NUT-HMS (#6-32)
14	WASHER-IT (#6)
13	SCREW-RHM (#6-32 x 3/8)
12	SPRING-RELAY HOLD-DOWN
11	SOCKET-RELAY
10	RELAY-TPDT
9	PLUG-CONNECTOR
8	
7	CAPACITOR-TANT (47µF, 20V)
6	SOLDER-BAR
5	SILKSCREEN-ENG MON
4	SILKSCREEN-ENG MON
3	SILKSCREEN-ENG MON
2	SILKSCREEN-ENG MON
1	PRINTED CIRCUIT BOARD
ITEM	DESCRIPTION OR MATERIAL

	Dash No.
Model	12V 32V
ES 9 Light	-04

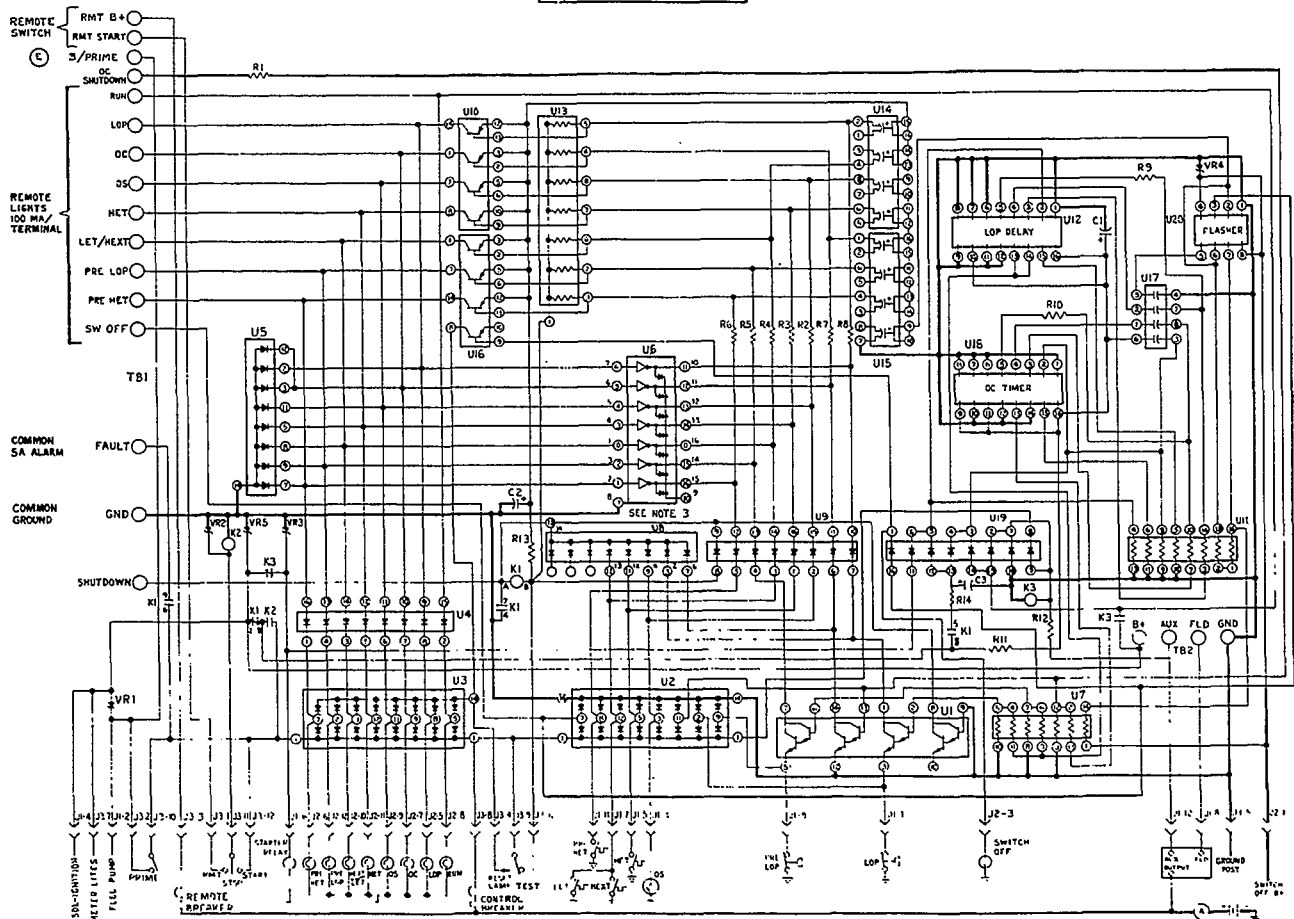


FIGURE 28. ENGINE MONITOR PCB SCHEMATIC 300-2453

# Control Component Checkout

The following component checkouts are referenced in the Control Troubleshooting flow charts, pages 26 to 29. They are an aid to isolating circuit problems caused by faulty engine control components.

## [A]

### BATTERY CHECKOUT

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

**WARNING** Do not smoke while servicing batteries. Explosive gases are emitted from batteries in operation. Ignition of these gases might cause severe personal injury or death.

**WARNING** Avoid skin or clothing contact with electrolyte or serious personal injury might result.

If the battery loses excess water, the generator charge rate may be too high. Likewise, if battery state of charge is not maintained, the charge rate may be too low. Refer to CHARGING CIRCUIT CHECKOUT [C].

## [B]

### BATTERY CABLE CHECKOUT

With the starter motor operating, check the voltage drops (1) from the battery negative post (not the cable clamp) to the cylinder block, (2) from the battery positive post to the battery terminal stud on the solenoid. Normally, each of these should be less than 0.3 volt. If extra long battery cables are used, slightly higher voltage drops may result. Thoroughly clean all connections in any part of the circuit showing excessive voltage drop.

## [C]

### CHARGING CIRCUIT CHECKOUT

1. With engine running at rated speed, check alternator output at battery positive (+). Voltage should indicate between 13.9 and 14.7 volts depending on regulator ambient temperature. A voltage higher than 15 volts may indicate a bad ground or defective voltage regulator.
2. If alternator output is low or absent perform Field Circuit Test first.
  - A. With engine not running, disconnect Field Terminal connector, place ammeter and field

rheostat in series with the alternator Output Terminal and Field Terminal. Current should be 2 to 2.5 amperes. If less than 2 amperes, check alternator brushes and slip rings.

- B. With engine running, disconnect voltage regulator and Field Terminal connectors. Jumper Output Terminal to Field Terminal. If voltage to battery positive (+) rises to 15-16 volts and field circuit tested good, regulator is defective and should be replaced. If voltage does not rise, defect is in the stator or rectifier diodes.

