POWER PLANT

302A (J86434)

OPERATING METHODS

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1. GENERAL

1.01 The 302A power plant consists principally of motor-generators, rectifiers, or various combinations of both, and the associated battery equipment. This plant is designed for use with dial and toll systems or their combinations. However, it may be used for other equipments for which the capacity, voltage range, and circuit arrangements are satisfactory. The plant operates from a commercial 60-Hz, 3-phase, ac power supply with voltage variations of 208, 230, 240, or 460 volts. An output provides −24 volts, −48 volts, or a combination of both voltages, with 100 to 10,000 amperes battery charging capacity. Special equipment arrangements allow an increase in charging capacity up to 20,000 amperes. The charging units are automatically started and connected in service to a value so that the charging unit or units in service are fully loaded. As the load decreases, the charging units no longer required are automatically disconnected. In some cases when a 24-volt battery supply of less than 100 amperes is required, it is obtained by using 14 CEMF cells connected in series with the 48-volt battery. Four of these cells are automatically switched in or out of the discharge circuit, one at a time, under voltage control.

1.02 This section is reissued for the following reasons:

- To add preparatory steps to generator manual control handwheel adjustment procedure.
- To change rotation of OLR potentiometer.

- To revise the 70-type fuse alarm test methods.
- To reference both EM CELL CONT fuses.
- To add a caution and reference to capacitor charging procedure on rectifiers that have been removed from service.
- To clarify S1 and S3 switch designations on KS-19210 and KS-19211 rectifiers.
- To revise procedure for charging both groups of EM cells after power failure.
- To revise procedures for adjusting G1 and G2 generators.

This section does not affect the Equipment Test List.

Warning: This plant includes automatically controlled equipment. Care must be exercised to prevent accidental starting of the plant while maintenance activity is being performed. Before starting work, prevent automatic starting of equipment by removing fuses, blocking relays, opening switches, etc, as may be necessary. When maintenance has been completed, make sure that the circuit is restored to normal.

1.03 Motor-generators or rectifiers (either or both) are used as charging units. The motor-generator, together with an automatic motor starter and a floor-supported generator control bay which mounts the switches, meters, and control relays, are required for automatic start control with automatic voltage or current regulation. Regulated rectifiers are used as G or G-zero charging units. Two types of coded rectifiers are used, the J-code charging unit and the KS-type rectifier. Voltage regulated rectifiers may be used as the principal charging unit in a new plant, or used to supplement the charging units in an existing plant, or as replacement of any motor-generator in any position. Voltage regulated rectifiers are available for G1 and G2 positions and for G-zero applications. The G-zero units are always voltage-regulated type units and operate in parallel ahead of the G1 charging unit. Charging units as they exist are listed as follows:

24-VOLT CHARGING UNITS

MOTOR-GENERATORS	OUTPUT CURRENT CAPACITY AMPERES
KS-5123	100, 200, 400, 600, 800, 1000, 1500
KS-5668-01	100, 200, 400, 600, 800
KS-15839	400, 600, 800, 1000

RECTIFIERS

J86249	100 or 200
KS-19210	400
KS-19211	800
KS-19212	1600
KS-19356	1600
KS-20039	800
KS-20040	1600

CHARGE BAY ASSEMBLY

J87246 H (consists of one to four J87222 C-D 100-ampere rectifiers)	100 to 400
J87246 W (consists of one to four J87222 C-D 100-ampere rectifiers)	100 to 400

48-VOLT CHARGING UNITS

MOTOR-GENERATORS	OUTPUT CURRENT CAPACITY AMPERES
KS-5123	100, 200, 400, 500, 750, 1200
KS-5668	100, 200, 400, 500, 750
KS-15839	400, 500, 750

RECTIFIERS

J86249	100
J86273	200
J86295	200
J86296	400
KS-15689	200

48-VOLT CHARGING UNITS

RECTIFIERS

KS-19213	800
KS-19214	800
KS-19215	1600
KS-19790	800
KS-19791	800
KS-19792	1600
KS-19793	1600
KS-20489	400
KS-20490	400

CHARGE BAY ASSEMBLY

J87246 J (consists of one to four J87223 C-D 100-ampere rectifiers)	100 to 400
J87246 Y (consists of one to four J87223 C-D 100-ampere rectifiers)	100 to 400

1.04 Where provided, the J87339A rectifier sequence control unit provides for manual and automatic shutdown and sequence starting of preselected groups of voltage-regulated rectifiers. The sequence operation occurs when ac power is transferred from commercial power to engine standby power, or vice versa, due to power failure or during routine engine test. The rectifier sequence control reduces the excessive inrush current due to initial rectifier loads on the standby engine alternator and commercial power when transfer from one to the other takes place.

1.05 The J86323J L1 and L2 applique units are provided for automatic disconnect of G1 and/or G2 generators on light load when 302A power plants are equipped with G-zero rectifiers. The J86323J applique unit consists of a KS-20522 controller (packaged electronic control circuit) with the necessary circuit components to permit the unit to be used in 302A power plants equipped with G-zero rectifiers. The J86323 L1 unit applies to the 24-volt plants and the J86323 L2 unit applies to 48-volt plants.

1.06 With the J86323J applique unit, G1 or G2 generators are automatically disconnected under light load conditions. These units include a timer which can be adjusted so that a disconnect does not occur until the light load condition has persisted for a predetermined time. If the load exceeds the threshold level after timer initiation, the timer is automatically reset to zero. The light-load threshold level is adjusted from no load to near full load of the plant ammeter. The disconnection of the G1 and G2 generators due to light load allows the G-zero rectifier to take control. If the load current increases, the circuit operation is reversed and the G1 and G2 generators are reconnected to the load. If a G-zero rectifier fails, the circuit will also reconnect the G1 and G2 generators to the load. The applique unit will not operate if supplementary charging units (rectifiers or generators) G3, G4, G- are in operation in addition to the G1 and G2 generators. Also, in case of a low float condition of the battery plant, the applique circuit will not operate and the generators will be reconnected to the load.

1.07 The J86323H applique units allow certain rectifiers designed for use in the 302B power plants suitable for use in the G1 or G2 positions in 302A power plants. The J86323H applique units consist of two KS-20522 controllers (packaged electronic control circuits) and other necessary circuit components. The J86323H applique units are coded as follows:

APPLIQUE UNIT	PLANT VOLTAGE	RECTIFIER POSITION
J86323H L2	24	G2
J86323H L3	24	G1
J86323H L4	48	G2
J86323H L5	48	G1

1.08 One bay of main control board is to be used for each power plant, which mounts the voltage, control, and alarm relays together with the fuses, lamps, and keys associated with the control and alarm circuits (see Fig. 1). Each main control board has equipment and control facilities for ten charging units for ***each*** voltage. The regulated rectifiers for trickle charging the emergency cells are also on the main control board, space being available for a maximum of five rectifiers.

1.09 A battery control board is provided for each power plant, which is the control and distribution center between the charging equipment, batteries, and fuse panels to which the battery supply is furnished. The battery control board

