ELECTRO-MOTIVE

M.I. 6845
*Rev. B

MAINTENANCE INSTRUCTION

TESTING AND SETTING THE POWER CONTROL SYSTEM SR11, SR12, AND SR16 DRILLING RIG POWER UNITS

INTRODUCTION

This maintenance instruction provides general procedures for testing and setting the excitation and power control system used on the SR11, SR12, and SR16 drilling rig power units.

The excitation and power control systems of generators 1 and 2 of the SR11, SR12, and SR16 drilling rig power units are similar. However, the SR16 drilling rig power unit has a third generator, the component designations of the units may be different, and the units may be set up for different levels of power. Therefore, maintenance personnel involved in testing and setting of the excitation and power control system must have a working knowledge of their specific installation and should use these instructions in conjunction with the "Charts And Graphs" and schematic diagrams for their installation.

WARNING

Improper settings or adjustments may result in damage to equipment and injury to personnel.

It is necessary to use accurate and reliable test equipment when making checks and adjustments specified in this instruction.

DESCRIPTION

A detailed description of the SR11, SR12, and SR16 drilling rig power units is provided in the operator's manual.

The SR11, SR12, and SR16 drilling rig power units require an outside source of 440 to 480 volts, three phase 60 Hz and 120 volts, single phase, 60 Hz.

The 440 volts, three phase, 60 Hz is applied to the generator blower motors and to the primary of transformers T1, T2, and T3. The 108 volts output of transformers T1, T2, and T3 is applied through a rectifier and magnetic amplifier assembly to excite the generator field. The 108 volts output from T1, T2, and T3 is also applied through generator current transductors GCT and generator voltage tranductors GVT and feedback transformers to provide a feedback signal proportional to generator output current and voltage. This feedback signal is compared, by the power limit static device PLS, Fig. 1, with a reference signal from the driller's control to provide voltage, current, and power limiting.

*This bulletin is revised and supersedes previous issue of this number.
Areas of change are indicated by vertical bars.

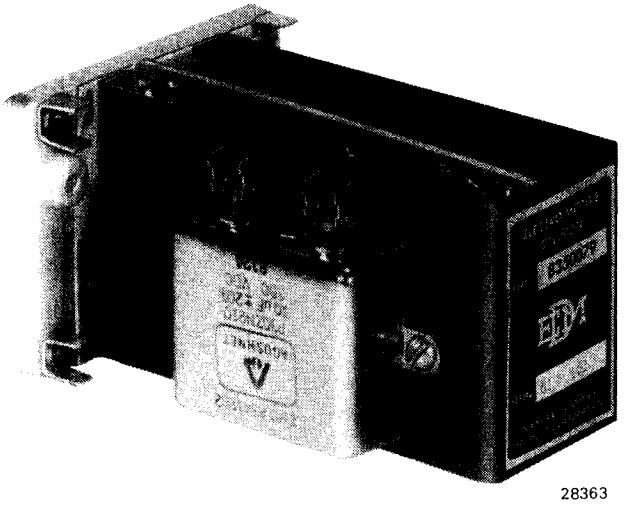

Fig.1 - Power Limit Static Device; PLS

POWER LIMIT STATIC DEVICE; PLS

This device, Fig. 2, is a solid state switching device used to control generator output proportional to the signal provided from the driller's control. The operating voltage for the device is applied between terminals 7 positive and 5 negative. The signal from the driller's control is applied between terminals 3 positive and 5 negative. A feedback signal proportional to generator output voltage and current is applied between terminals 1 positive and 5 negative.

Output transistor Q1 is turned on when the driller's control signal at terminal 3 is larger than the feedback signal applied to terminal 1. This results in current flow through the magnetic amplifier control winding 11-12. An increase in the driller's control signal results in an increase of current through control winding 11-12. An increase of current through control winding 11-12 results in an increase of current through the magnetic amplifier output windings, an increase in generator field excitation, and an increase in generator output voltage and current.

The generator voltage and current feedback signal applied to terminal 1 contains ripples. Transistor Q1 turns off when the ripple voltage at terminal 1 rises above the driller's control signal applied to terminal 3. The output transistor turns on when the ripple voltage falls below the driller's control signal. therefore, with a constant signal from the driller's control, the average feedback signal is equal to the driller's control signal. However, the ripples of the

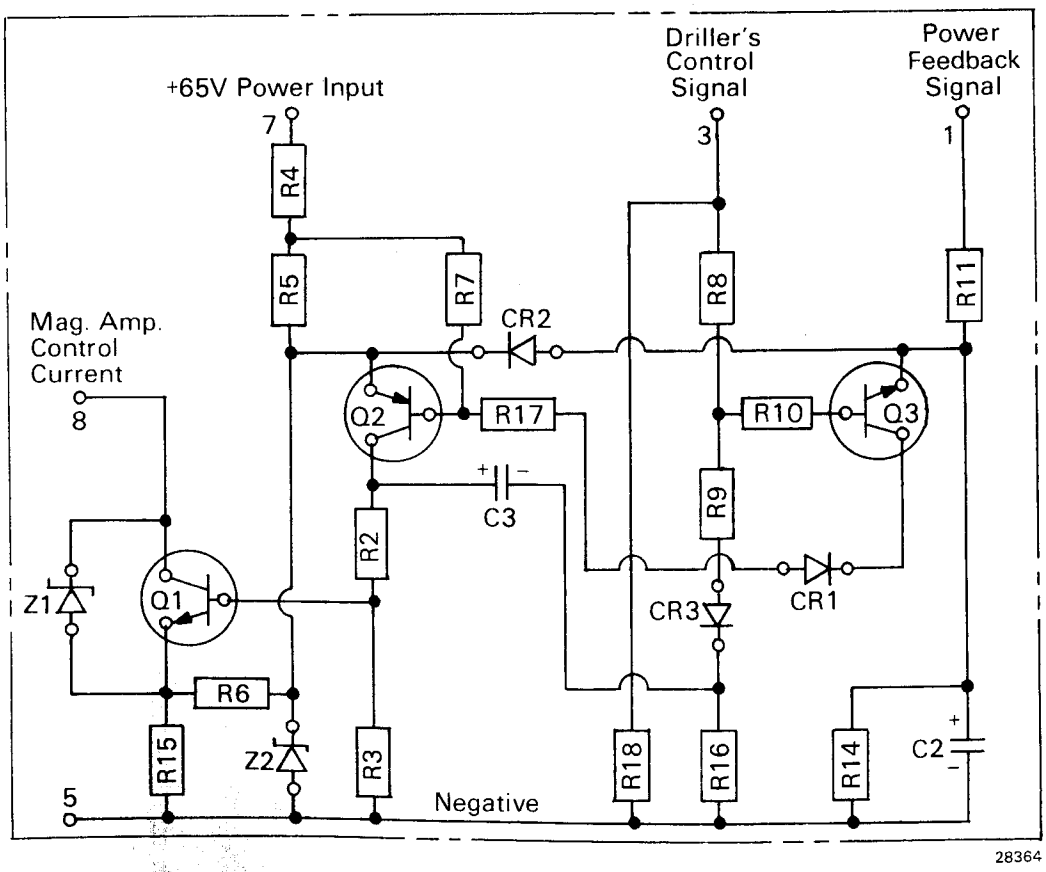

Fig.2 - PLS Panel, Schematic Diagram

feedback signal rise above and fall below the driller's control signal. This results in rapid switching of the transistor as necessary to maintain generator voltage and current at a value proportional to the driller's control signal. Current through the magnetic amplifier bias windings 7-8 is adjusted for minimum output from the generator when there is no signal from the driller's control.