## [D]

### SOLENOID CHECKOUT

1. Apply 12 volts to battery terminal.
2. Jumper a ground wire to terminal marked "S". Solenoid should activate.
3. If contacts are good, 12 volts should be read between terminal S1 and ground. The voltage drop measured across contacts should never exceed 1 volt in circuit application.

## [E]

### RELAY CHECKOUT

1. Connect 12 volts across relay coil terminals. Relay should activate if coil is okay.
2. Connect a 12 volt source to one side of relay contacts.
3. Connect a voltmeter to other side of relay contact and 12 volt source. If 12 volts appears when relay is energized, contact is okay. The 12 volt reading appears in reverse order when checking normally closed (NC) contacts.

## [F]

### RESISTOR CHECKOUT

1. Remove battery B+ cable.
2. Disconnect one side of resistor and using an ohmmeter measure across resistor for an accurate reading.

## [G]

### SWITCH CHECKOUT

1. Remove battery B+ cable.
2. Place ohmmeter leads across switch.
3. Activate switch. If meter reads continuity, switch is good.

# Governor Adjustment

## GENERAL

The governor controls the speed of the engine, and therefore the frequency. Engine speed also affects AC output voltage. Use either a tachometer or frequency meter to check engine speed for proper governor adjustment.

### Governor Adjustment-Engine Speed

A Barber-Colman governor is standard equipment. The governor is set at the Onan testing facility and does not require further adjustment for normal standby service. If however, unit is used frequently or if the governor is removed for service, adjustment may be required. This is accomplished as follows:

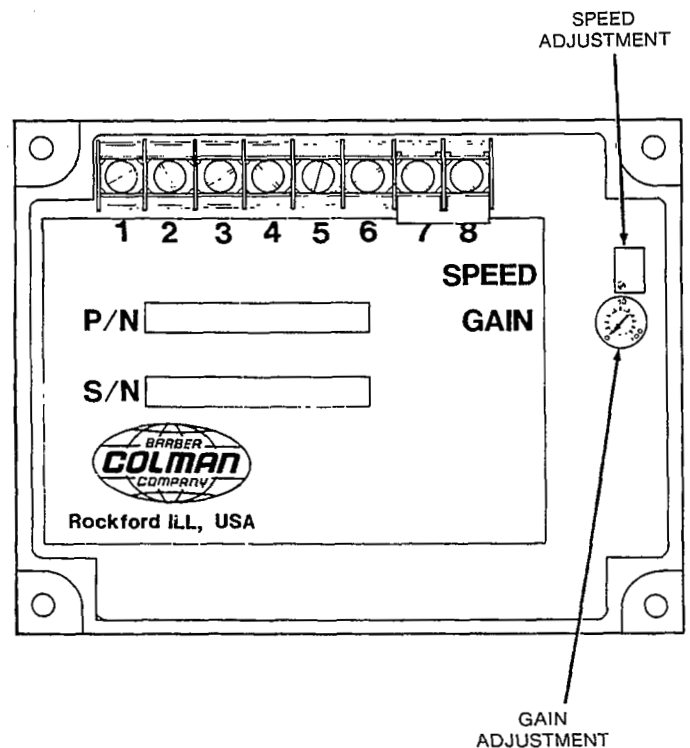
1. Remove cover from control box.

**Prior to adjusting governor control, ensure that governor control terminals 7 and 8 are jumpered.**

2. Attach tachometer to engine or frequency meter to generator output leads if control panel does not come equipped with one of these meters.
3. Place Run-Stop-Remote switch in Run position. Hold throttle linkage so that engine will not overspeed, should the governor control be out of adjustment.
4. Adjust speed potentiometer clockwise or counterclockwise to increase or decrease speed, until desired speed is attained; 1800 r/min for 60 HZ. See Figure 29. Adjust the carburetor idle stop so that less than 300 r/min (10 hertz) droop occurs when the throttle is held closed.

**When using generator frequency meter to determine engine speed, multiply frequency by 30 to calculate engine speed. Example: 30 x 60 HZ = 1800 r/min.**

5. Adjust gain potentiometer until engine is stable and responsive to governor control (clockwise increases gain, counterclockwise decreases gain).
6. Manually actuate governor linkage several times to ensure correct gain adjustment. Unit should respond quickly but should not hunt, use maximum possible gain setting.
7. Shut down engine. Restart engine to make sure that unit does not overspeed.
8. Shut down engine and remove tachometer or frequency meter previously attached.
9. Replace cover to control box.
10. Engine is now ready for service.



SC-1195

FIGURE 29. GOVERNOR CONTROL ADJUSTMENT



# Wiring Diagrams

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The electrical schematics and wiring diagrams listed below are applicable to the ES Series Engine and Generator Controls.