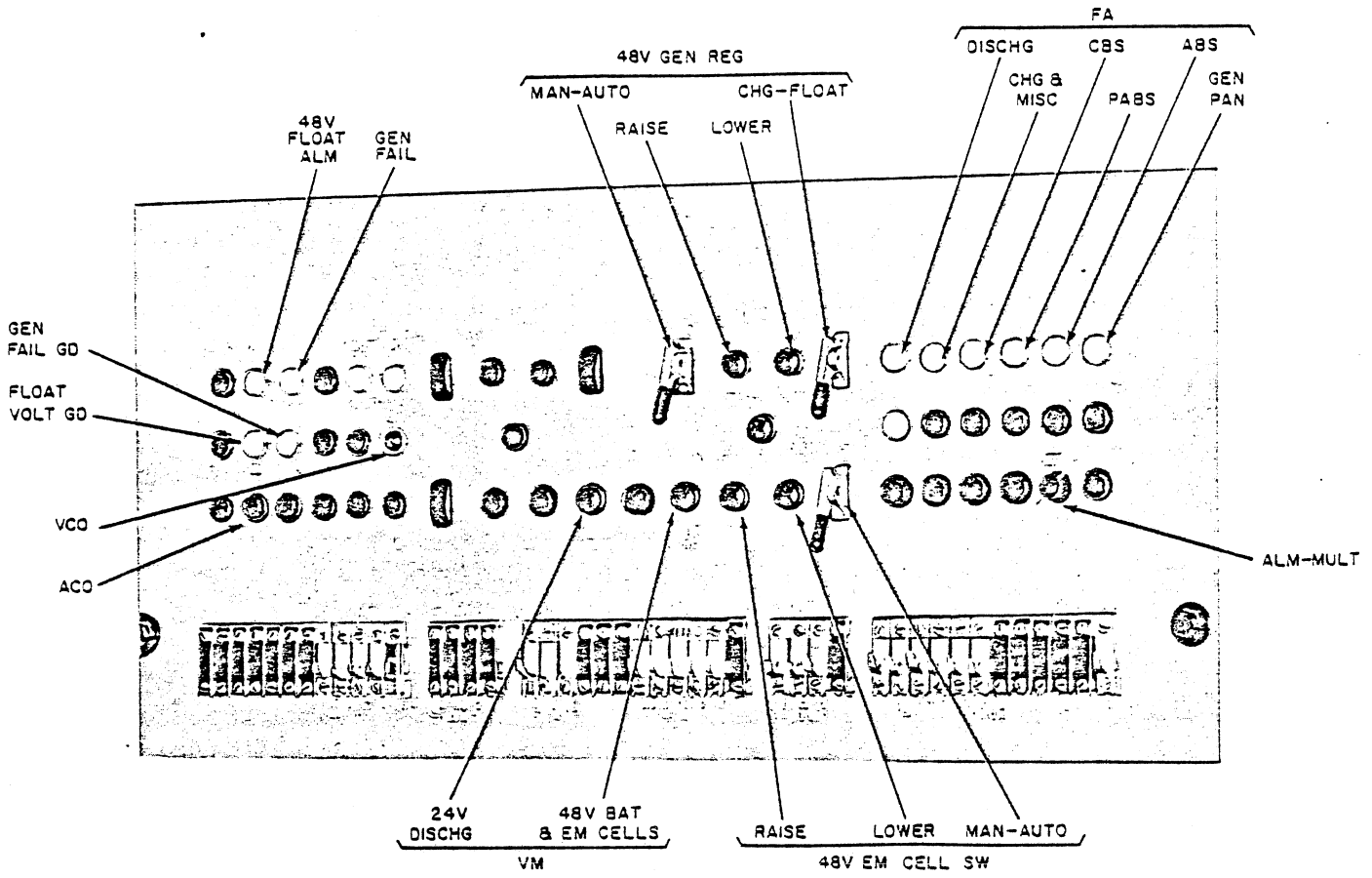


Fig. 1—Typical Main Control Board Panel Showing A Combined 24- and 48-Volt Plant Having a G Charging Unit

consists of two or more bays of panels, mounting voltage relays which actuate the control board mounted switches required for cutting the emergency cells into or out of the discharge circuit. It also contains the charge fuses, the discharge fuses, the discharge load ammeter, and the suppressed zero voltmeter. The control equipment for the 24-volt CEMF cells is mounted on a box-type framework in the battery control bay. The 4 CEMF cells are mounted on a battery stand near the storage batteries.

1.10 A single-string battery is used for each voltage. This battery may consist of one or more groups of enclosed-type cells permanently connected in parallel. For a −48 volt battery, each group consists of 23 cells in the main battery with two 4-volt emergency cell groups that are automatically switched in series with the main battery in the event of a power failure. For a −24 volt battery, each group consists of either 11 or 12 cells in the main battery with two 2-volt emergency cell groups that are switched in series with the main battery during a power failure, when the automatic charging equipment is not operating.

1.11 Combination fuse and switch units are provided for the ac supply to the −24 and −48 volt motor-generator or rectifier charging units. The fuse and switch units will be mounted either on the power service distributing cabinet or the bus duct, depending upon the size of the power plant.

1.12 Instructions are based on the following circuit drawings. For a detailed description of the operation of the individual circuits, refer to the corresponding circuit description. If this section is to be used with equipment that is associated with earlier or later issues of the drawings, reference should be made to the SDs and CDs to determine the extent of the changes and the manner in which the section may be affected.

AC DISTRIBUTION AND SERVICE CIRCUIT

SD-81185-01, Issue 6D—General Power Service Circuit, 3-Phase Service

SD-81393-01, Issue 5D—Motor Starter Circuit

CHARGE CIRCUITS

SD80965-01, Issue 12B—Calculation of Equipment and Lead Size

SD-81155-01, Issue 19D—Charging Generator Circuit With Motor Driven Rheostat

SD-81160-01, Issue 20B—Charging Generator Circuit, 33- or 65-Volt M/G Sets With Automatic Regulation (A & M Only)

SD-81184-01, Issue 9D—Application Schematic, 100-Ampere, 24- and 48-Volt; 200-Ampere, 24- and 48-Volt Regulated Metallic Rectifiers

SD-81714-01, Issue 5AC—Charge Bay Assembly, 100- to 400-Ampere, 24- and 48-Volt, J87246H & J

SD-81888-01, Issue 4A—Application and Conversion Schematic for 302A and 302B Type Rectifiers for use in Chargers in 301C, 302A, and 302B Plants (A & M Only)

CHARGE CONTROL CIRCUITS

SD-81037-01—(Mfr. Disc.) M/G Sets and Rectifiers, Automatic Operation 45-50 Volts

SD-81039-01—(Mfr.Disc.) M/G Sets and Rectifiers, Automatic Operation 22-26 Volts

SD-81049-01, Iss 3D—(Mfr. Disc.) Generator Regulation, Manual Start Control 22-26 and 45-50 Volts

SD-81148-01, Iss 26B—(A & M Only) M/G Sets and Rectifiers, Automatic Operation 45-50 Volts

CHARGE CONTROL CIRCUITS (CONT)

SD-81148-02, Iss 11B—M/G Sets and Rectifiers, Automatic Operation 45-50 Volts

SD-81175-01, Iss 27B—M/G Sets and Rectifiers, Automatic Operation 22-26 Volts

BATTERY CONTROL CIRCUITS

SD-80833-01—(Mfr. Disc.) Manual Switching of Emergency Cells, 45-50 Volts

SD-80834-01—(Mfr. Disc.) Manual Switching of Emergency Cells, 22-26 and 45-50 Volts

SD-80835-01, Iss 8D—(A & M Only) Automatic Switching of Emergency Cells, 45-50 Volts with 22-26 obtained from CEMF Cells

SD-80836-01, Iss 19D—(A & M Only) Automatic Switching of Emergency Cells, 22-26 and 45-50 Volts

SD-80837-01—(Mfr. Disc.) Manual Switching of Emergency Cells, 22-26 Volts

SD-80838-01, Iss 20B—Automatic Switching of Emergency Cells, 22-26 Volts

SD-81109-01, Iss 4B—24-Volt CEMF Cell Control Circuit, 24-Volt Supply from 48-Volt Battery, 10-100 Amperes, 22-26 Volts

SD-81121-01, Iss 17D—Automatic Switching of Emergency Cells, 45-50 Volts

SD-81220-01, Iss 2AR—(Mfr. Disc.) Automatic Switching of Emergency Cells, 6000 to 10,000 Amperes, 45 to 50 Volts and 100 to 6000 Amperes, 22 to 26 Volts

BATTERY CONTROL CIRCUITS (CONT)

SD-81234-01, Iss 13D—Automatic Switching of Emergency Cells, 6000 to 10,000 Amperes, 45-50 Volts or 6000 to 10,000 Amperes, 22 to 26 Volts

DISCHARGE CIRCUIT

SD-80966-01, Iss 7D—Discharge Circuit, 22 to 26 and 45 to 50 Volts

ALARM CIRCUITS

SD-81060-01, Iss 13D—DC Power Alarm Circuit

SD-81061-01, Iss 17D—Power Audible Alarm Circuit

RECTIFIER CIRCUITS

SD-81064-01, Iss 5D—J86220B, 10-Volt, 12-Ampere, Rectifier Circuit (Emergency Cell Trickle Charger)

SD-81129-01, Iss 25B—J86249, 24-Volt, 100- and 200-Ampere; 48-Volt, 100-Ampere Rectifier Circuit

SD-81242-01, Iss 7D—KS-15689, 48-Volt, 200-Ampere Rectifier Circuit (A&M Only)

SD-81317-01, Iss 13B—J86273, 48-Volt, 200-Ampere Rectifier Circuit

SD-81398-01, Iss 9B—J86296, 48-Volt, 400-Ampere Rectifier Circuit

SD-81410-01, Iss 13B—J86295, 48-Volt, 200-Ampere Rectifier Circuit

SD-81552-01, Iss 11B—J87223A, 48-Volt, 100-Ampere Rectifier Circuit (Part of J87246J)

SD-81553-01, Iss 11B—J87222A, 24-Volt, 100-Ampere Rectifier Circuit (Part of J87246H)

SD-81627-01, Iss 2B—KS-19210 L1, L2, L3, L4, L7, and L9, 24-Volt, 400-Ampere Rectifier Circuit

RECTIFIER CIRCUITS (CONT)

SD-81627-02, Iss 4B—KS-19210 L11 and L12, 24-Volt, 400-Ampere Rectifier Circuit

SD-81628-01, Iss 2B—KS-19211 L1 and L3, 24-Volt, 800-Ampere Rectifier Circuit

SD-81628-02, Iss 3B—KS-19211 L11 and L12, 24-Volt, 800-Ampere Rectifier Circuit

SD-81629-01, Iss 3B—KS-19212 L1, L2, L3, L4, 24-Volt, 1600-Ampere Rectifier Circuit

SD-81629-02, Iss 4B—KS-19212 L11 and L12, 24-Volt, 1600-Ampere Rectifier Circuit

SD-81630-01, Iss 2AR—KS-19213 L2, L3, L5, L6, L7, and L9, 48-Volt, 800-Ampere Rectifier Circuit

SD-81630-02, Iss 6AC—KS-19213 L11 and L12, 48-Volt, 800-Ampere Rectifier Circuit

SD-81631-01, Iss 7B—KS-19214 L2, L3, L5, L6, L11, and L12, 48-Volt, 800-Ampere Rectifier Circuit

SD-81632-01, Iss 3B—KS-19215 L1, L2, L3 and L4, 48-Volt, 1600-Ampere Rectifier Circuit

SD-81632-02, Iss 5A—KS-19215 L11 and L12, 48-Volt, 1600-Ampere Rectifier Circuit

SD-81684-01, Iss 4B—KS-19356 L1, L2, L3, L4, L11, and L12, 24-Volt, 1600-Ampere Rectifier Circuit

SD-81753-01, Iss 16B—J87222C and D, Regulated Rectifier 24 Volts, 100 Amperes—Semiconductor Type