Potentiometers, rheostats, and adjustable resistors are provided for adjusting the power and control circuits to obtain the desired performance. The following paragraphs are provided for personnel involved in testing and setting the excitation and power control system.

TESTING AND SETTING THE POWER CONTROL SYSTEM

Testing and setting of the power control system should be performed in the sequence provided in this instruction.

PRELIMINARY

1. Before applying any power, remove fuses F11 thru F33.
2. Remove wires from PLS terminals 3,7 and 8 in all generator control cabinets. Tape the wire ends.
3. Set all rheostats in the generator control cabinets to midposition.

CHECK AC INPUT VOLTAGES

1. Check for 440 to 480 volts, 60 Hz, three phase voltage from GB1 A to C, C to E, and E to A. The AC voltmeter must indicate 440 to 480 volts AC for each measurement.
2. Check for 108 volts, 60 Hz, three phase voltage between fuseholders F11 thru F33. The AC voltmeter must indicate 108 volts for each measurement. Adjust taps on T1, T2, and T3 if necessary to obtain 108 volts for each measurement.
3. If voltages are correct, install fuses.
4. Check for 120 volts, 60 Hz between terminals A26 and A28. The voltmeter must indicate 120 volts AC.

CHECK INPUT VOLTAGE TO POWER LIMIT STATIC DEVICE PLS, Fig. 3

CAUTION

Before connecting any wire to PLS, make sure the terminal voltage of the wire is less than 75V with respect to PLS terminal 5. A voltage higher than 75V may result in damage to PLS.

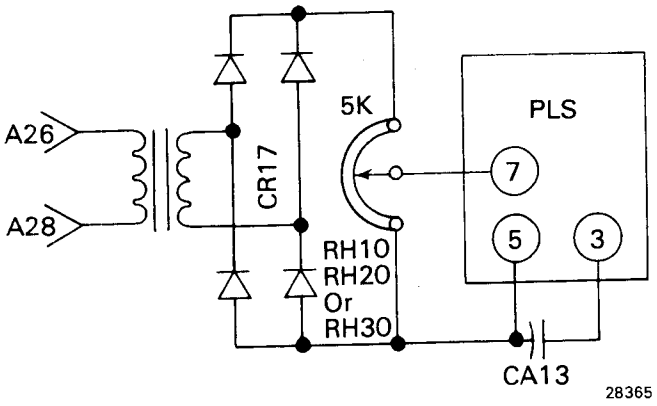

Fig.3 - Schematic Diagram For Checking PLS Input Voltage

1. Connect appropriate wire to PLS terminal 7. With 120 volts AC applied between terminals A26 and A28 check DC voltage between terminals 7 positive and 5 negative of PLS1. Adjust RH10 as necessary to obtain 65 volts DC between terminals 7 and 5 of PLS1.
2. Repeat for PLS2 using RH20.
3. Repeat for PLS3 on SR16 units using RH30.

CHECK MAGNETIC AMPLIFIER FM BIAS FOR MINIMUM OUTPUT TO GENERATOR FIELD, Fig. 4

1. With 440 to 480 volts applied and engine isolation switch in "OFF-START" position, connect a 0-2.5 or 0-5 volt DC voltmeter across the field of No. 1 generator.
2. Connect a milliammeter (0-200 ma minimum) in series with magnetic amplifier FM bias windings 7-8.
3. Disconnect wire from interlock E of GF1 contactor. This removes any driller's control signal.

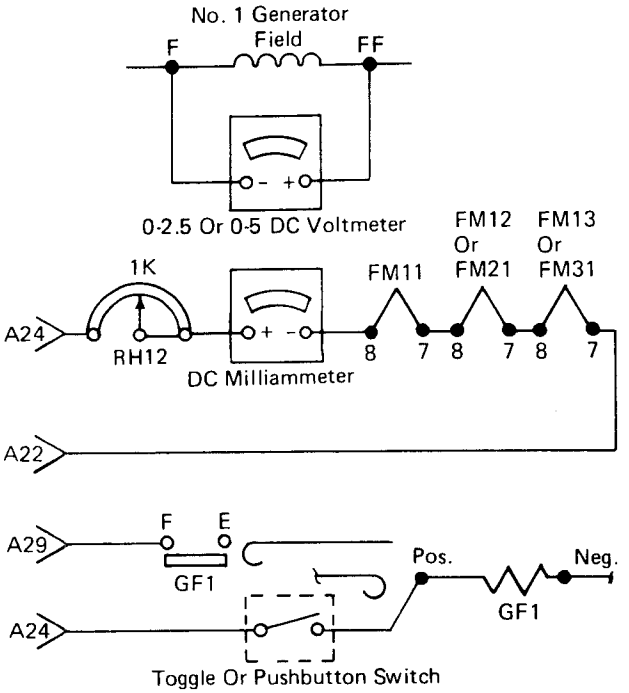

Fig.4 - Test Setup For Checking Magnetic Amplifier Bias

4. Remove wire from positive coil terminal of GF1, then connect a jumper wire from terminal A24 to one contact of a normally open switch. Connect the other contact of the normally open switch to the positive coil terminal of GF1.

5. With 108 volts AC at fuses F11, F12, and F13, close the toggle or pushbutton switch and adjust RH12 to reduce milliamperes through bias windings 7-8. Voltage across generator field should increase.

6. Adjust RH12 to obtain minimum voltage across generator field. Current through bias windings 7-8 must be less than 200 milliamperes and is normally 150 to 170 milliamperes when voltage across the generator field is at a minimum.

7. After RH12 has been adjusted for the desired indication, perform a through e.

   a. Remove DC voltmeter from across generator field.

   b. Disconnect DC milliammeter from the bias circuit and ensure that a complete circuit exists through RH12 and FM bias windings 7-8, from terminal A24 to terminal A22.

   c. Reconnect the wire removed from E interlock of GF1.

   d. Disconnect the jumper wire from A24 to the toggle or pushbutton switch and from the switch to the positive coil terminal of GF1.

   e. Reconnect the wire removed from the positive coil terminal of GF1.

8. Repeat Steps 1 through 7 for generator No. 2 using RH22.

9. If applicable, repeat Steps 1 through 7 for generator No. 3, using RH32.

GENERATOR VOLTAGE LIMIT

1. Connect a jumper wire from terminal A26 to interlock E of GF1. This provides 120 volts AC to CR11 rectifier, which simulates maximum signal from the driller's control.

CAUTION

Before connecting any wire to PLS, make sure the terminal voltage of the wire is less than 75V with respect to PLS terminal 5. A voltage higher than 75V may result in damage to PLS.

2. Connect appropriate wires to PLS terminals 3 and 8. Adjust RH11 as necessary to provide a 65 volt DC indication between terminals 3 positive and 5 negative of PLS1.

3. Remove the jumper between terminal A26 and interlock E of GF1.

4. Remove No. 1 generator power leads between generator cabinet and motor cabinet, then connect a 0-1000 volt DC voltmeter to generator terminals at the generator cabinet.