**FIGURE 30. 2 LIGHT DC CONTROL MODULE**

**FIGURE 31. 9 LIGHT DC CONTROL MODULE**

**FIGURE 32. 2 LIGHT DC CONTROL SCHEMATIC DIAGRAM**

**FIGURE 33. 9 LIGHT DC CONTROL SCHEMATIC DIAGRAM**

**FIGURE 34. 2 LIGHT DC CONTROL WIRING DIAGRAM (STANDARD METERING)**

**FIGURE 35. 2 LIGHT DC CONTROL WIRING SCHEMATIC (STANDARD METERING)**

**FIGURE 36. 2 LIGHT DC CONTROL WIRING DIAGRAM (OPTIONAL METERING)**

**FIGURE 37. 2 LIGHT DC CONTROL WIRING SCHEMATIC (OPTIONAL METERING)**

**FIGURE 38. 9 LIGHT DC CONTROL WIRING DIAGRAM (STANDARD METERING)**

**FIGURE 39. 9 LIGHT DC CONTROL WIRING SCHEMATIC (STANDARD METERING)**

**FIGURE 40. 9 LIGHT DC CONTROL WIRING DIAGRAM (OPTIONAL METERING)**

**FIGURE 41. 9 LIGHT DC CONTROL WIRING SCHEMATIC (OPTIONAL METERING)**

**FIGURE 42. GENERATOR REGULATOR SCHEMATIC DIAGRAM**

**FIGURE 43. 1 $\emptyset$  AC GENERATOR CONTROL**

**FIGURE 44. 3 $\emptyset$  AC GENERATOR CONTROL**

**FIGURE 45. VOLTAGE REGULATOR ASSEMBLY**

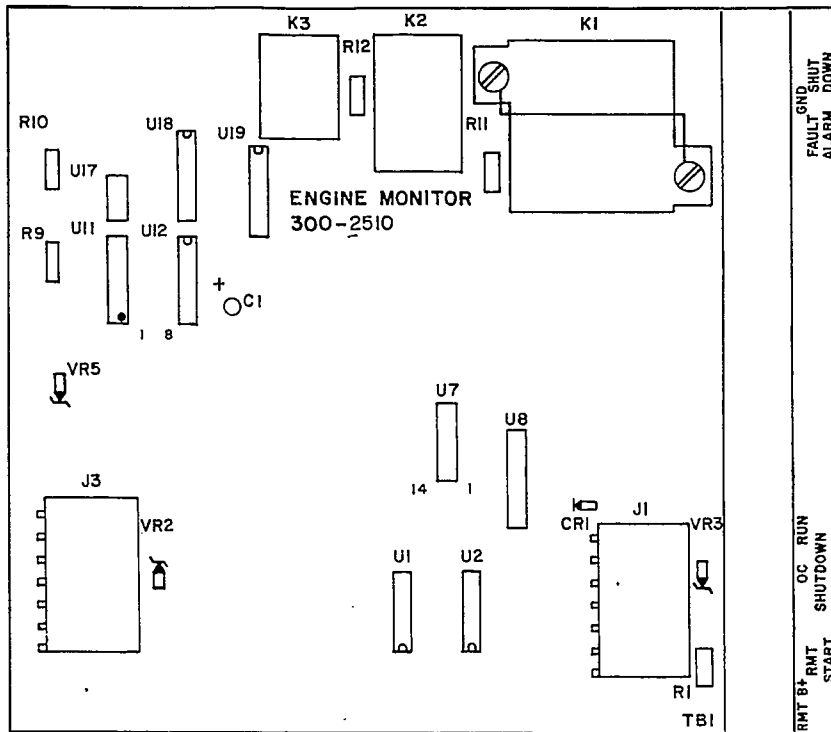


FIGURE 30. 2 LIGHT DC CONTROL MODULE