SD-81756-01, Iss 14B—J87223C and D, Regulated Rectifier, 48 Volts, 100 Amperes—Semiconductor Type

RECTIFIER CIRCUITS (CONT)

SD-81810-01, Iss 1—KS-19790 L11 and L12, 48-Volt, 800-Ampere Rectifier Circuit

SD-81811-01, Iss 5B—KS-19791 L11 and L12, 48-Volt, 800-Ampere Rectifier Circuit

SD-81812-01, Iss 6B—KS-19792 L11 and L12, 48-Volt, 1600-Ampere Rectifier Circuit

SD-81813-01, Iss 1—KS-19793 L11 and L12, 48-Volt, 1600-Ampere Rectifier Circuit

SD-81895-01, Iss 1—KS-20039 L11 and L12, 48-Volt, 800-Ampere Rectifier Circuit

SD-81897-01, Iss 5B—KS-20040 L11 and L12, 48-Volt, 1600-Ampere Rectifier Circuit

SD-81995-01, Iss 4B—KS-20489 L11 and L12, 48-Volt 400-Ampere Rectifier Circuit

SD-81996-01, Iss 3AR—KS-20490 L11 and L12, 48-Volt, 400-Ampere Rectifier Circuit

1.13 The abbreviations used in this section are defined as follows:

cw—Clockwise

ccw—Counterclockwise

G1—Rectifier or Generator designated 24VG1 or 48VG1

G2—Rectifier or Generator designated 24VG2 or 48VG2

G3 through G10—Rectifiers or Generators designated 24VG3 up to 24VG10 or 48VG3 up to 48VG10

G-Zero—Voltage regulated rectifiers or charge bay assemblies designated 24VG01 up to 24VG010 or 48VG01 up to 48VG010.

1.14 For more detailed information on the operation and maintenance of individual equipment of apparatus, refer to the appropriate Bell System Practices. All relays and other apparatus should be adjusted, when required, in accordance with these sections and the circuit requirements table on the circuit drawings.

1.15 Adjustment of the stationary low-contact pointer of AR, AR1, and AR2 ammeter relays necessitates removal of the relay cover. The position of the low-contact pointer may be changed by grasping it at the insulated lower end and moving it as required. Adjustment of the high-contact pointer may be made by rotating the screw at the front of the relay.

1.16 The J87246H or J87246W and the J87246J or J87246Y charge bay assemblies (G-zero units) consist of one to four J87222 and J87223 rectifiers. Unless otherwise specified, the checks and adjustments for the G-zero rectifiers covered in this section also pertain to the rectifiers in the G-zero charge bay assemblies.

2. LIST OF TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
365	Connecting Clip (four reqd)
411C	Test Pick (two reqd)
KS-6320	Orange Stick
—	3-Inch C Screwdriver
—	Fuse Puller, 7-1/2 Inch, Ideal Industries
—	Blocking Tools as required. Apply Tools as covered in Section 069-020-801.
141	Cord Tip
720A	Battery Pickup Tool

CODE OR SPEC NO.	DESCRIPTION
TEST APPARATUS	
KS-8039	Volt-Milliammeter (or equivalent)
KS-14510	Volt-Ohm-Milliammeter (or equivalent)
KS-20538	Volt-Ohm-Milliammeter (or equivalent)
W1AY	Cord (8-1/2 feet long, equipped with one 360A tool at each end, four reqd)
2W17A	Cord (W2W cord, equipped with one 310 plug and two 360 tools)
—	35-Type Test Set
—	DC Voltmeter, Weston Model 931, 0- to 3-Volt Scale (or equivalent)
MATERIALS	
—	Dry Cell, 1-1/2 Volts

3. OPERATION

3.01 The 302A power plant will operate with G charging units alone or in combination with G-zero charging units. G charging units can be either motor-generators or rectifiers and are arranged for voltage-regulation or current-controlled operation and are connected to operate successively. The first two charging units in the plant, G1 and G2, are electronic-type voltage-regulated units. (See Fig. 2 and 3.) All subsequent units are current-controlled (raise/lower) units. (See Fig. 4) G-zero charging units are ***always*** voltage-regulated rectifiers and may be added to the −24 or −48 volt plant to operate ahead of the G1 unit. In the 48-volt plant a replaced voltage-regulated G1 or G2 unit may be reconnected as a 2-step current unit. As many as two of the 2-step units may be added.

A. Automatic Operation of Plant

3.02 For normal automatic operation of the plant, a sufficient number of rectifiers and/or motor-generators should be in operation to carry the office load and float the battery string at 2.17 volts per cell. The controls should be in the positions indicated in Table A for the main control board and the generator control keys and switches. Table B indicates the position of the keys and switches for various applicable rectifiers.

3.03 ***Operation of J87339 Rectifier Sequence Control Unit:*** With the TRA1 through TRA4 switches in the NORM position, the engine control circuit controls the stopping and sequence starting of each group of voltage-regulated rectifiers. In the event of an ac power transfer, the rectifiers are stopped and then the rectifiers controlled by the TRA1 switch come back on immediately. The rectifiers controlled by the TRA2 switch come on approximately one second later. The rectifiers controlled by the TRA3 switch come on approximately one second after the TRA2 switch controlled rectifiers come back on. The rectifiers controlled by the TRA4 switch come on approximately one second after the TRA3 switch controlled rectifiers come back on. Operation of any TRA( ) switch to the MAN-STOP position stops all rectifiers within its group and higher numbered groups. The associated MAN GD lamps for the stopped rectifiers are lighted. Restoring the TRA( ) switch to the NORM position will sequence start the associated group and higher numbered groups of rectifiers, with a one second delay between the starting of each group. Operation of the TRA( ) switch to the STOP-BY-AUTO-ENG position prevents its group and any higher numbered group from starting when the RO lead is grounded by the engine circuit. By preselection, some of the rectifier groups are held off to prevent overloading of small capacity automatic engines. Upon the return of commercial power, all rectifiers are started in sequence. If multiple engines are furnished to provide additional load capacity, additional rectifiers may be started by restoring the TRA( ) switch to the NORM position.

3.04 During extended heavy-load periods or in the event of partial loss of charging capacity, the available charging units may not have sufficient capacity to maintain the main battery at float voltage thereby causing the load to be switched to the end cells. Under this condition, the charging equipment connected to the regular or F bus will have incorrect polarity to the end cells. This will reverse the cells and if allowed to continue will damage the cells. In this event all charging units must be switched to the end cell bus. Although this will not effectively charge the battery, it will extend the reserve time until load has been reduced or until auxiliary charging equipment has been secured and added.

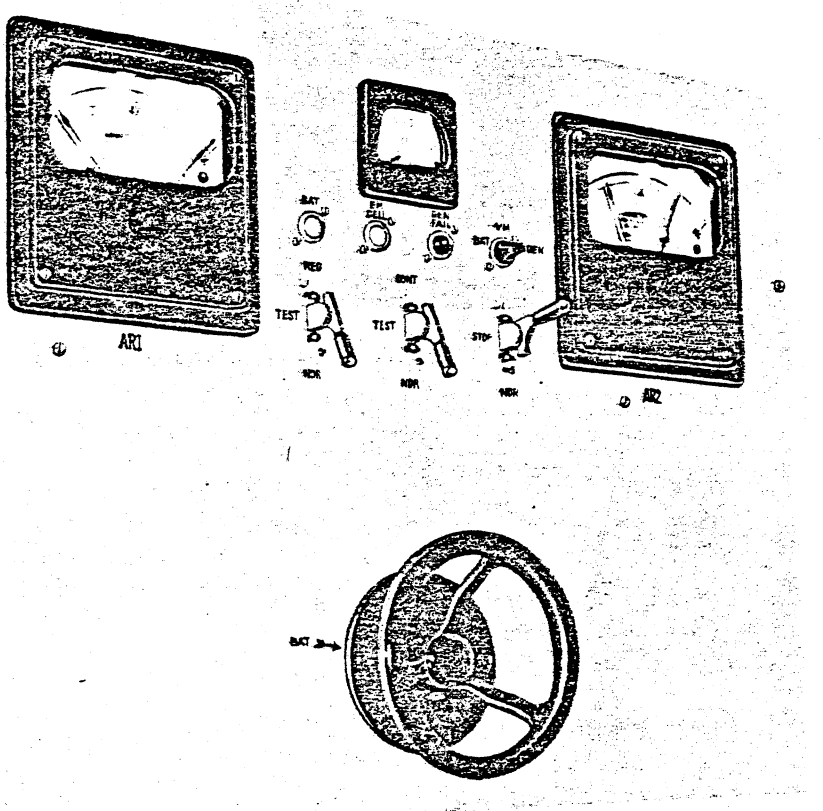


Fig. 2—Voltage Regulated Generator Controls

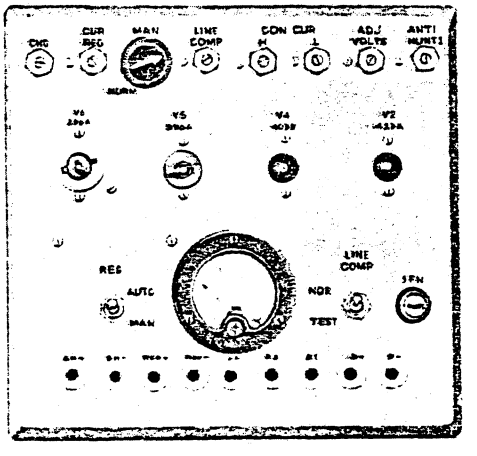


Fig. 3—Voltage Regulator and Exciter Controls Provided Only With G1 and G2 Generators