5. Place selector switch to assign generator under test for single generator operation if possible. If this cannot be done, set engine isolation switch to "OFF-START" position on all units not under test. This must be done so that generator fields will not be excited on the units not under test.

6. Place safety switch in "ON" position for equipment assigned to the generator under test.

7. Set engine speed selector to HIGH.

8. Start engine and set engine isolation switch to RUN after appropriate engine idle time. Verify engine is at full RPM, using a tachometer.

CAUTION

In performing steps 9 and 10, do not exceed voltage rating of generator.

9. Slowly open controller to maximum for equipment assigned to generator.

10. With engine at full RPM and controller full on, adjust RH13 to obtain the no-load voltage specified in the following table.

Generator	Motor	Engine RPM	No-Load Voltage
G69	D69M	835 or 857	865
G79	D79M	900	920
D32	D69M	835 or 857	865
D32	D79M	900	890

11. Stop engine and disconnect 0-1000 volt DC voltmeter.

12. Repeat procedures specified in Steps 1 through 11 for No. 2 generator using applicable connections and RH23.

13. Repeat procedures specified in Steps 1 through 11 for No. 3 generator, if equipped, using applicable connections and RH33.

CALIBRATION OF GENERATOR VOLTAGE TRANSDUCTORS GVT, Fig. 5

1. Remove No. 1 generator positive lead from RE11.

2. Connect the positive output lead of a motor generator MG set to the positive terminal of a 0-100 DC milliameter.

3. Connect the negative terminal of the milliameter to RE11 where the generator positive lead was removed.

4. Connect the negative output lead of the MG set to the No. 1 generator GN lead.

5. Connect a 0-1000 volt DC voltmeter to indicate MG set output voltage.

6. Connect input voltage to the MG set. 74 volts DC is available between terminals A24 and A22. Observe polarity when making this connection.

7. Operate MG set to provide a 70 to 75 milliampere indication on the milliammeter. Maintain this 70 to 75 milliampere current flow for about 10 minutes to raise RE11 and GVT bias winding 1-4 to normal operating temperature.

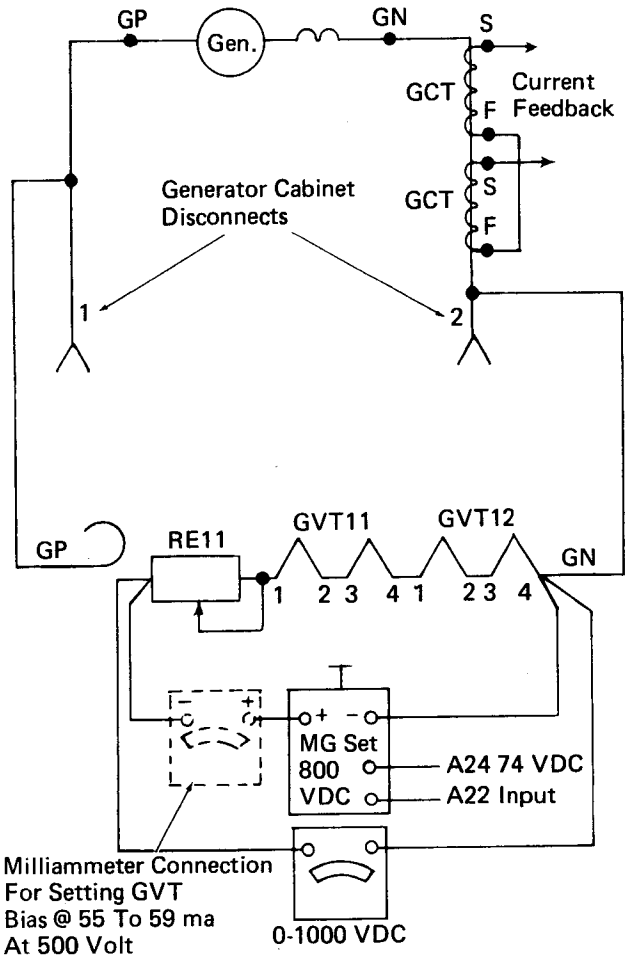

Fig.5 - Test Setup For Setting GVT Bias

8. After the 10 minute preheat period, adjust MG set output voltage to 500 volts. The milliammeter should indicate 55 to 59 milliamperes. If the milliammeter does not indicate 55 to 59 milliamperes, reduce MG set voltage to zero and adjust RE11 to increase or decrease current flow, then adjust MG set output voltage to 500 volts and observe milliammeter. Repeat adjustment of RE11 as necessary to obtain 55 to 59 miliamperes with MG set output voltage adjusted for 500 volts.

9. Reduce MG set output voltage to zero. Retain test setup if proceeding with the current and power limit test which follows.

10. Repeat Steps 1 through 9 for generator No. 2 and generator No. 3 if applicable.

CURRENT LIMIT AND POWER LIMIT TEST SETUP, Fig. 6

1. Remove power cables between generator cabinet and motor cabinet.

2. Short circuit the generator by connecting an ammeter shunt with 1100/24 cable and special male disconnects, as used for field connection cables, at the generator positive and negative power connections on the generator cabinet. Refer to following table for recommended shunt and cable. The shorting circuit must include the GCT transductors. Connect a 0-150 or appropriate millivolt meter across the shunt.

Generator	*Shunt	Connecting Cable For Shunt
G69 or G79	1000 Amp 50 MV EMD 8042783 (minimum)	1 Positive 1 Negative
D32	2000 Amp 50 MV EMD 8309746 and 4 Spacers EMD 8309755	2 Positive 2 Negative

*The 2000 Amp 50 MV shunt may be used with G69 and G79 generators.

3. At the magnetic amplifier output winding rectifier (CR16 for No. 1 generator) disconnect the generator positive field lead (1FF for No. 1 generator). Connect this lead to the output of a variable 0-12 volts 10 ampere DC power supply.

4. Connect the negative lead of the power supply to the generator field negative lead (1F on No. 1 generator). This connection may be at the negative terminal of CR16 or CR15. Set the variable power supply for zero volts and amperes.

5. Connect a 0-100 DC milliammeter in the magnetic amplifier control winding 11-12 circuit. This may be done by removing the wire from terminal 12 of one of the FM magnetic amplifiers and connecting this wire to meter negative terminal and connecting meter positive terminal to terminal 12 of the FM magnetic amplifier. The meter will read down scale until the GF contactor is energized.

6. Remove positive lead from the GF contactor coil, then connect a normally open single pole switch between terminal A24 and positive coil terminal of GF contactor. When closed, this switch will provide a feed to the GF contactor coil.

7. Place selector switch to assign generator under test for single generator operation if possible. If this cannot be done, remove the wire from terminal F of GF and connect a jumper wire from terminal A26 to terminal F of GF. This will provide 120 volts AC into CR11 when the GF coil is energized to provide a driller's control signal.

8. With controls set for the generator under test, safety switches off, controller opened to full on, and speed set for low, the AC voltage between terminal F of GF contactor and terminal A28 should be very close to 120 volts.

9. Disconnect positive generator wire (GP) from RE11, then connect the positive output lead of the MG set to RE11 where the GP wire was removed. Connect the negative output lead of the MG set to GVT at the GN wire connection. Set the MG set output voltage for minimum output and connect MG set input leads. Observe polarity when connecting MG set input leads.