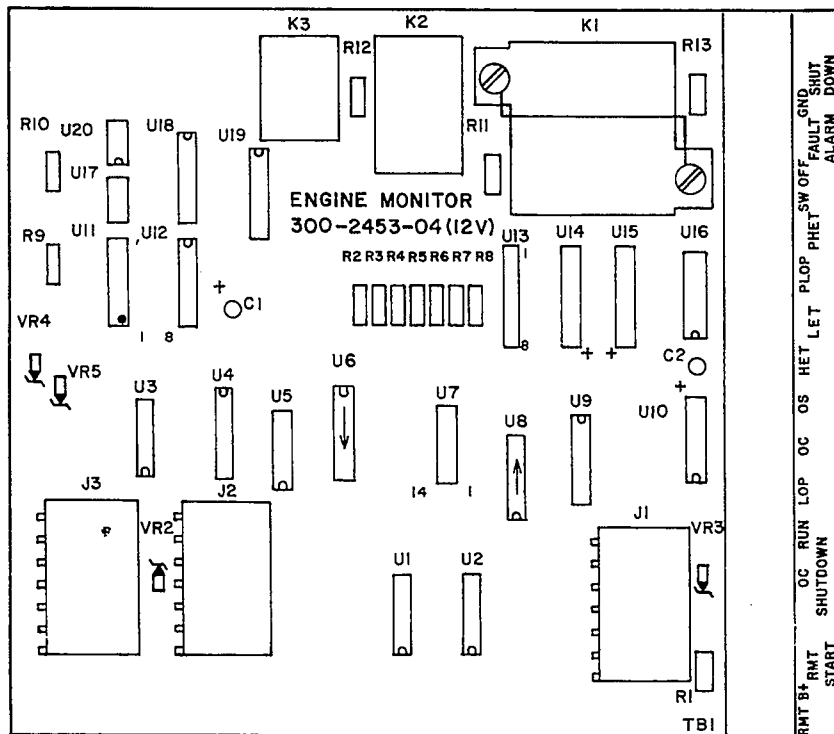


FIGURE 31. 9 LIGHT DC CONTROL MODULE

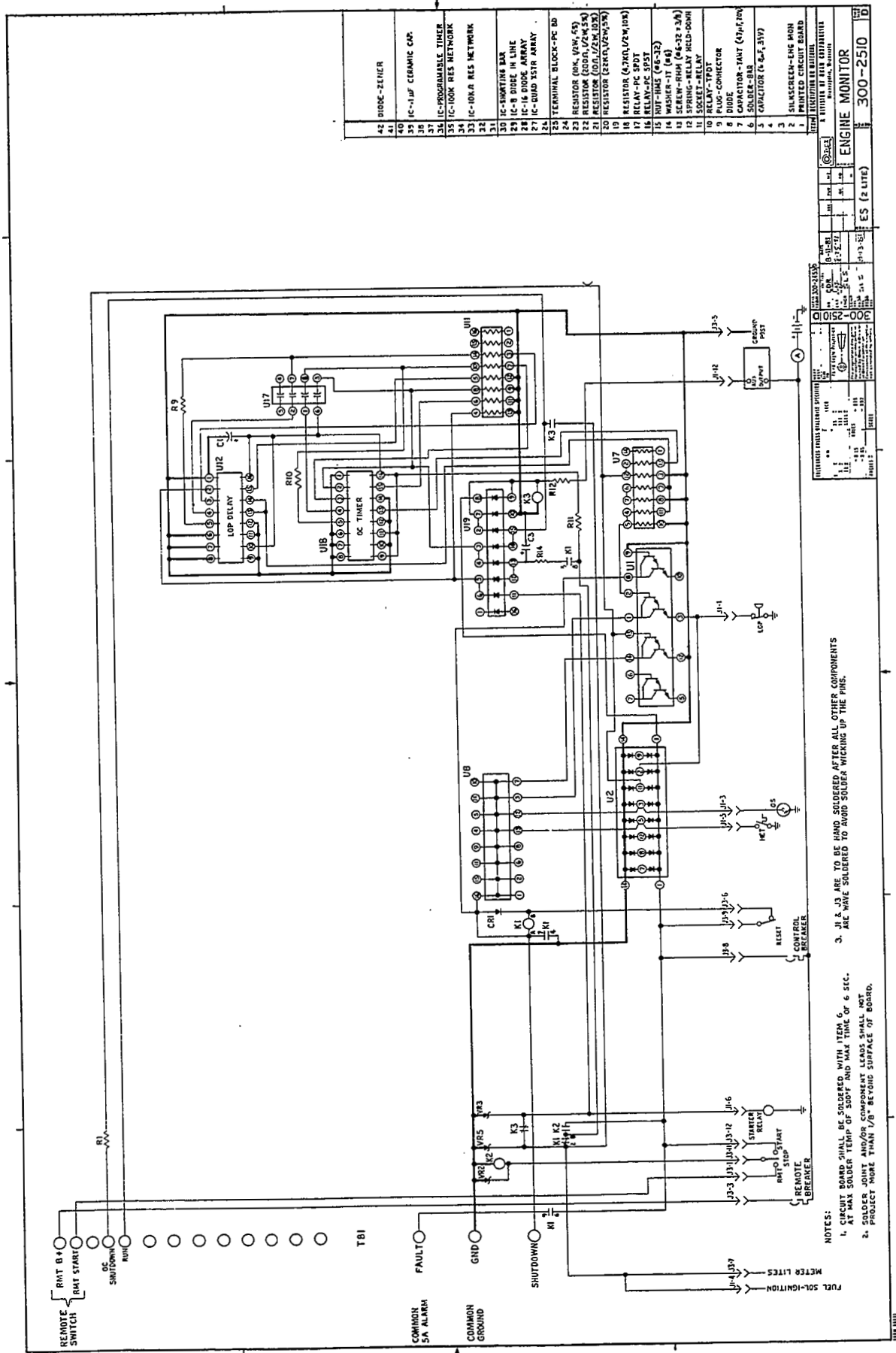


FIGURE 32. 2 LIGHT DC CONTROL SCHEMATIC DIAGRAM

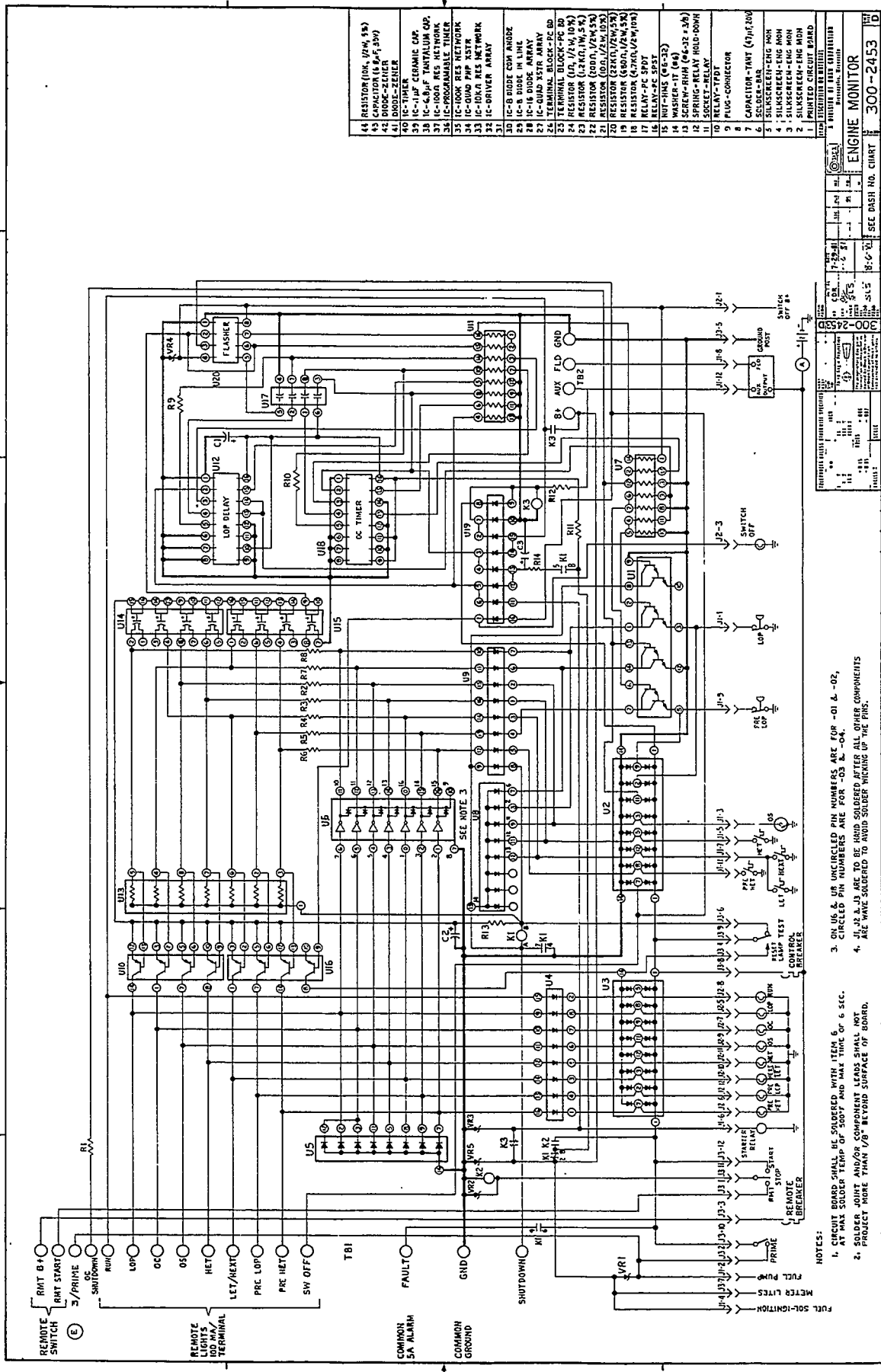


FIGURE 33. 9 LIGHT DC CONTROL SCHEMATIC DIAGRAM





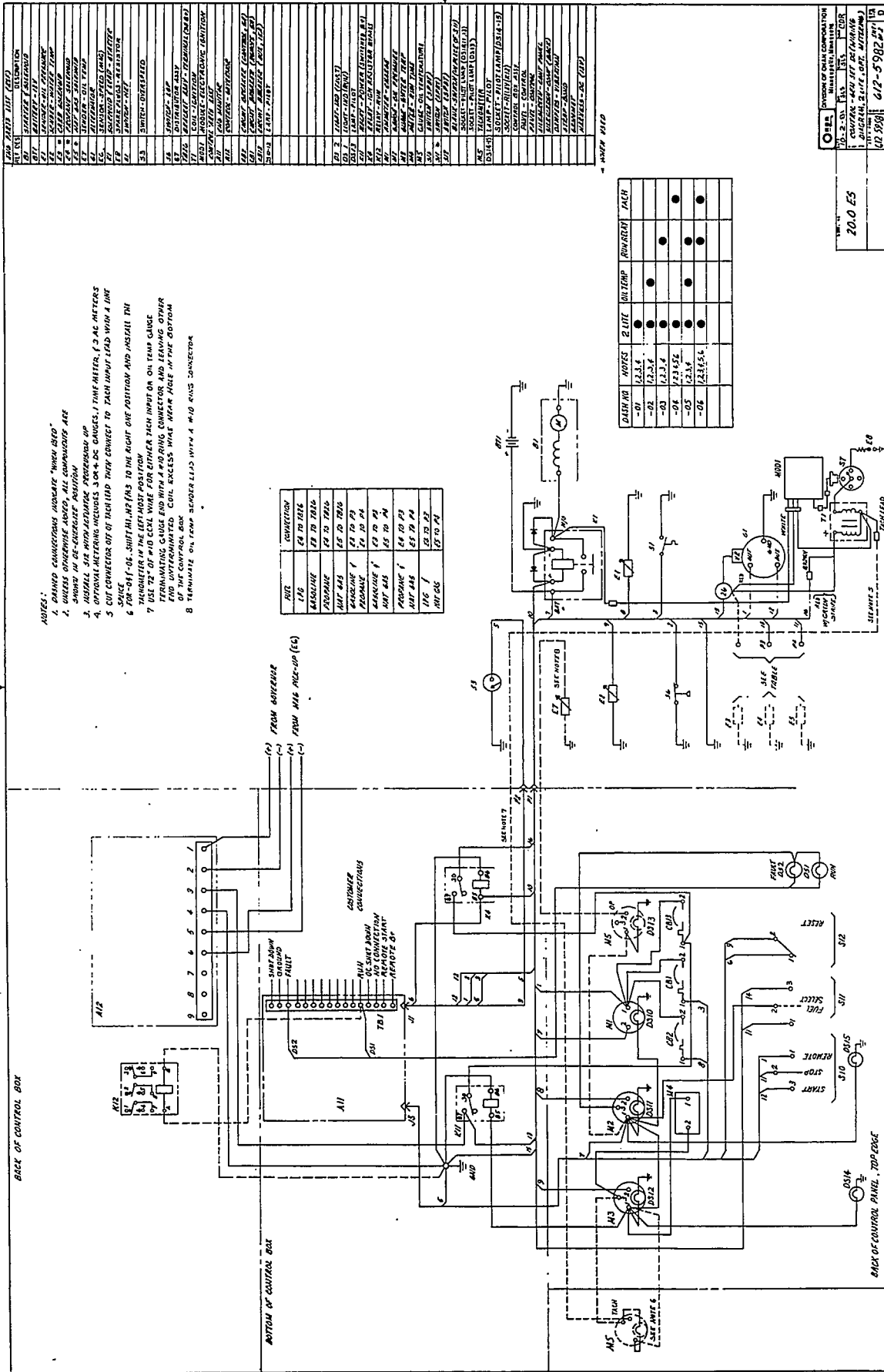


FIGURE 36. 2 LIGHT DC CONTROL WIRING DIAGRAM (OPTIONAL METERING)







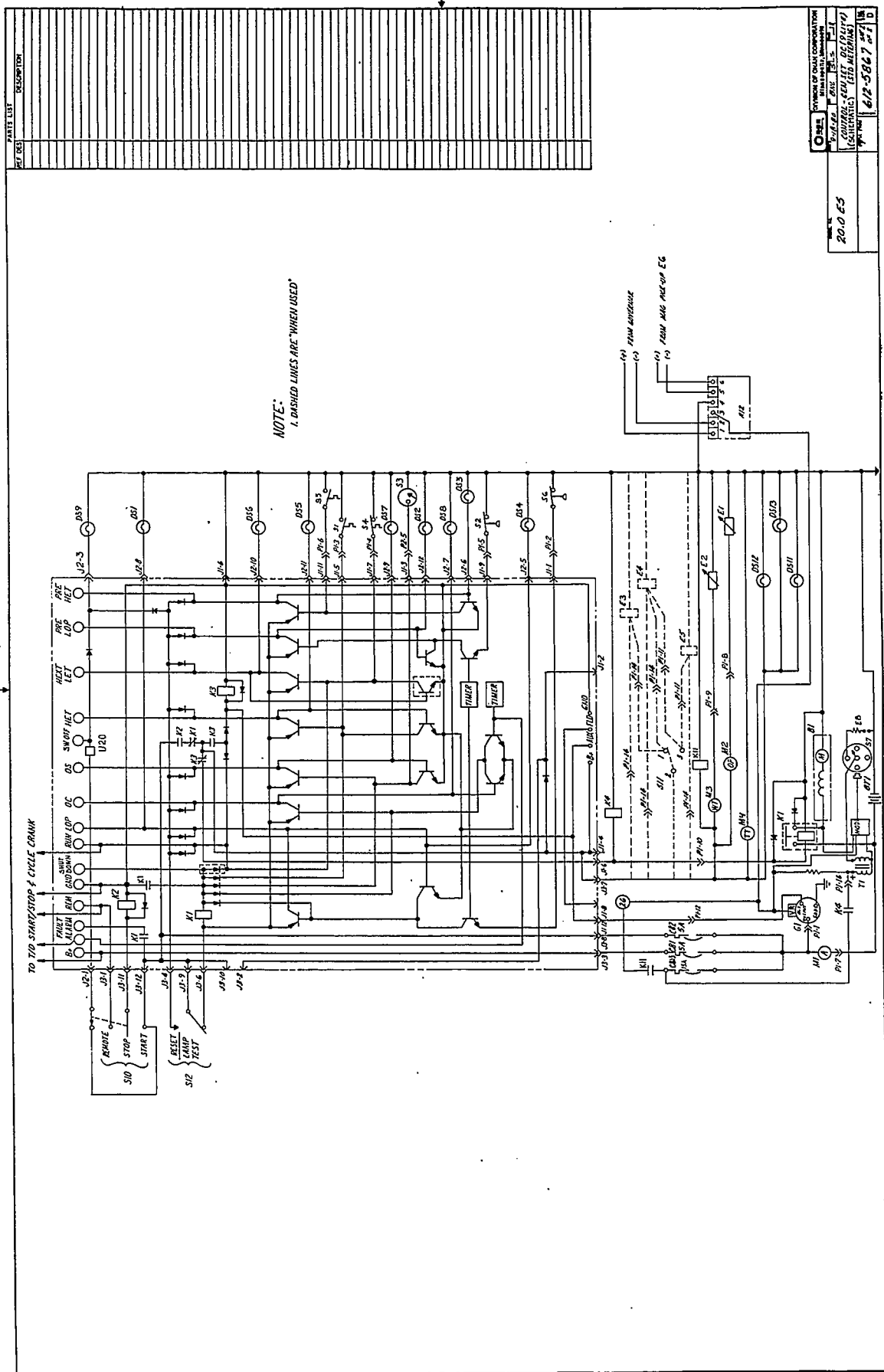


FIGURE 39. 9 LIGHT DC CONTROL WIRING SCHEMATIC (STANDARD METERING)