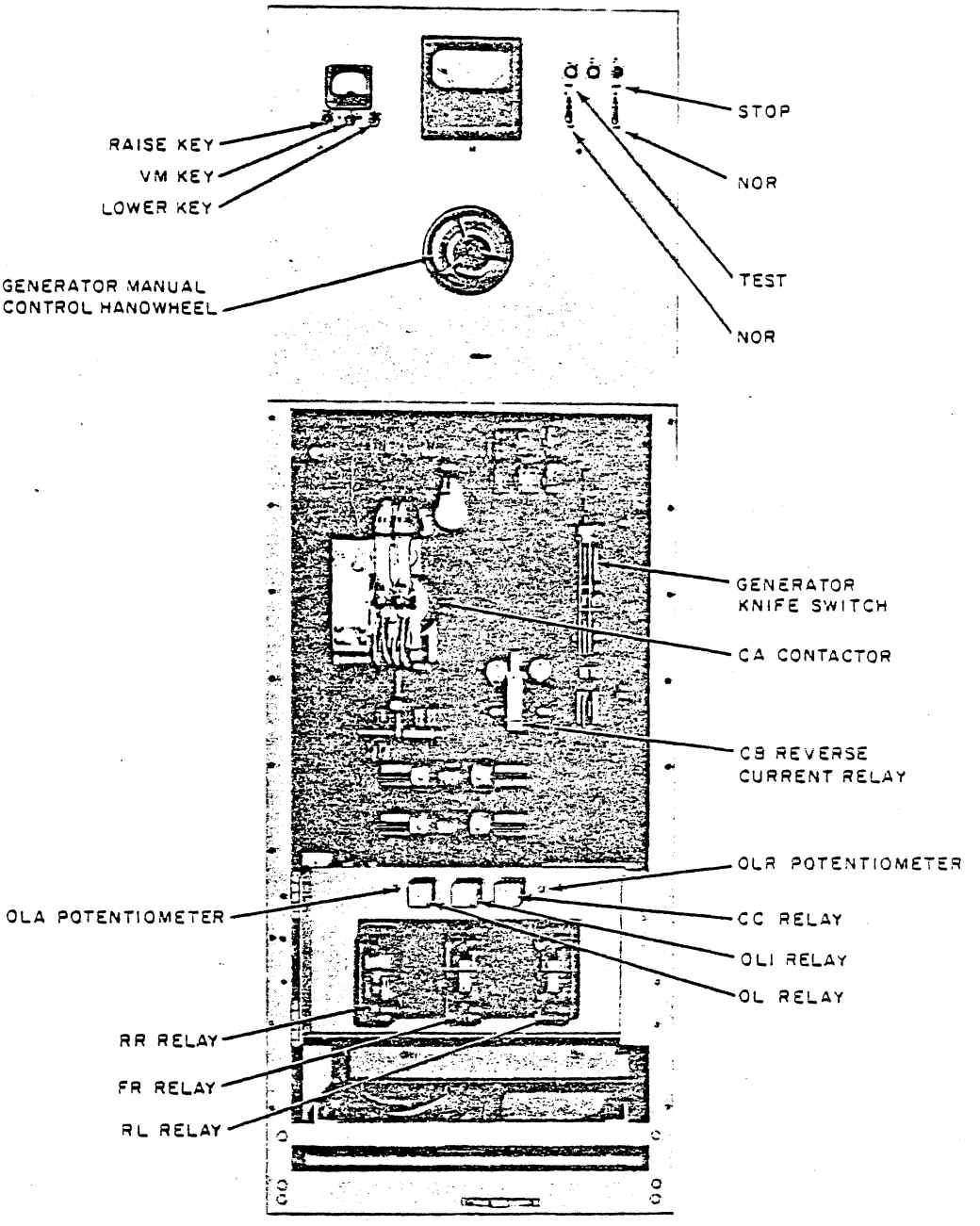


Fig. 4—Current Controlled Generator Control Bay

TABLE A

NORMAL AUTOMATIC OPERATION — POSITION OF CONTROLS FOR G1 THROUGH G10 GENERATORS

CONTROL DESIGNATIONS	POSITIONS
MAIN CONTROL BOARD (Fig. 1)	
GEN REG FLOAT-CHG Key	FLOAT
GEN REG MAN-AUTO Key	AUTO
EM CELL SW MAN-AUTO Key	AUTO
RECTIFIER SEQUENCE CONTROL UNIT	
TRA1 through TRA4 Switch	NORM
G1 AND G2 GENERATOR CONTROL BAY (Fig. 2)	
REG TEST-NOR Key	NOR
CONT TEST-NOR Key	NOR
NOR-STOP Key	NOR
VM BAT-GEN Key	GEN
Generator Manual Control Handwheel	BAT
Generator Knife Switch	closed
CC TEST Key (if provided)	NOR
VOLTAGE REGULATOR AND EXCITER FOR G1 AND G2 GENERATORS (Fig. 3)	
LINE COMP NOR-TEST Switch	NOR
REG-AUTO-MAN Switch	AUTO
G3 THROUGH G10 GENERATOR CONTROL BAY (Fig. 4)	
NOR-STOP Key	NOR
TST NOR Key	NOR
VM BAT-GEN Key	GEN
Generator Manual Control Handwheel	BAT
Generator Knife Switch	closed

TABLE B

NORMAL AUTOMATIC OPERATION – POSITION OF CONTROLS OF VOLTAGE-REGULATED AND CURRENT-CONTROLLED RECTIFIERS

RECTIFIER	KEYS, SWITCHES, AND CIRCUIT BREAKERS	POSITION
	G1 AND G2 RECTIFIERS – VOLTAGE REGULATED	
J86249 and KS-15689	NOR-OFF switch	NOR
	NOR-TEST 1 switch	NOR
	NOR-TEST 2 switch	NOR
	NOR-TEST 3 switch	NOR
	CONT (NOR-TEST R) key	NOR
	CC TST switch	NOR
	CHG-FLOAT (S2) switch	FLOAT
	OUTPUT (S3) switch	battery (vertically up)
	CONT circuit breaker	closed
	CHG ALM circuit breaker	closed
	door switches	operated (doors closed)
J86273, J86295, and J86296	RECT OFF-NOR switch	NOR
	S1 switch	BAT
	NOR-TST R key	NOR
	AMPL TST-NOR switch	NOR
	REG TST-NOR switch	NOR
	CON CUR TST, TST-NOR switch	NOR
	MAN-AUTO switch	AUTO
	CB1, CB2, & CB3 circuit breakers	closed
KS-19210 L3, L4, L9	OFF-NOR switch	NOR
	*S1 switch	BAT
	AUTO-MAN key	AUTO
	NOR-TST key	NOR
	CB1 circuit breaker	closed
KS-19211 L3, L4, L9	OFF-NOR switch	NOR
	†S3 switch	BAT
	AUTO-MAN key	AUTO
	NOR-TST key	NOR
	CB1 circuit breaker	closed
KS-19212 L3 & L4 and KS-19215 L3 & L4	OFF-NOR switch	NOR
	SW1 switch	F
	SW2 switch	BAT
	TST-MAN-AUTO switch	AUTO
KS-19213 L2, L5, & L9	OFF-NOR switch	NOR
	NOR-TST key	NOR
	MAN-AUTO potentiometer	AUTO
	CC TST switch	normal
	REG TST key	normal
	BAT-DISCH switch	ON or BAT

* This switch is labeled S3 on the KS-19210 L3

† This switch is labeled S1 for KS-19211 L4 and L9.

TABLE B (Cont)

RECTIFIER	KEYS, SWITCHES, AND CIRCUIT BREAKERS	POSITION
	CS switch	BAT
	SC circuit breaker	ON
	PS circuit breaker	ON
KS-19214 L2 & L5	NOR-OFF (S4) switch	NOR
	S1 switch	BAT
	S2 switch	BAT
	CB1, CB2, & CB3 circuit breakers	ON
	TST R — NOR key	NOR
	MAN-AUTO key	AUTO
	AMPL TST-NOR (S10) switch	NOR
	REG TST-NOR (S12) switch	NOR
	CON CUR TST-NOR (S3) switch	NOR
KS-19356 L3 & L4	OFF-NOR switch	NOR
	CC TST switch	OFF
	S1 switch	BAT
	CONT circuit breaker	ON
	AUTO-MAN key	AUTO
	NOR-TST key	NOR
G3 THROUGH G10 RECTIFIER — CURRENT CONTROLLED		
RECTIFIER	KEYS, SWITCHES, AND CIRCUIT BREAKERS	POSITION
J86249 and KS-15689	ON-OFF switch	ON
	MAN-TEST key	normal
	CHG-FLOAT switch	FLOAT
	OPEN (S3) switch	battery (vertically up)
	CONT circuit breaker	closed
	CHG ALM circuit breaker	closed
	door switches	operated (doors closed)
J86273, J86295, and J86296	RECT OFF-NOR switch	NOR
	S1 switch	BAT
	TST-NOR-MAN key	NOR
	CB1, CB2, & CB3 circuit breakers	closed
KS-19210 L1	OFF-NOR (S1) switch	NOR
	S3 (DC Output) switch	F
	AUTO-MAN (S2) key	AUTO
	NOR-TST (S4) key	NOR
	LOWER-NOR (S5) switch	NOR
	RAISE-NOR (S6) switch	NOR
	CB1 circuit breaker	closed
KS-19210 L2 & L7	OFF-NOR (S4) switch	NOR
	S1 (DC OUTPUT) switch	F
	AUTO-MAN (S2) switch	AUTO