10. Connect a 0-1000 volt DC voltmeter to indicate MG set output voltage, with RE12 positive.

PROCEDURE

The rheostats and resistors used for setting current and power limit have designations such as RE13, RE23, RE33, RH15, RH25, and RH35. The first digit in the designation indicates the generator number. Therefore, RH15 is associated with No. 1 generator, RH25 is associated with No. 2 generator, and RH35 is associated with No. 3 generator.

NOTE

Refer to Fig. 7 for designations used in a typical installation. However, it should be understood that the installation will vary from unit to unit. Some of the components shown in Fig. 7 may not be applicable to some installations. Other installations may include some components not shown in Fig. 7.

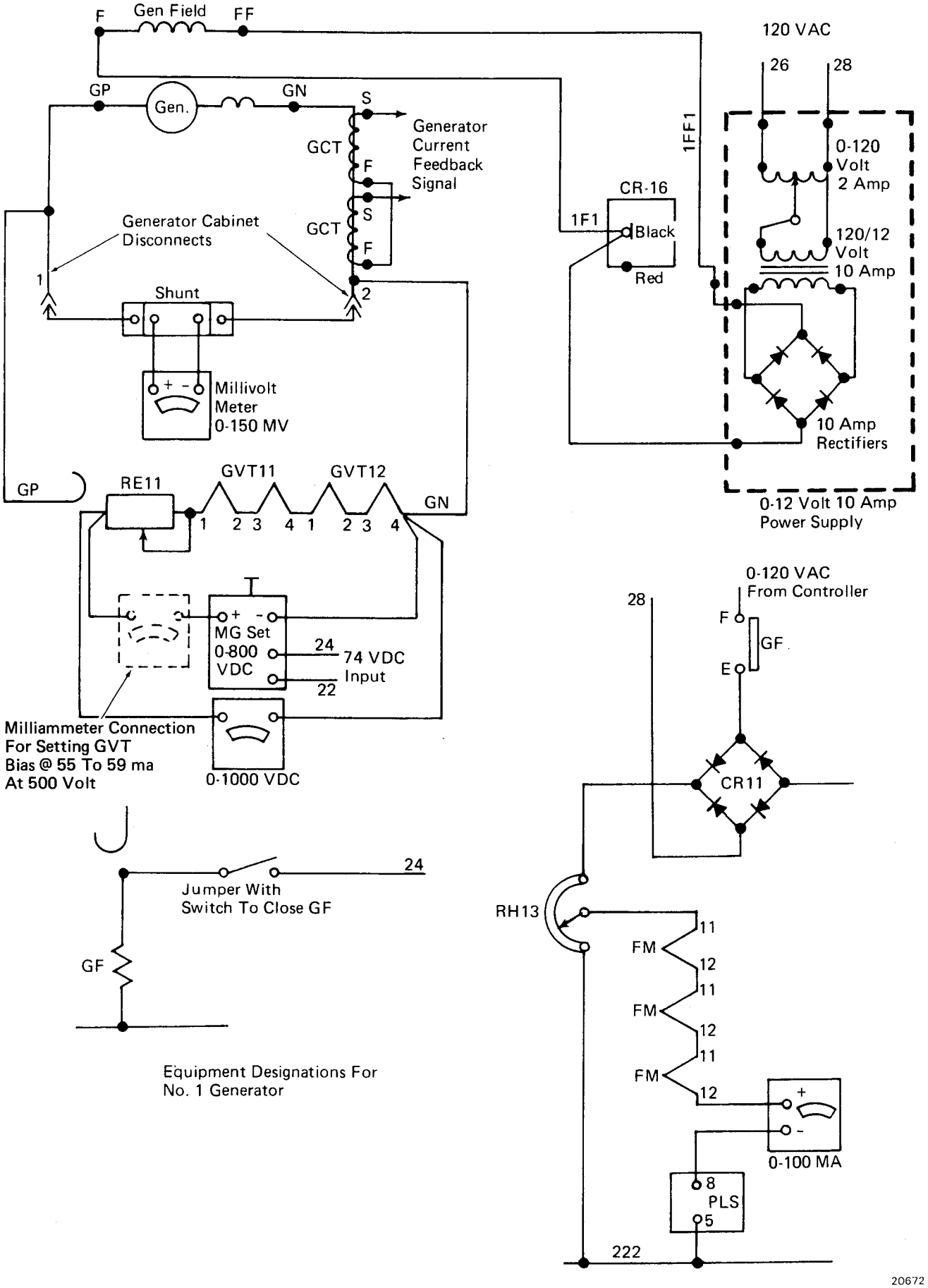

Fig.6 - Test Setup For Current And Power Limit Checks

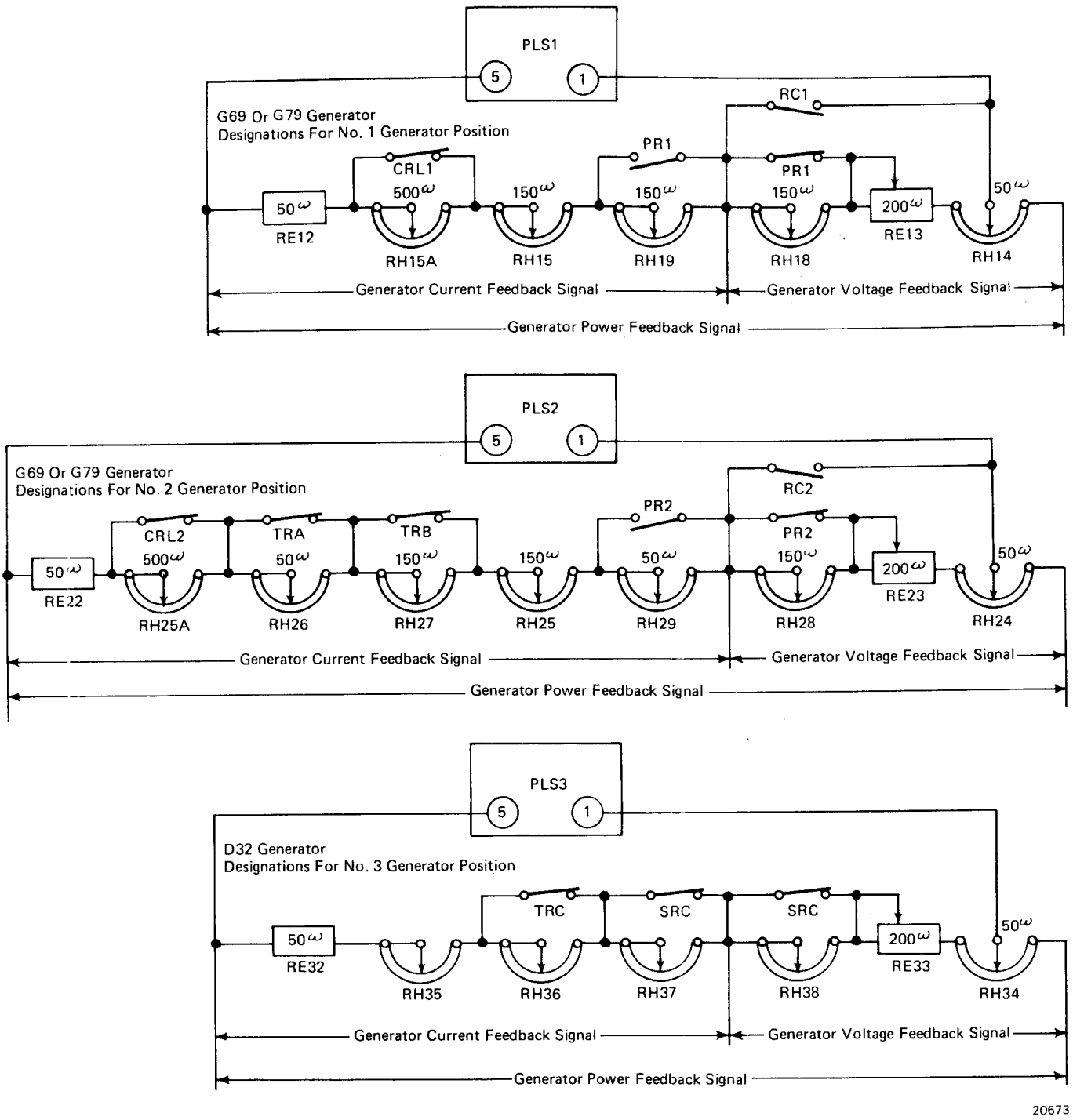

Fig.7 – Simplified Schematic Diagram Of Typical Current And Power Limiting Circuit

Charts and graphs for four different type installations are provided in this instruction. These charts and graphs should be used as a guide. However, the charts and graphs and wiring diagrams provided with the installation take precedence over the charts and graphs provided in this instruction. See Figs. 8 through 11.

The charts provided with this instruction indicate one or more relays are energized during some steps. There may be other relays in parallel with the indicated relays. Therefore, it may be necessary to refer to the installation wiring diagram to determine the most practical method for energizing the specified relays without energizing other relays

which may cause undesirable operation. In some instances it may be necessary to disconnect wires from the positive terminal of the coil and provide a separate feed to the coil.

NOTE

When performing these procedures, do not maintain short circuit current longer than necessary to make the required adjustments. Also, insure operation of all generator blowers.

1. Start the engine, then remove the governor plug to hold the engine at idle speed.

2. Place engine isolation switch in RUN position. The generator blowers should start, the millivolt meter connected across the short circuiting shunt should read up scale, and short circuiting current should not be excessive.

3. With all AC power on (440 and 120 volts) close the GF contactor and observe that milliammeter connected to FM terminal 12 reads up scale.

NOTE

With the 0-12 volts 10 ampere power supply, it may be necessary to increase engine speed from idle to low in order to obtain the desired short circuit current on the G69 and G79 generators. However, the short circuit current may be excessive on the D32 generator after the 0-12 volts 10 ampere power supply is turned off. It may be necessary to reverse the polarity of the 0-12 volts 10 ampere power supply to reduce short circuit current. Increasing the generator field amperes from the 0-12 volts 10 ampere power supply with reverse polarity will result in decreasing the residual field and a corresponding decrease in generator amperes. A further increase in generator field current may result in a reversal of generator output current.

4. Refer to Step 1 of the applicable charts and graphs. Energize the specified recalibration relay, then adjust the 0-12 volt 10 ampere power supply to set the generator short circuit current at the specified value on the chart.

5. With generator short circuit current at the specified value, adjust RH15, RH25, or RH35 so that the indication on the milliammeter connected to FM terminal 12 is reduced to a minimum, then adjust RH15, RH25, or RH35 until the indication on the milliammeter connected to FM terminal 12 is slightly above minimum or about 5 to 10 milliamperes. Lock rheostat RH15, RH25, or RH35. Recheck the generator current limit by varying the 0-12 volt power supply. As current increases to the maximum value listed in chart, the PLS should decrease the FM control current to 5 or 10 milliamperes.