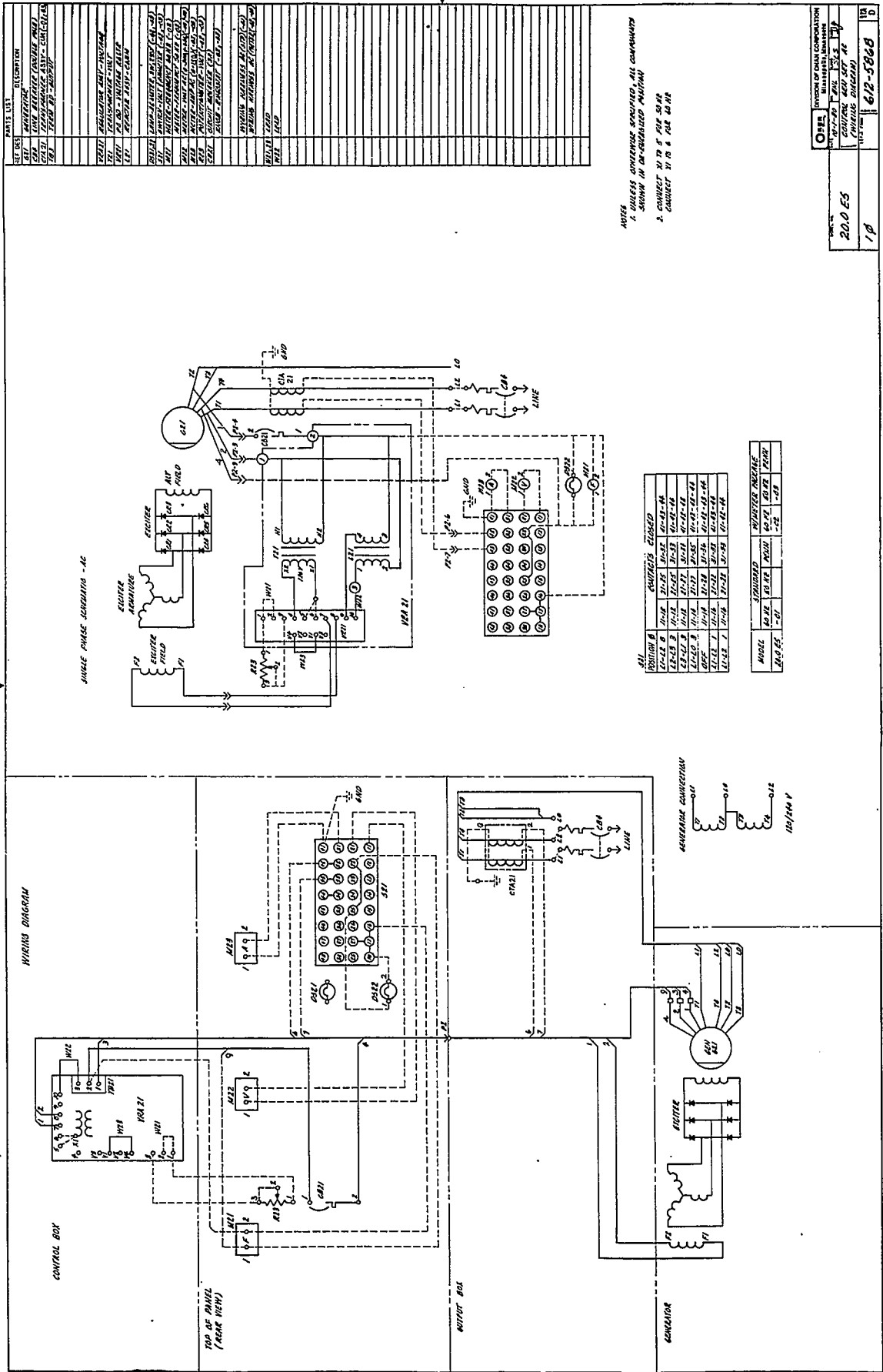
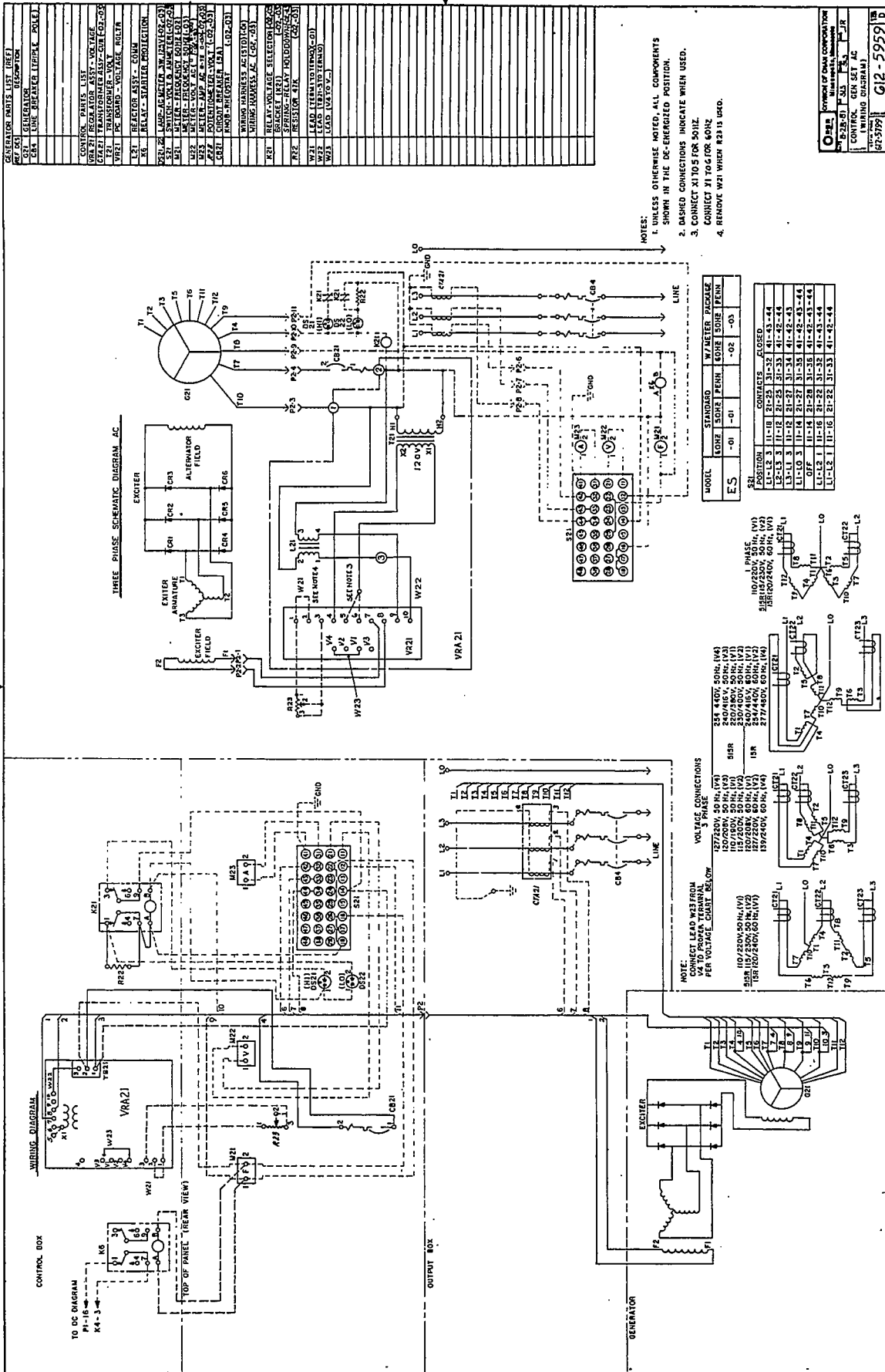
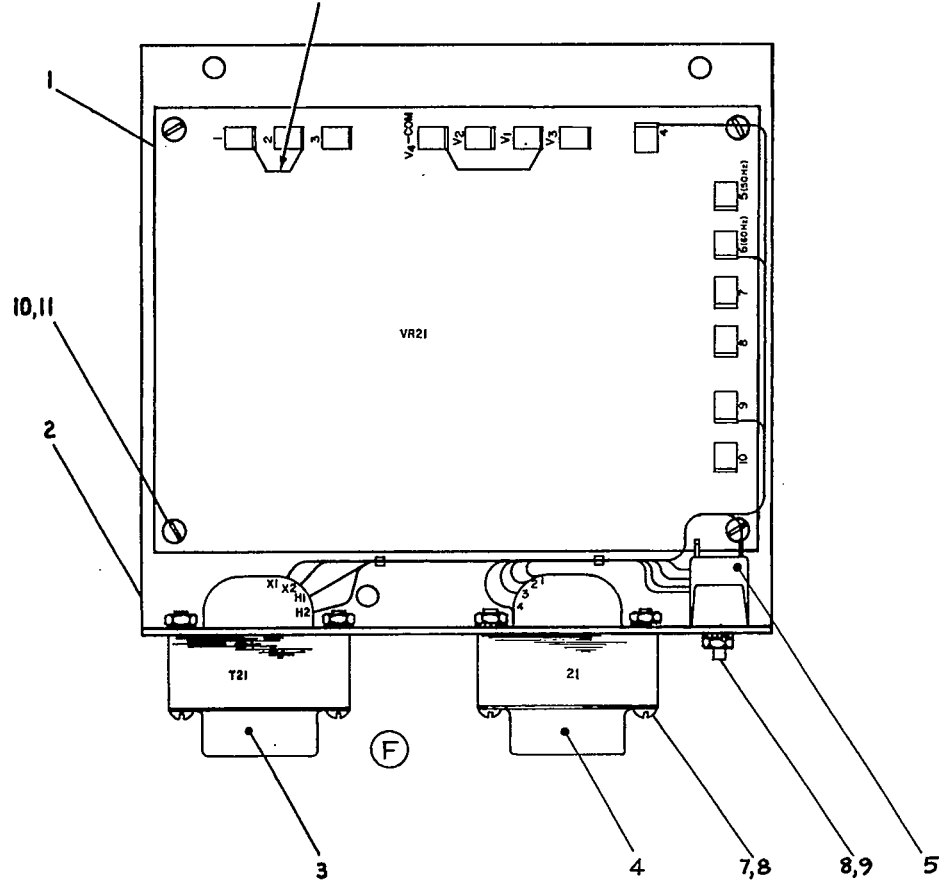