TABLE B (Cont)

RECTIFIER	KEYS, SWITCHES, AND CIRCUIT BREAKERS	POSITION
	NOR-TST (S5) switch	NOR
	RAISE-NOR (S6) switch	NOR
	LOWER-NOR (S7) switch	NOR
KS-19211 L1	OFF-NOR switch	NOR
	S3 (DC OUTPUT) switch	BAT
	NOR-TST key	NOR
	AUTO-MAN key	AUTO
	RAISE-NOR switch	NOR
	LOWER-NOR switch	NOR
KS-19211 L2 & L7	OFF-NOR switch	NOR
	S1 (DC OUTPUT) switch	BAT
	NOR-TST key	NOR
	AUTO-MAN key	AUTO
	RAISE-NOR switch	NOR
	LOWER-NOR switch	NOR
KS-19212 L1 & L2 and KS-19215 L1 & L2	OFF-NOR switch	NOR
	SW1 switch	F
	SW2 switch	BAT
	TST-MAN-AUTO switch	AUTO
	RAISE-LOWER switch	normal
KS-19213 L3, L6, & L7	OFF-NOR switch	NOR
	NOR-TST key	NOR
	MAN-AUTO potentiometer	AUTO
	CC TST switch	normal
	CS switch	BAT
	CHG switch	BAT
	PS circuit breaker	ON
	SC circuit breaker	ON
KS-19214 L3 & L6	OFF-NOR (S4) switch	NOR
	S1 switch	BAT
	S2 switch	BAT
	CB1, CB2, & CB3 circuit breakers	ON
	TST-NOR-MAN key	NOR
	AMPL TST-NOR switch	NOR
	CON CUR TST-NOR (S3) switch	NOR
KS-19356 L1 & L2	OFF-NOR switch	NOR
	CC TST switch	OFF
	S1 switch	BAT
	CONT circuit breaker	ON
	MAN-AUTO key	AUTO
	NOR-TST key	NOR

TABLE B (Cont)

G-ZERO RECTIFIERS – VOLTAGE REGULATED		
RECTIFIER	KEYS, SWITCHES, AND CIRCUIT BREAKERS	POSITION
J87222 and J87223	ON-OFF key DC OUTPUT switch (on charge bay assembly)	ON BAT
KS-19210 L11 & L12, KS-19211 L11 & L12, and KS-19356 L11 & L12	OFF-NOR switch †DC OUTPUT switch AUTO-MAN key NOR-TST key CB1 circuit breaker	NOR BAT AUTO NOR closed
KS-19212 L11 & L12 and KS-19215 L11 & L12	OFF-NOR switch SW1 switch SW2 switch TST-MAN-AUTO switch TCR switch	NOR F BAT AUTO normal
KS-19213 L11 & L12	OFF-NOR switch NOR-TST key CC TST switch REG TST key CHG switch CS switch SC circuit breaker PS circuit breaker	NOR NOR normal normal BAT BAT ON ON
KS-19214 L11 & L12	NOR-OFF (S4) switch S1 switch S2 switch CB1, CB2, & CB3 circuit breakers CB4 circuit breaker MAN-AUTO (S13) switch AMPL TST-NOR (S10) switch REG TST-NOR (S12) switch CON CUR TST-NOR (S3) switch TST SIG (S11) switch	NOR 1 (BAT) BAT ON OFF AUTO NOR NOR NOR normal
KS-19790 L11 & L12	POWER ON-POWER OFF (S1) switch AC TAP (S2) switch DC OUTPUT (S3) switch CB1, CB2 circuit breakers	POWER ON BAT BAT ON
KS-19791 L11 & L12	POWER ON-POWER OFF (S1) switch DC OUTPUT (S2) switch CB1 circuit breaker CB2 circuit breaker (L12 only)	POWER ON BAT ON ON
KS-19792 L11 & L12	POWER ON-POWER OFF (S600) switch DC OUTPUT (S1) switch AC TAP SWITCH (S2) switch CB600, CB601, CB602, CB603, and CB604 circuit breakers	POWER ON BAT F F ON

† This switch is labeled S1 on KS-19211 L11 and L12 rectifiers

TABLE B (Cont)

RECTIFIER	KEYS, SWITCHES, AND CIRCUIT BREAKERS	POSITION
KS-19793 L11 & L12	POWER ON-POWER OFF (S1) switch AC TAP (S2) switch DC OUTPUT (S3) switch AUX AC PWR A circuit breaker AUX AC PWR B circuit breaker	POWER ON BAT BAT ON ON
KS-20039 L11 & L12	POWER ON-POWER OFF (S1) switch AC TAP (S2) switch DC OUTPUT (S3) switch CB1 circuit breaker CB2 circuit breaker	POWER ON BAT BAT ON ON
KS-20040 L11 & L12	POWER ON-POWER OFF (S600) switch DC OUTPUT (S1) switch AC TAP (S2) switch CB600, CB601, CB602, CB603, and CB604 circuit breakers	POWER ON BAT F 11 CELL OR 12 CELL ON
KS-20489 L11 & L12	POWER ON-POWER OFF (S1) switch DC OUTPUT (S3) switch SIMULATED OUTPUT CURRENT (S2) switch	POWER ON BAT OFF
KS-20490 L11 & L12	POWER ON-POWER OFF (S2) switch DC OUTPUT (S1) switch SIMULATED OUTPUT CURRENT (S3) switch OFF-TEST (S4) switch CB1 circuit breaker CB2 circuit breaker	POWER ON BAT OFF OFF ON ON

3.05 *24-Volt Countercell Control Circuit:* In some cases when a 24-volt supply of less than 100 amperes is required, it is obtained from the 48-volt plant through automatically controlled countercells.

B. Manual Operation of Plant

3.06 *Plants Provided with G Charging Units:* To manually control the output current of the plant, operate the GEN REG MAN-AUTO key on the main control board to the MAN position. The output may then be controlled by operating the RAISE or LOWER key on the main control board. The G1 or G2 charging unit will maintain voltage regulation unless the output current capacities are exceeded. Manual operation of the individual charging units is covered in 3.20 through 3.24.

C. Boost Charging Main Battery

3.07 To boost charge the battery, operate the FLOAT-CHG key on the main control board to the CHG position. When the charge has been completed, restore the FLOAT-CHG key on the main control board to the FLOAT position.

D. Boost Charging Emergency Cells

3.08 Adjust trickle charger in accordance with 4.24 to boost charge the emergency cells at 2.2 volts per cell.

E. Stopping and Starting Charging Units

3.09 *General:* The procedure for stopping a charging unit depends on whether the unit is supplying load and, in some cases, on the operating sequence of the unit. Unless a trouble condition exists, removal of a charging unit from service should be done during a light load period. The G1 and G2 unit should be kept in service at all times since these are the only units in the plant arranged for automatic voltage regulation. The procedures for stopping G charging units that are not operating or the G-zero units are covered in 3.10. Stopping a G charging unit when it is supplying load should be done only in an emergency or when a slight voltage drop will not affect service. The normal procedures for stopping G charging units that are operating are given in 3.11 through 3.19.

Note: If the G1 and G2 units are motor-generators and the G-zero units have sufficient capacity to carry the load, the G1 and G2 units may be automatically shut down.

F. Stopping and Starting G-Zero Rectifiers and Nonoperating G Charging Units

3.10 *Stopping and Starting G-Zero Rectifiers and Nonoperating G Charging Units*

(a) *To remove a G-zero or nonoperating G charging unit from service,* operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, ON-OFF, NOR-STOP, POWER ON-POWER OFF switch on the unit to the OFF, STOP, or POWER OFF position. Then disconnect the unit from the battery circuit as follows.

(1) *If the unit is a generator,* open the battery knife switch on the associated control bay.

(2) *If the unit is a G1 through G10 rectifier or a G-zero rectifier that is not part of a charge bay assembly,* operate the rotary or knife battery switch specified in Table C for the rectifier to the position indicated in the table.

(3) *If the unit is part of a G-zero charge bay assembly,* operate the DC OUTPUT switch on the charge bay to the OFF position only if the other rectifiers are not provided in the charge bay or, where provided, have also been removed from service.

(b) *To restore a G charging unit to service,* proceed in accordance with 3.11 through 3.19.