A generator voltage (MG set voltage) is specified for some steps provided in the typical charts. The specified voltage should be applied for about 10 minutes to preheat the circuit before adjustments are made. The generator current should be at minimum during the preheat period. On settings where both generator volts and generator amperes are applied, the appropriate rheostat is adjusted using the milliammeter connected to FM terminal 12 as was done with generator amperage only.

In some cases there will be special power limit settings for winch motors or DC bus operation which must be adjusted in accordance with the installation wiring diagrams. These special settings are not listed in the following charts and graphs.

When all adjustments have been completed, recheck all of the power limit settings to ensure that the first settings were not disturbed by the last settings.

EXAMPLE

As an example, the following procedure can be used to set the current and power limits of a D32 generator with D79 motors. Refer to Fig. 7 and Fig. 11.

Step 1 in Fig. 11 limits generator current to 2400 amperes under stall conditions. For example, if the rotary table stalls, the current will be high while voltage (motor speed) drops to zero. This calibration is made with 2400 amperes applied to the current feedback circuit and 0 volts applied to the voltage feedback circuit.

1. With engine idling, slowly increase excitation with the 0-12 volt power supply and adjust generator current to 2400 amperes. (If current rises too high, reverse the excitation polarity to decrease the current.)

2. While maintaining 2400 amperes, adjust the current feedback signal in Fig. 7 with rheostat RH35 such that the milliammeter reading decreases to 5-10 milliamperes. This decrease in control winding current is caused by excitation limiting by PLS at the current limit setting of 2400 amperes.

3. Decrease current to zero, lock rheostat, then check setting by increasing excitation. As generator current approaches 2400 amperes,

PLS should begin limiting. Control winding current should decrease to 5-10 milliamperes as the current limit is reached.

4. Step 2 in Fig. 11 is a power limit calibration made with both current and voltage feedback signals. The generator current is set to 1975 amperes and voltage is set to 800 volts using the MG set. This power feedback signal is calibrated with rheostat RH34 to obtain PLS limiting as above.

5. Steps 3, 4, and 5 in Fig. 11 are performed with speed recalibration relay SRC and torque recalibration relay TRC. Energizing these relays places rheostats RH36, 37, and 38 into the feedback circuits and allows recalibration for different power limits as shown in the graph of Fig. 11. In each case, PLS limiting should occur at the current and voltage combinations given.

6. After all rheostats have been adjusted, seal the locknuts with a drop of white paint.

NOTE

The sequence of steps must be followed carefully and the rheostats must be adjusted in the order shown. Once adjustments have been made, one cannot change a previously adjusted rheostat without disturbing all other adjustments. If this happens, it will be necessary to repeat the entire calibration.

G69 GENERATOR - D69 MOTORS 60 HZ Blowers - 835 OR 857 TOP ENGINE RPM					
				Adjust Rheostat	
Step	Gen. Amps	Gen. Volts (MG Set)	Relays Energized	Gen. No. 1	Gen. No. 2
1	1150	0	RC PR	RH15	RH25
2	1000	0	RC	RH19	RH29
3	700	720	NONE	See Note 1 RH14	See Note 1 RH24
4	700	745	PR	RH18	RH28
5	See Note 2	0	TRA		RH26
6	See Note 2	0	TRB		RH27
7	375	0	CRL	RH15A	RH25A

1. If RH14 or RH24 rheostat wipers reach the end of travel before proper settings are obtained, it will be necessary to adjust RE13 or RE23. If adjustment of resistor is required, make adjustments so that rheostat wipers are at approximately mid-point with proper power limit settings.