FIGURE 43. 1? AC GENERATOR CONTROL



REMOVE JUMPER WHEN VOLTAGE ADJUST R22 IS USED FOR REFERENCE VOLTAGE REGULATION.



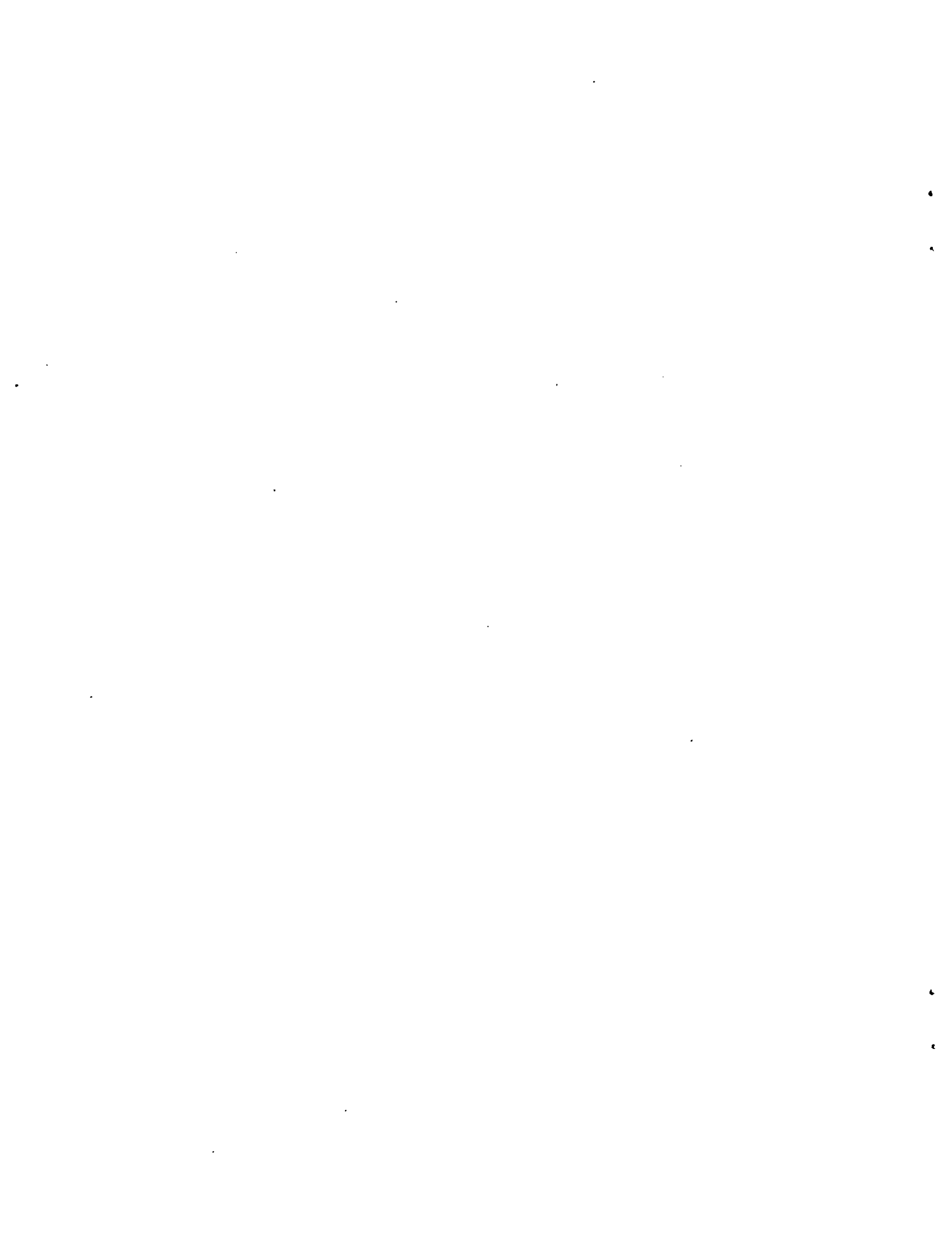
WIRING TABULATION		
FROM STATION NO.	TO STATION NO.	LEAD FIND NO.
T21 X1	VR21-6	_____
T21 X2	VR21-4	_____
T21 H1	TB21-1	_____
T21-H2	TB21-2	_____
CMR21-1	TB21-3	_____
CMR21-2	TB21-1	_____
CMR21-3	TB21-2	_____
CMR21-4	VR21-9	_____
VR21-1	VR21-2	13
VR21-V4 COM	VR21-V1	13