Caution 1: ***Do not restore the rotary or knife battery switch to the BAT or F position without first charging the output filter capacitors. Reference should be made to the operating methods section, for each individual rectifier, for this capacitor charging procedure.***

Caution 2: ***Do not start the rectifier before connecting the battery, otherwise the rectifying element may be damaged.***

(c) *To restore a G-zero rectifier other than a KS-19212 or KS-19215 rectifier to service,*

TABLE C

SETTING OF RECTIFIER CONTROLS

RECTIFIER	I		II		III	
	CONTROL KEY OR SWITCH	POSITION	POWER ON/OFF SWITCH	POSITION	ROTARY OR KNIFE BATTERY SWITCH	POSITION
J86249	CONT NOR-TEST R	TEST R	NOR-OFF	OFF	S3	OPEN
J86273	NOR-TST R	TST R	RECT OFF-NOR	OFF	S1	BAT OFF
J86295	NOR-TST R	TST R	RECT OFF-NOR	OFF	S1	BAT OFF
J86296	NOR-TST R	TST R	RECT OFF-NOR	OFF	S1	BAT OFF
J87222*	—	—	ON-OFF	OFF	DC OUTPUT	OFF
J87223*	—	—	ON-OFF	OFF	DC OUTPUT	OFF
KS-15689	CONT NOR-TEST R	TEST R	NOR-OFF	OFF	S3	OPEN
KS-19210	NOR-TST	TST	OFF-NOR	OFF	†S3 or S1	BAT OFF
KS-19211	NOR-TST	TST	OFF-NOR	OFF	†S3 or S1	BAT OFF
KS-19212	—	—	OFF-NOR	OFF	SW2	OPEN
KS-19213	NOR-TST	TST	OFF-NOR	OFF	CHG	OFF
KS-19214	NOR-MAN TST	TST	NOR-OFF	OFF	S2	OPEN
KS-19215	—	—	OFF-NOR	OFF	SW2	OPEN
KS-19356	NOR-TST	TST	OFF-NOR	OFF	S1	OFF
KS-19790	—	—	POWER ON-POWER OFF	POWER OFF	S3	OFF
KS-19791	—	—	POWER ON-POWER OFF	POWER OFF	S2	OFF
KS-19792	—	—	POWER ON-POWER OFF	POWER OFF	S1	OFF
KS-19793	—	—	POWER ON-POWER OFF	POWER OFF	S3	OFF-TEST
KS-20039	—	—	POWER ON-POWER OFF	POWER OFF	S3	OFF
KS-20040	—	—	POWER ON-POWER OFF	POWER OFF	S1	OFF
KS-20489	—	—	POWER ON-POWER OFF	POWER OFF	S3	OFF
KS-20496	—	—	POWER ON-POWER OFF	POWER OFF	S1	OFF-TEST

*CHARGE BAY ASSEMBLY

† The switch designation differs with list numbers. See TABLE B for list number.

restore the DC OUTPUT switch on the charge bay assembly, if the rectifier is part of the charge bay, to the BAT position. If the rectifier is not part of a charge bay, restore the rotary or knife battery switch (specified in Table C) on the rectifier to the BAT position. Then restore the NOR-OFF, RECT OFF-NOR, OFF-NOR, ON-OFF, or POWER ON-POWER OFF switch on the rectifier to the NOR, ON, or POWER ON position.

(d) *To restore a G-zero KS-19212 or KS-19215 rectifier to service,* operate the rectifier switches in the order given.

(1) Operate the TST-MAN-AUTO switch to the TST position.

(2) Operate the OFF-NOR switch to the NOR position.

(3) Operate the SW2 switch to the BAT position.

(4) Operate the OFF-NOR switch to the OFF position.

(5) Operate the TST-MAN-AUTO switch to the AUTO position.

(6) Operate the OFF-NOR switch to the NOR position.

G. Stopping and Starting G1 and G2 Charging Units—Plants Arranged for Generator Cutoff

3.11 *Stopping and Starting G1 Rectifier*

(a) *To remove the G1 rectifier from service,* operate the keys or switches specified in Table C in the order given.

Caution 1: ▶Do not restore the rotary or knife battery switch to the BAT or F position without first charging the output filter capacitors. Reference should be made to the operating methods section, for each individual rectifier, for this capacitor charging procedure.◀

Caution 2: Do not start the rectifier before connecting the battery, otherwise the rectifying element may be damaged.

(b) *To restore the G1 rectifier to service,* restore the control key or switch specified in Table C to the NOR position. Connect the rectifier to the battery circuit by operating the rotary or knife battery switch specified in the table to the BAT position. Then restore the NOR-OFF, RECT OFF-NOR, OFF-NOR, ON-OFF, or POWER ON-POWER OFF switch to the NOR, ON, or POWER ON position.

(c) When the G1 rectifier is restored to service, if G2 is the only charging unit operating and the load is of a value that can be carried by G1, the generator cutoff feature will time out and cause G1 to restart in 3 minutes. If more than one charging unit is operating, G1 will not restart automatically until the load decreases to a value which can be carried by G1 without the aid of any other charging unit or until the total load on the plant requires all charging units, at which time, the control circuit will function and restart G1 after a 3-minute delay.

3.12 *Stopping and Starting G1 Generator*

(a) *To remove the G1 generator from service,* first operate the ▶REG-TEST-NORMAL◀ and ▶CONT-TEST-NORMAL◀ keys, in that order, on the G1 generator control bay to the TEST positions.

(b) When the G2 unit starts and the RECT FAIL or GEN FAIL lamp on G2 is extinguished, operate the ▶NORMAL-STOP◀ key on the G1 generator control bay to the STOP position. When the CA contactor on the G1 generator control bay is released, open the G1 generator knife switch.

(c) *To restore the G1 generator to service,* restore the◀ REG-TEST-NORMAL◀ and the ▶CONT-TEST-NORMAL◀ keys to the ▶NORMAL◀ position. Restore the generator knife switch to the closed position. Then operate the ▶NORMAL-STOP◀ key to the ▶NORMAL◀ position. [See 3.10(c)].

Warning: Never close the generator knife switch while the CA contactor is operated, as personal injury and commutator damage may result.

3.13 *Stopping and Starting G2 Rectifier*

(a) *To remove the G2 rectifier from service,* first operate the control key or switch specified in Table C for the rectifier to the position indicated.

(b) When the G1 unit starts and the RECT FAIL or GEN FAIL lamp of G1 is extinguished, G1 may go to full load and cause G3 to start. After G3 connects, its output will rise until the output of G1 is below 75 percent of its load capacity. The G-zero rectifiers provide voltage regulation.

(c) When the output of the G2 rectifier has decreased to zero, operate the G2 rectifier NOR-OFF, RECT OFF-NOR, OFF-NOR, ON-OFF, or POWER ON-POWER OFF switch to the OFF or POWER OFF position.

(d) Operate the rotary or knife battery switch specified in Table C for the rectifier to the position indicated.

(e) *To restore the G2 rectifier to service, proceed as covered in 3.11(b) for the G1 rectifier.*

(f) When the G2 unit is restored to service, if the load on the G1 unit is over 25 percent of its capacity and G3 is operating, the G2 unit will start and cause the G1 unit to shut down. If the total plant load is less than 80 percent of the capacity of the G1 unit, G1 will restart in approximately 3 minutes and G2 will then be disconnected.

3.14 *Stopping and Starting G2 Generator*

(a) *To remove the G2 generator from service,* first operate the ▸REG TEST-NORMAL◂ and CONT TEST-NORMAL keys, in that order, on the G2 generator control bay to the TEST positions.

(b) When the G1 unit starts and the RECT FAIL or GEN FAIL lamp of G1 is extinguished, G1 may go to full load and cause the G3 unit to start. After G3 connects, its output will rise until the output of G1 is below 75 percent of its load capacity.

(c) When the output of the G2 generator has decreased to zero, operate the NOR-STOP key on the G2 generator control bay to the STOP position. When the CA contactor on the G2 generator control bay is released, open the G2 generator knife switch.

(d) To restore the G2 generator to service, restore the ▸REG-TEST-NORMAL◂ and ▸CONT-TEST-NORMAL◂ keys to the NORMAL positions. Restore the generator knife switch to the closed position. Then restore the to the closed position. Then restore the ▸NORMAL-STOP◂ key to the ▸NORMAL◂ position. [3.13(f).]

Warning: Never close the generator knife switch while the CA contactor is operated, as personal injury and commutator damage may result.

H. Stopping and Starting G1 and G2 Charging Units—Plants Not Arranged for Generator Cutoff

3.15 *Stopping and Starting G1 Rectifier:*

G2 Unit Not Supplying Load—

(a) *To remove the G1 rectifier from service,* operate the keys or switches specified in Table C for the rectifier in the order given.

(b) *To restore the G1 rectifier other than a KS-19212 or KS-19215 rectifier to service,* proceed in accordance with 3.11(b).

(c) *To restore the G1 KS-19212 or KS-19215 rectifier to service,* proceed as specified in 3.10(d) for the G-zero rectifier.

G2 Unit Supplying Load—

(d) *To remove the G1 rectifier from service when the capacity of the G2 unit is sufficient to carry the additional load given up by the G1 rectifier when G1 is removed from service,* proceed as follows. Operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, ON-OFF, or POWER ON-POWER OFF switch on the G1 rectifier to the OFF or POWER OFF position. Then operate the rotary or knife battery switch specified in Table C for the rectifier to the position indicated in the table.

(e) *To remove the G1 rectifier from service when the capacity of the G2 unit is insufficient to carry the additional load given up by the G1 rectifier when G1 is removed from service,* place the current-controlled (G3 through G10) charging unit which succeeds the last operating unit under manual control in accordance with 3.20 and 3.22 or 3.24. Then proceed as follows.

Caution: KS-19212 and KS-19215 rectifiers provided as G3 through G10 units must be shut off before being placed under manual control or restored to automatic operation as specified in 3.23.

(1) Raise the output of the unit under manual control until the output of the G2 unit is reduced sufficiently to allow G2 to carry the additional load of the G1 rectifier when G1 is removed from service.

(2) When the output of G2 is reduced sufficiently to carry the additional load, operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, ON-OFF, or POWER ON-POWER OFF switch on the G1 rectifier to the OFF or POWER OFF position.

(3) Restore the unit under manual control to automatic operation as covered in 3.22 or 3.24.

Caution: ▶Do not restore the rotary or knife battery switch to the BAT or F position without first charging the output filter capacitors. Reference should be made to the operating methods section, for each individual rectifier, for this capacitor charging procedure.◀

(4) Operate the rotary or knife battery switch specified in Table C for the G1 rectifier to the position indicated in the table.