2. Generator amperes should be as designated on wiring diagram for the installation.

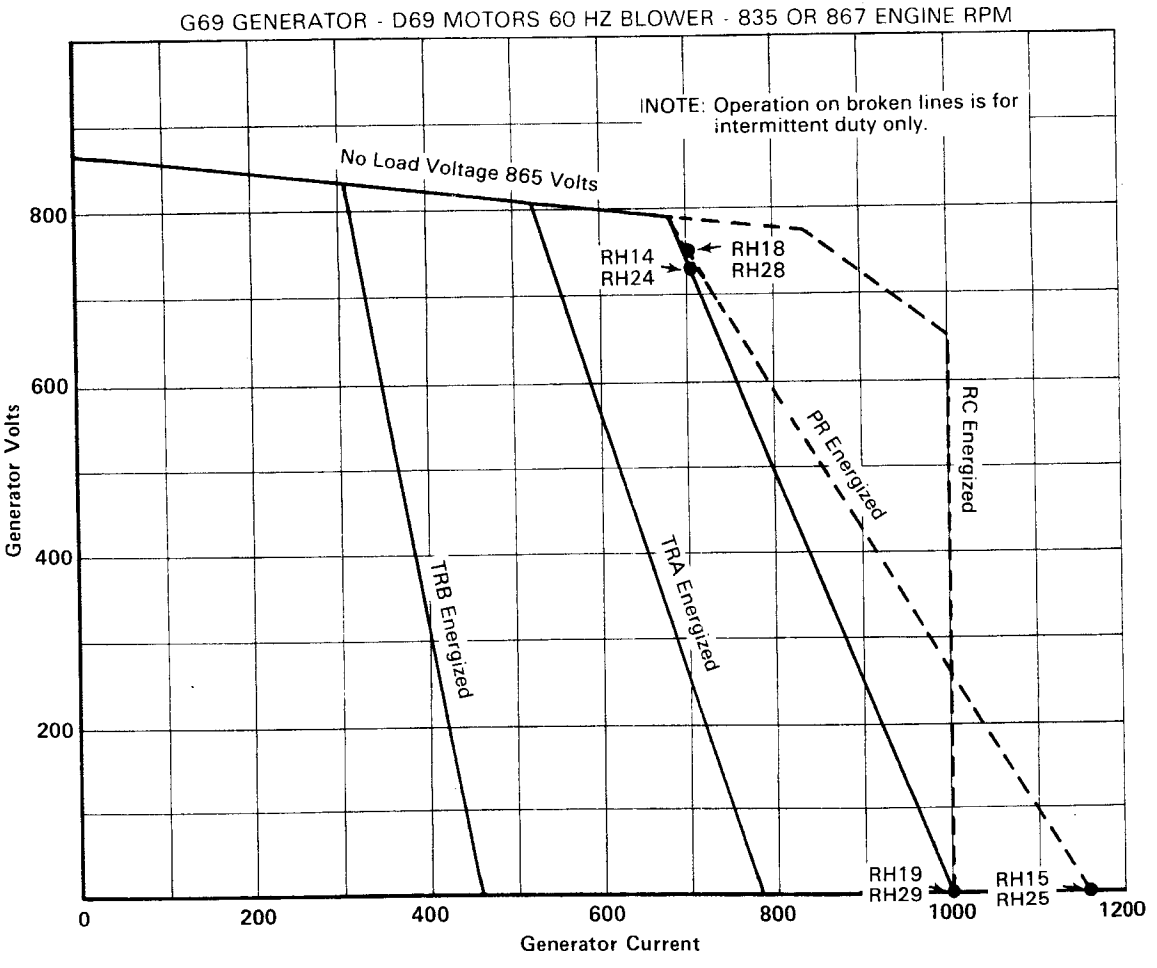

Fig.8 – Setting Chart And Graph - G69 Generator - D69 Motors

G79 GENERATOR - D79 MOTORS 60 HZ Blowers - 900 TOP ENGINE RPM					
				Adjust Rheostat	
Step	Gen. Amps	Gen. Volts (MG Set)	Relays Energized	Gen. No. 1	Gen. No. 2
1	1150	0	RC PR	RH15	RH25
2	1000	0	RC	RH19	RH29
3	800	680	NONE	RH14 See Note 1	RH24 See Note 1
4	800	750	PR	RH18	RH28
5	See Note 2	0	TRA		RH26
6	See Note 2	0	TRB		RH27
7	375	0	CRL	RH15A	RH25A

1. If RH14 or RH24 rheostat wipers reach the end of travel before proper settings are obtained, it will be necessary to adjust RE13 or RE23. If adjustment of resistor is required, make adjustments so that rheostat wipers are at approximately mid-point with proper power limit settings.