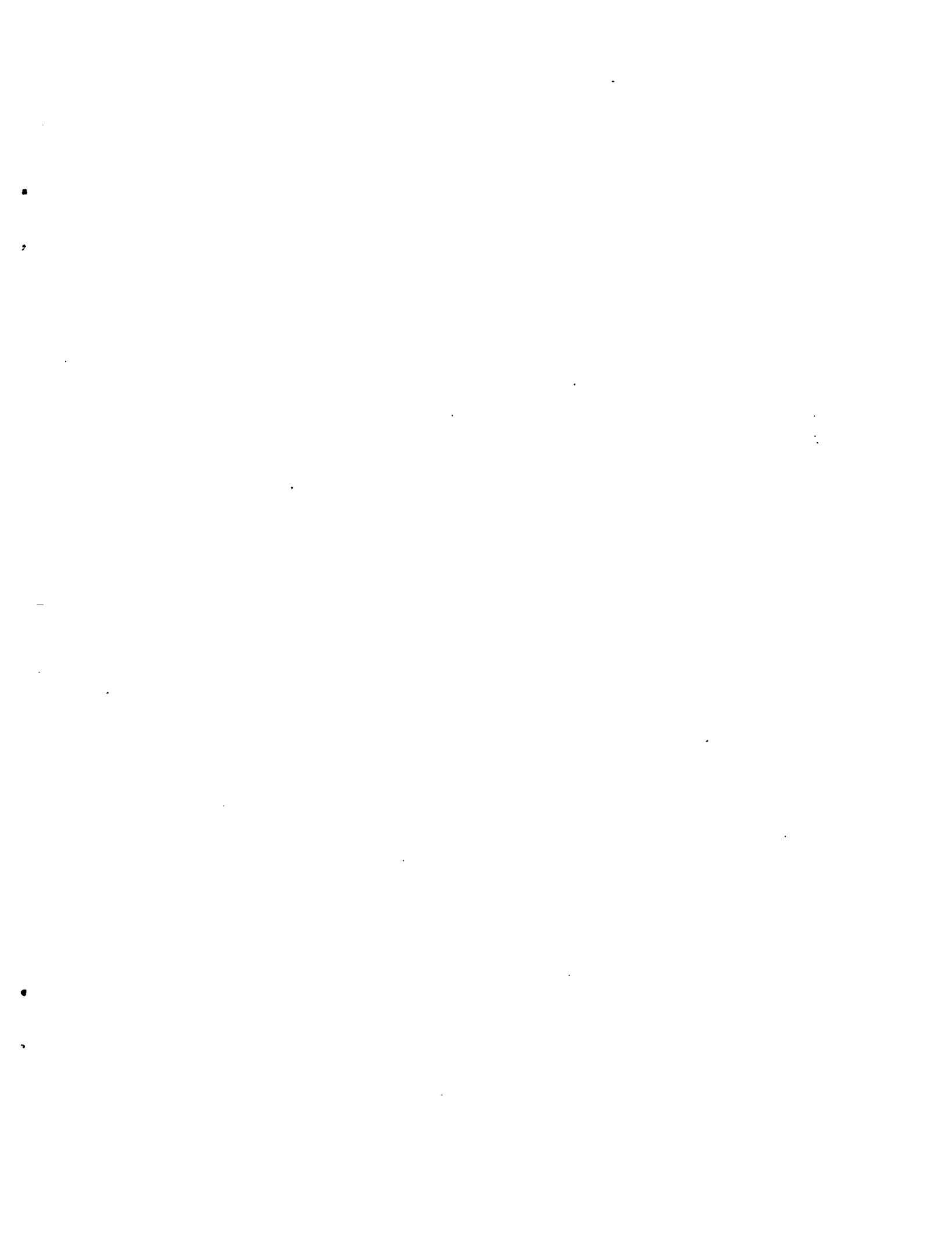
13	LEAD ASSY
12	TIE-CABLE (SELF LOCKING)
11	WASHER-ET LK (-6)
10	SCREW-RHM (6-32 x 3/8" LG)
9	SCREW-RHM (6-32 x 1 2" LG)
8	NUT-HEX # E1 (6-32)
7	SCREW-RHM (6-32 x 1-1/4" LG)
6	
5	TERMINAL STRIP
4	REACT-COMM
3	TRANSFORMER-VOLTAGE REF
2	PANEL-VOLT RGLTR MTG
1	REGULATOR BOARD ASSY

6-19-73	1/1		<b>REGULATOR ASSY-VOLTAGE</b>
YD		305-0583	

FIGURE 45. VOLTAGE ASSEMBLY







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