(f) *To restore the G1 rectifier other than a KS-19212 or KS-19215 rectifier to service,* restore the rotary or knife battery switch specified in Table C for the rectifier to the BAT position. Then operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, ON-OFF, or POWER ON-POWER OFF switch on the rectifier to the NOR, ON, or POWER ON position. [See caution in 3.15(e)(3).]

Caution: Do not start the rectifier before connecting the battery, otherwise the rectifying element may be damaged.

(g) *To restore the G1 KS-19212 or KS-19215 rectifier to service,* proceed as specified in 3.10(d) for the G-zero rectifier.

3.16 *Stopping and Starting G1 Generator:*

G2 Unit Not Supplying Load—

(a) *To remove the G1 generator from service,* proceed as follows.

(1) Operate the ▶REG TEST-NORMAL◀ and ▶CONT-TEST-NORMAL◀ keys, in that order, on the G1 generator control bay to the TEST position. The G2 unit will start and cause the G1 generator to disconnect from the battery.

(2) When the CA contactor on the G1 generator control bay is released, operate the ▶STOP-NORMAL◀ key on the control bay to the STOP position. Then open the G1 generator knife switch.

G2 Unit Supplying Load—

(b) *To remove the G1 generator from service,* proceed as follows.

(1) Mark the setting of the CUR REG potentiometer on the voltage regulator and exciter associated with the G1 generator.

(2) Slowly rotate the CUR REG potentiometer ccw to transfer the G1 load to the G2 unit. If the G2 unit goes to full load, the current-controlled (G3 through G10) unit succeeding the last operating unit will start. Slowly rotate the CUR REG potentiometer cw to maintain the output of the G2 unit slightly below full load while the current-controlled unit is starting.

(3) When the output of the G2 unit goes below 75 percent of its rated capacity, rotate the CUR REG potentiometer for G1 ccw (slowly to allow time for the current-controlled unit to raise its output) until the CA contactor on the G1 generator control bay is released.

(4) When the CA contactor for G1 is released, operate the STOP-NOR key on the G1 generator control bay to the STOP position. Then open the G1 generator knife switch.

(5) Restore the CUR REG potentiometer for G1 to its normal setting.

(c) *To restore the G1 generator to service,* first mark the setting of the CUR REG potentiometer on the associated voltage regulator and exciter. Then rotate the potentiometer fully ccw.

(d) ON the G1 generator control bay, restore the REG TEST-NOR and CONT TEST-NOR keys, where necessary, to the NOR position and close the generator knife switch.

Warning: Never close the generator knife switch while the CA contactor is operated, as personal injury and commutator damage may result.

(e) Operate the STOP-NOR key on the G1 generator control bay to the NOR position. G1 will start, connect to the battery circuit, and possibly disconnect on reverse current.

(f) Rotate the CUR REG potentiometer for G1 slowly cw thus causing G1 to connect to the battery circuit. Continue rotating the CUR REG potentiometer slowly cw to its normal setting, allowing time for the last operating current-controlled unit to lower its output, as required.

3.17 *Stopping and Starting G2 Rectifier:*

(a) *To remove the G2 rectifier from service,* place the current-controlled (G3 through G10) charging unit which succeeds the last operating unit under manual control in accordance with 3.20 and 3.22 or 3.24. Then proceed as follows. [See Caution of 3.15(e).]

(1) Raise the output of the unit under manual control until the output of the G2 unit is nearly zero.

(2) Operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, ON-OFF, or POWER ON-POWER OFF switch on the G2 rectifier to the OFF or POWER OFF position.

(3) Restore the unit under manual control to automatic operation as covered in 3.22 or 3.24.

Caution: Do not restore the rotary or knife battery switch to the BAT or F position without first charging the output filter capacitors. Reference should be made to the operating methods section, for each individual rectifier, for this capacitor charging procedure.

(4) Operate the rotary or knife battery switch specified in Table C for the G2 rectifier to the position indicated in the table.

(b) *To restore the G2 rectifier other than the KS-19212 or KS-19215 rectifier to service,* restore the rotary or knife battery switch specified in Table C to the BAT position. Then operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, ON-OFF, or POWER ON-POWER OFF switch to the NOR, ON, or POWER ON position. [See caution in (3).]

Caution: Do not start the rectifier before connecting the battery, otherwise the rectifying element may be damaged.

(c) *To restore the G2 KS-19212 or KS-19215 rectifier to service,* proceed as specified in 3.10(d) for the G-zero rectifier.

3.18 *Stopping and Starting G2 Generator*

(a) *To remove the G2 generator from service,* proceed as follows.

(1) Mark the setting of the CUR REG potentiometer for the G1 charging unit.

(2) Slowly rotate the CUR REG potentiometer for the G1 unit ccw to transfer the G1 load to the G2 generator. If the G2 generator goes to full load, the current-controlled (G3 through G10) unit succeeding the last operating unit will start.

(3) Continue rotating the CUR REG potentiometer for G1 slowly ccw until the output of G1 is nearly zero and the G2 generator is operating at approximately 75 percent of its rated capacity. Then rotate the potentiometer sufficiently cw to cause the output of G2 to

drop to approximately 25 percent of its rated capacity.

(4) Operate the CONT TEST-NOR key on the G2 generator control bay to the TEST position. The G1 unit will assume voltage regulation and the output of the G2 generator will decrease to zero and cause the CA contactor for G2 to release.

(5) When the CA contactor is released, operate the STOP-NOR key on the G2 generator control bay to the STOP position. Then open the G2 generator knife switch.

(6) Restore the CUR REG potentiometer for the G1 unit to its normal setting.

(b) *To restore the G2 generator to service,* proceed as follows.

Current-Controlled (G3 Through G10) Units Not Operating—

Warning: Never close the generator knife switch while the CA contactor is operated as personal injury and commutator damage may result.

(1) On the G2 generator control bay, restore the CONT TEST-NOR key to the NOR position, close the generator knife switch, and operate the STOP-NOR key to the NOR position, in the order given.

Current-Controlled (G3 Through G10) Unit Operating—

(2) Mark the setting of the CUR REG potentiometer for the G1 charging unit and rotate the potentiometer fully ccw.

Warning: Never close the generator knife switch while the CA contactor is operated, as personal injury and commutator damage may result.

(3) On the G2 generator control bay, restore the CONT TEST-NOR key to the NOR position and close the generator knife switch.

(4) Operate the STOP-NOR key on the G2 generator control bay to the NOR position. The G2 generator will start, connect to the battery circuit, and assume voltage regulation causing the G1 unit to disconnect on reverse current.

(5) Slowly rotate the CUR REG potentiometer for the G1 unit cw until G1 connects. Continue rotating the CUR REG potentiometer slowly cw to its normal setting allowing time for the last operating current-controlled unit to lower its output as required.

I. Stopping and Starting G3 Through G10 Charging Units

3.19 *Stopping and Starting G3 Through G10 Charging Units*

(a) *To remove a G3 through G10 current-controlled rectifier other than a KS-19212 or KS-19215 rectifier or a G3 through G10 current-controlled motor-generator set from service,* proceed as follows.

(1) Place the unit to be removed from service under manual control in accordance with 3.20 and 3.22 or 3.24 and lower its output until it is decreased to a low value and a succeeding current-controlled unit starts and assumes the load.

(2) When the output of the G2 charging unit is 75 percent or less of its rated capacity, lower the output of the unit to be removed from service to zero. Then operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, NOR-STOP, ON-OFF, or POWER ON-POWER OFF switch on the unit to the OFF, STOP, or POWER OFF position.

(3) If the unit removed from service is a rectifier, operate the rotary or knife battery switch specified in Table C for the rectifier to the position indicated in the table. Then restore the MAN-TEST, TST-NOR-MAN, AUTO-MAN-TEST, or TST-NOR key on the rectifier to the normal, NOR, or AUTO position.

(4) If the unit removed from service is a generator, open the knife switch on the associated control bay. Then restore the TEST-NOR key on the control bay to the NOR position.

through G10 KS-19212
r from service, proceed

t capacity of the
units is sufficient
load of the KS-19212
er when it is shut off,
NOR switch on the rectifier
position. Then operate the SW2
che rectifier to the OPEN position.

If the output current capacity of the other *operating* charging units is insufficient to pick up the additional load of the KS-19212 or KS-19215 rectifier to be removed from service, proceed as follows. Successively place one or more, as required, of the nonoperating current-controlled charging units under manual control in accordance with 3.20 and 3.22 or 3.24, and increase the output of these units so that the output of the automatically controlled units is reduced sufficiently to pick up the additional load of the rectifier to be removed from service. Then remove the rectifier from service as covered in (1).

(3) Restore the manually controlled charging units successively to automatic operation as covered in 3.22 or 3.24 starting with the last unit.

(c) *To restore the G3 through G10 charging unit other than a KS-19212 or KS-19215 rectifier to service,* proceed as follows.

Caution 1: ***Do not restore the rotary or knife battery switch to the BAT or F position without first charging the output filter capacitors. Reference should be made to the operating methods section, for each individual rectifier of this capacitor charging procedure.***

Caution 2: ***Do not start a rectifier before connecting the battery, otherwise the rectifying element may be damaged.***

Warning: ***Never close the generator knife switch while the CA contactor is operated, as personal injury and commutator damage may result.***

(1) If the unit to be restored to service is a rectifier, restore the rotary or knife battery switch specified in Table C for the rectifier to the BAT position. If the unit is a generator, close the battery knife switch on the associated control bay.