2. Generator amperes should be as designated on wiring diagram for the installation.

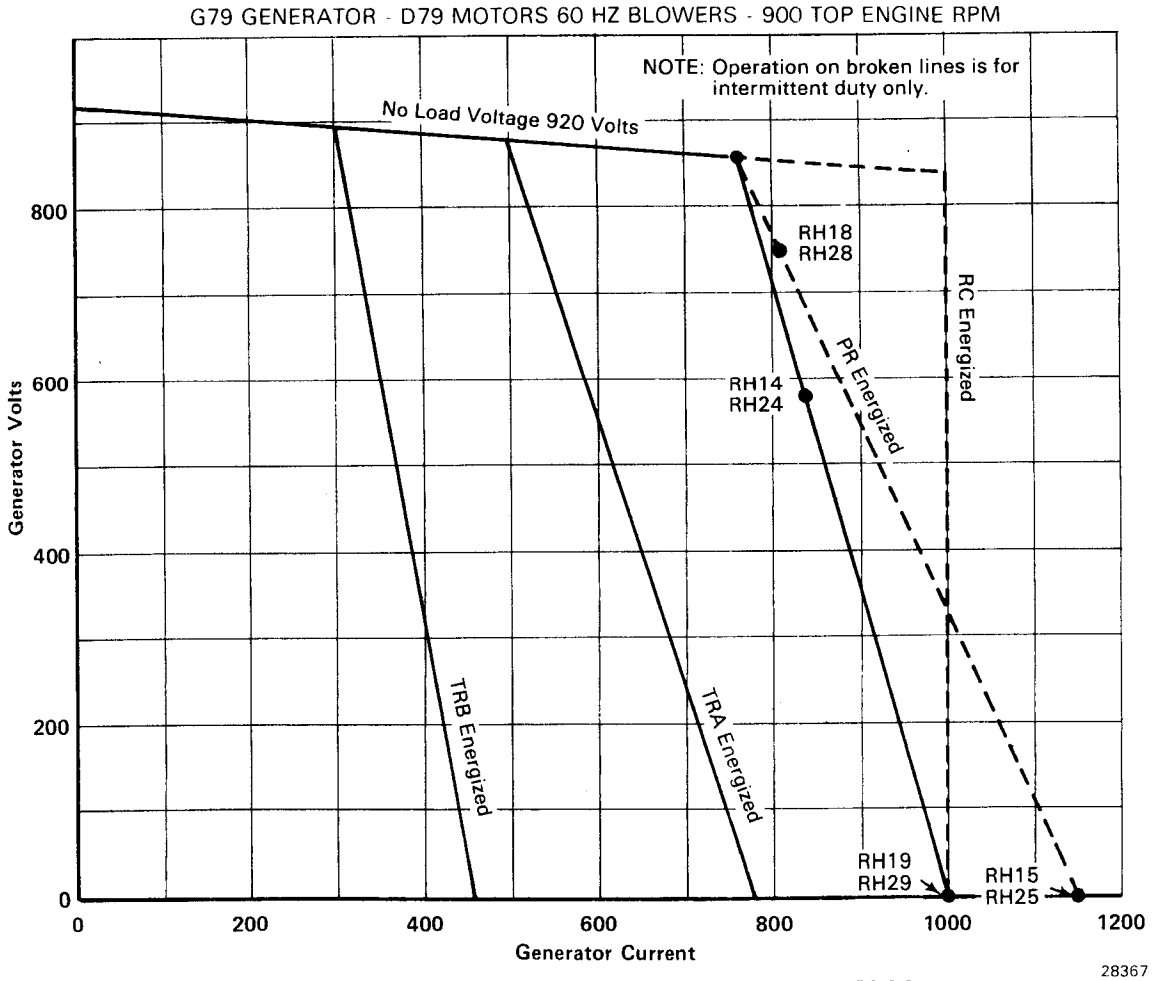

Fig.9 - Setting Chart And Graph - G79 Generator - D79 Motors

D32 GENERATOR - D69 MOTORS 835 OR 857 TOP ENGINE RPM				
Step	Gen. Amps	Gen. Volts (MG Set)	Relays Energized	Adjust Rheostat
1	2800	0	NONE	RH35
2	1710	800	NONE	RH34 See Note 1
3	2180	0	SRC	RH37
4	1500	640	SRC	RH38
5	See Note 2	0	TRC	RH36

1. If RH34 rheostat wiper reaches the end of travel before proper settings are obtained, it will be necessary to adjust RE33. If adjustment of RE33 is required, make adjustment so that RH34 wiper is at approximately mid-point with proper power limit setting.

2. Generator amperes should be as designated on wiring diagram for the installation.

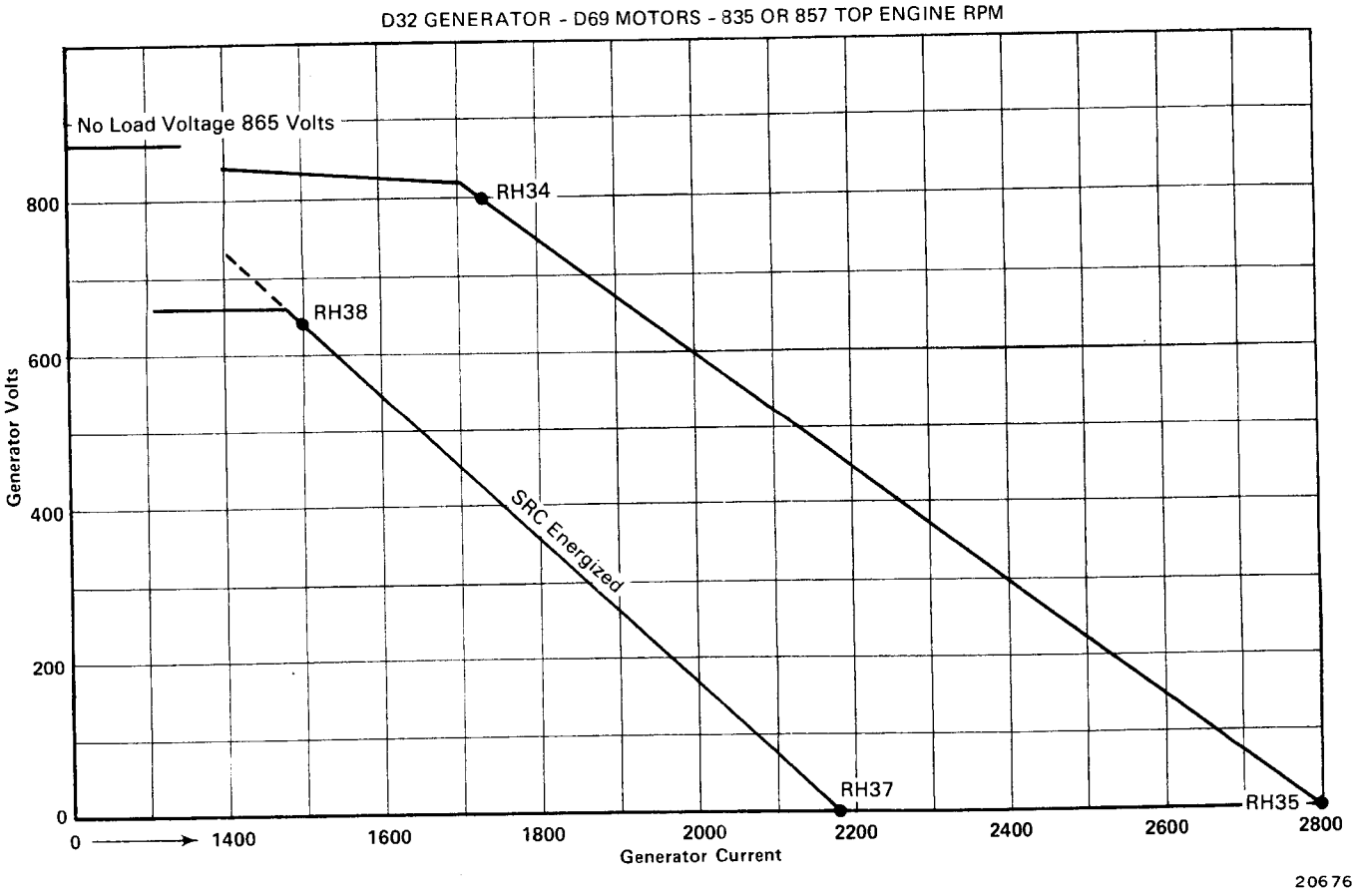

Fig.10 – Setting Chart And Graph - D32 Generator - D69 Motors

D32 GENERATOR - D79 MOTORS 900 TOP ENGINE RPM				
Step	Gen. Amps	Gen. Volts (MG Set)	Relays Energized	Adjust Rheostat
1	2400	0	NONE	RH35
2	1975	800	NONE	RH34 See Note 1
3	1890	0	SRC	RH37
4	1550	800	SRC	RH38
5	See Note 2	0	TRC	RH36

1. If RH34 rheostat wiper reaches the end of travel before proper settings are obtained, it will be necessary to adjust RE33. If adjustment of RE33 is required, make adjustment so that RH34 wiper is at approximately mid-point with proper power limit setting.

2. Generator amperes should be as designated on wiring diagram for the installation.

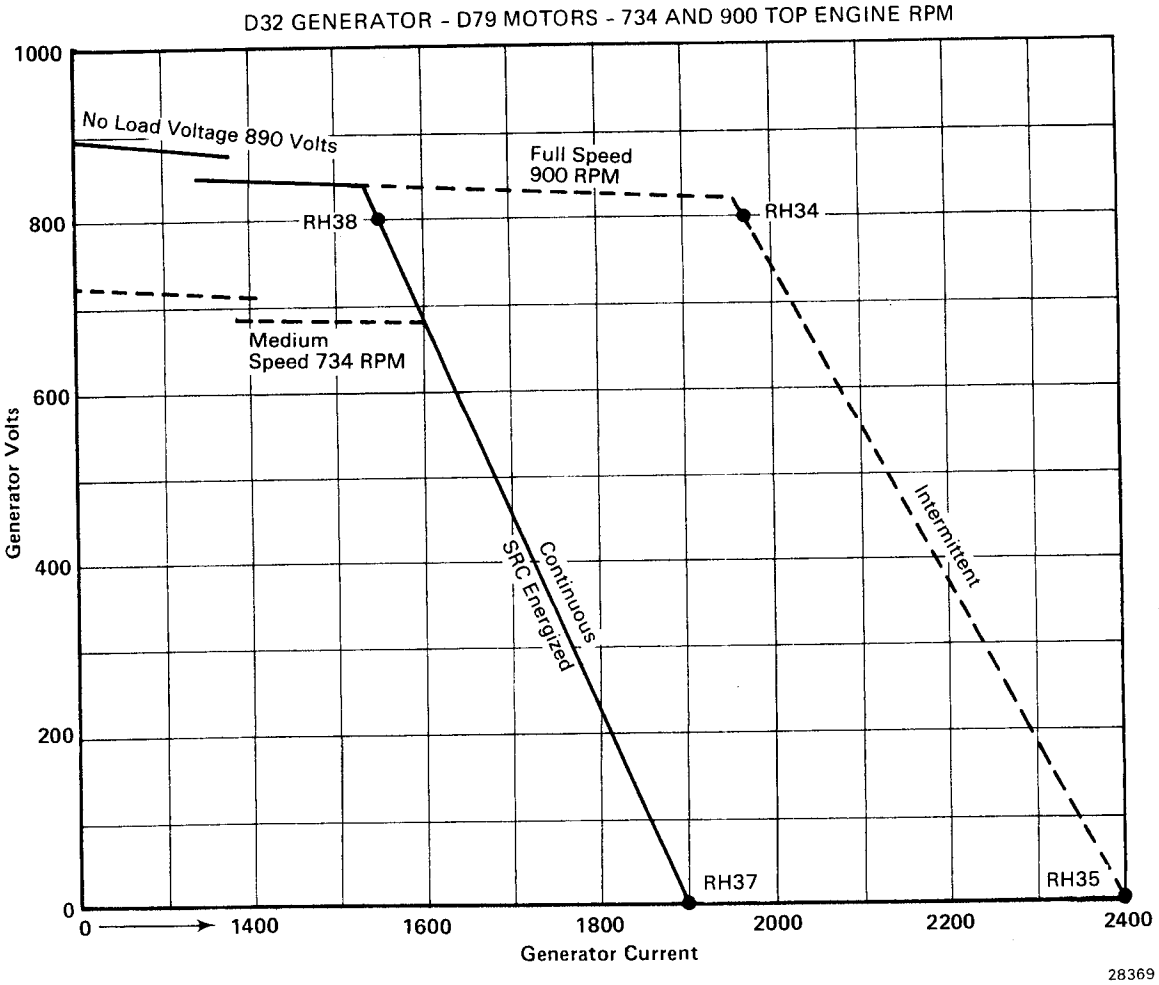

Fig.11 – Setting Chart And Graph - D32 Generator - D79 Motors

SPEED LIMIT ADJUSTMENT, FIG. 12

The purpose of the speed limit circuit is to protect the driven equipment from overspeed by removing generator excitation when a maximum speed is reached. Draw works, rotary table, mud pumps, cement pumps, winches, etc. are all protected by a speed limit relay, SL. Refer to SR Operating Manual for details of operation.

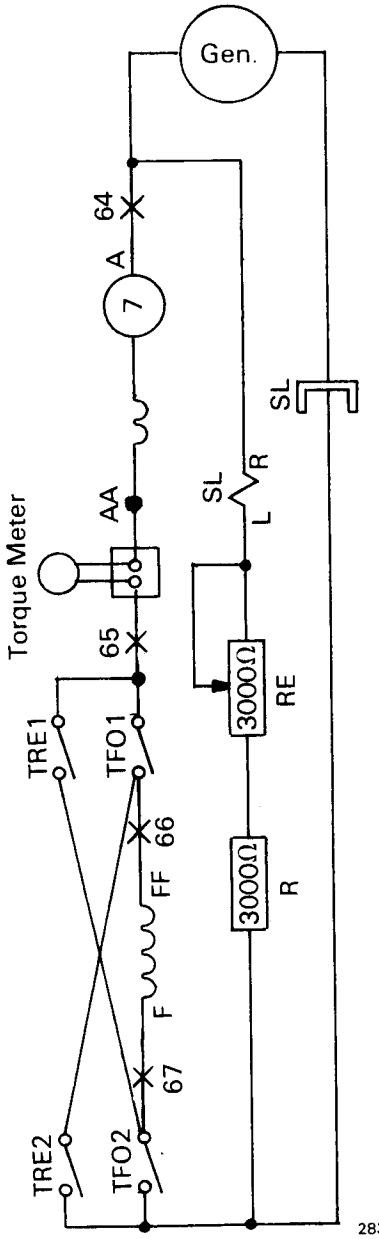

Fig.12 – Rotary Table Speed Limit Circuit, Schematic Diagram

To adjust the speed limit of the rotary table, for example, operate the table with no load and increase the speed until the speed limit trips. Measure trip speed with a tachometer.

CAUTION

Do not exceed maximum table speed. If the speed limit is set too high, the SL relay will not trip. In all cases, the maximum D79 motor speed is 2350 RPM.

If the speed limit is too high or too low, adjust using the slideband resistor RE. Decreasing the resistance by moving the slider away from its fixed end will lower the trip value. Use trial and error to obtain the desired trip speed.

SPIN-OUT SPEED ADJUSTMENT, FIG. 13

Pressing the SPIN-OUT button on the driller's control cabinet will rotate the table at a fixed speed. The button energizes SPOR relay and applies a fixed reference signal to the excitation circuit.

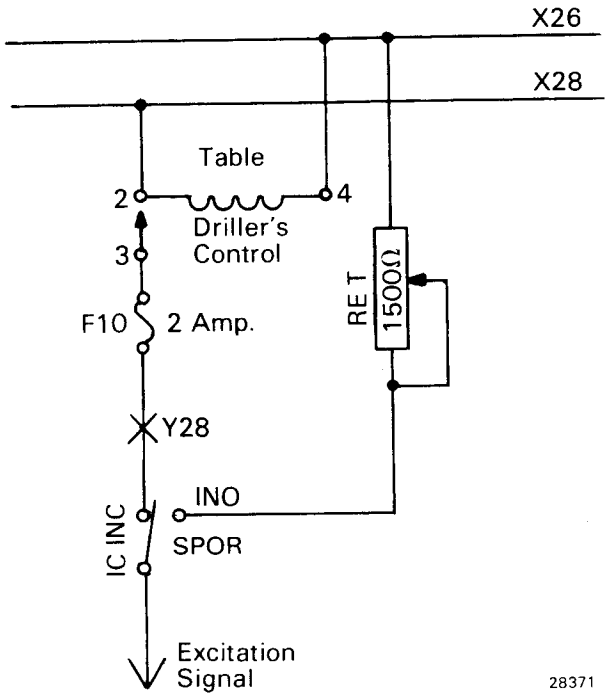

Fig.13 – Spinout Circuit, Schematic Diagram

The spin-out speed is adjusted with slideband resistor RE T. Decreasing the resistance by moving the slider away from its fixed end will increase speed. Adjust by trial and error.

After all resistors have been adjusted, seal the sliders in position with a drop of white paint. For actual identification of resistors RE and RE T, refer to specific installation schematics.