(2) Operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, NOR-STOP, ON-OFF, or POWER ON-POWER OFF switch on the unit to the NOR, ON, or POWER ON position.

(3) If succeeding G3 through G10 current-controlled units are operating, place the last operating unit under manual control in accordance with 3.20 and 3.22 or 3.24 and lower its output until the G2 unit goes to full load and starts the unit being restored to service.

Caution: ***KS-19212 and KS-19215 rectifiers provided as G3 through G10 units must be shut off before being placed under manual control or restored to automatic operation as specified in 3.23.***

(4) Restore the unit under manual control to automatic operation as covered in 3.22 or 3.24.

(d) *To restore a G3 through G10 KS-19212 or KS-19215 rectifier to service,* proceed as follows. Perform each operation on the rectifier in the order given.

(1) Operate the TST-MAN-AUTO switch to the TST position.

(2) Operate the OFF-NOR switch to the NOR position.

(3) Operate the RAISE-NOR-LOWER switch to the RAISE position and hold operated until the rectifier output voltage is approximately equal to the plant battery voltage. Then operate the SW2 switch to the BAT position. [See caution 1 in (c).]

(4) Operate the OFF-NOR switch to the OFF position.

(5) Operate the TST-MAN-AUTO switch to the AUTO position.

(6) Operate the OFF-NOR switch to the NOR position, and proceed as covered in (c)(3) and (4).

J. Manual Operation of Charging Units

3.20 To operate a motor-generator set or rectifier other than a G-zero rectifier manually, proceed as covered in 3.21 though 3.24. G-zero rectifiers, where provided, are not designed for manual operation.

Caution 1: Generators and rectifiers placed under manual control should not be left unattended.

Caution 2: Raising or lowering the current output of a charging unit manually will cause one or more of the automatically controlled units to decrease or increase their outputs, respectively. Lowering the output of a charging unit in plants where the capacity of the other units is insufficient to carry additional load may cause the plant voltage to go out of limits. Care should be exercised when operating a unit manually to maintain the battery within float voltage limits.

3.21 *Manual Operation of G1 or G2 Motor-Generator Set:* Since it is not practical to change a G1 or G2 motor-generator set from automatic to manual control while it is supplying load, the following procedures are intended for G1 or G2 generators which are shut off and are to be placed into operation under manual control.

Note: Unless otherwise specified, all key, switch, and handwheel operations are performed on the generator control bay.

(a) *To place the G1 or G2 motor-generator set into operation under manual control,* proceed as follows.

(1) Check that the NOR-STOP key on the generator control bay is in the STOP position and that all of the other keys and switches on the generator control bay and the associated voltage regulator and exciter are positioned as indicated in Table A.

(2) Operate CONT TEST-NOR key to the TEST position.

(3) Operate the NOR-STOP key to the N position.

(4) The starter must operate to the run position as indicated by the sound of the run contactor operating.

Caution: If the starter fails to go to the run position, application of the load will cause the starter autotransformer to burn out.

(5) Rotate the generator manual control handwheel ccw until the CA contactor operates, indicating the set is connected to the battery.

(6) Raise or lower the output, as required by use of the handwheel.

(7) After manual operation is completed, operate the NOR-STOP key to the STOP position, restore the handwheel to the BAT position, and the CONT TEST-NOR key to the NOR position. Then restore the NOR-STOP key to the NOR position.

(b) *For an alternate method of placing G1 or G2 motor-generator set into operation under manual control,* proceed as follows.

(1) Check that all keys and switches are positioned in accordance with (a)(1).

(2) Operate the MAN potentiometer on the voltage regulator to the NOR position.

(3) Operate the REG AUTO-MAN switch on the voltage regulator to the MAN position.

(4) Operate the CONT TEST-NOR key to the TEST position.

(5) Operate the REG TEST-NOR key to the TEST position.

(6) Operate the NOR-STOP key to the NOR position.

(7) The starter must operate to the run position as indicated by the sound of the run contactor operating.

Caution: ***If the starter fails to go to the run position, application of the load will cause the starter autotransformer to burn out.***

(8) Rotate the MAN potentiometer on the voltage regulator slowly until the CA contactor operates. Connection of the generator to the battery is indicated by the sound of the CA contactor operating.

(9) Control the output as required using the MAN potentiometer.

(10) When manual operation is completed, operate the NOR-STOP key to the STOP position, operate the REG and CONT keys to the NOR position, operate the REG AUTO-MAN switch on the voltage regulator to the AUTO position, operate the MAN potentiometer on the voltage regulator to the NOR position, and restore the NOR-STOP key to the NOR position.

3.22 ***Manual Operation of G3 Through G10 Motor-Generator Set:*** To manually operate a G3 through G10 motor-generator set, proceed as covered in (a) or (b). When manual operation is completed, restore the generator to automatic operation in accordance with (c).

Note: All key operations are performed on the generator control bay.

(a) If the generator is operating, operate the TEST-NOR key to the TEST position. Then operate the RAISE or LOWER key, as required, to increase or decrease the current output of the generator.

(b) If the generator is not operating, proceed as follows.

(1) Operate the TEST-NOR key to the TEST position. This should cause the starter to operate to the run position as indicated by the sound of the CA contactor operating.

Caution: ***If the starter fails to operate to the run position, application of load will cause the starter autotransformer to burn out.***

(2) When the generator connects to the battery, as indicated by the operation of the CA contactor, operate the RAISE key, as required, to increase the current output of the generator. To decrease the output of the generator when it is supplying load, operate the LOWER key.

(c) To restore the generator to the automatic control of the plant, operate the LOWER key until the generator disconnects from the battery. Then operate the TEST-NOR key to the NOR position.

3.23 ***Manual Operation of G1 or G2 Rectifier:*** Since it is not practical to change a G1 or G2 rectifier from automatic to manual control while it is supplying load, the following procedures are intended for a G1 or G2 rectifier which is shut off and is to be placed into operation under manual control. To place the rectifier into operation manually, first check that the keys, switches, and circuit breakers on the rectifier are positioned as indicated in Table B. Then proceed as follows.

Note: All key and switch operations are performed on the rectifier control panel.

J86249 and KS-15689 Rectifiers—

(a) Operate the NOR-TEST 1 switch to the TEST 1 position, the NOR-OFF switch to the NOR position, and the CONT key to the TEST R position, in that order, and allow approximately 1 minute for warmup.

(b) Rotate the MAN potentiometer slowly cw until the CA contactor of the rectifier operates. Operation of the CA contactor indicates that the rectifier has connected to the battery. After the CA contactor operates, rotate the MAN potentiometer cw or ccw, as required, to increase or decrease the rectifier output, respectively.

(c) When manual operation is completed, restore the MAN potentiometer to its extreme ccw (NOR) position and the NOR-TEST 1 switch and CONT key, in that order, to the NOR positions.

J86273, J86295, J86296, KS-19210, KS-19211, KS-19214, and KS-19356 Rectifiers—

(d) Operate the NOR-TST or NOR-TST R key to the TST or TST R position.

(e) Operate the RECT OFF-NOR, OFF-NOR, or NOR-OFF switch to the NOR position. Then operate the AUTO-MAN key to the MAN position.

(f) Rotate the MAN, MAN ADJ, or MANUAL ADJ potentiometer slowly cw until the rectifier failure alarm lamp is extinguished. Rotate the MAN potentiometer cw or ccw, as required, to increase or decrease the rectifier output, respectively.

(g) When manual operation is completed, restore the MAN, MAN ADJ, or MANUAL ADJ potentiometer to its extreme ccw (NOR or normal) position. Operate the AUTO-MAN key to the AUTO position. Then operate the NOR-TST or NOR-TST R key to the NOR position.

KS-19212 and KS-19215 Rectifiers—

Caution: The MAN potentiometer should always be rotated fully ccw before operating the TST-MAN-AUTO switch to the MAN position.

(h) Operate the TST-MAN-AUTO switch to the MAN position. Then operate the OFF-NOR switch to the NOR position.

(i) Rotate the MAN potentiometer slowly cw until the rectifier failure alarm lamp is extinguished. Rotate the MAN potentiometer cw or ccw, as required, to increase or decrease the rectifier output, respectively.

(j) When manual operation is completed, restore the MAN potentiometer to its extreme ccw (normal) position. Then, in the order given, operate the rectifier OFF-NOR switch to the OFF position, the TST-MAN-AUTO switch to the AUTO position, and restore the OFF-NOR switch to the NOR position.

KS-19213 Rectifier—

(k) Operate the NOR-TST key to the TST position. Then operate the OFF-NOR switch to the NOR position.

(l) Rotate the MAN potentiometer slowly cw until the rectifier failure alarm lamp is extinguished. Rotate the MAN potentiometer cw or ccw, as required, to increase or decrease the rectifier output, respectively.

(m) When manual operation is completed, restore the MAN potentiometer to its extreme ccw (normal) position. Then operate the NOR-TST key to the NOR position.

3.24 *Manual Operation of a G3 Through G10 Rectifier:* To manually operate a G3 through G10 rectifier, proceed as covered in (a) through (j).

J86249 and KS-15689 Rectifiers—

(a) *If the rectifier is supplying load,* operate the MAN-TEST key on the rectifier to the TEST position. Then operate the RAISE or LOWER key on the rectifier, as required, to increase or decrease the current output of the rectifier.

(b) Before restoring the rectifier to automatic operation, lower the output until the rectifier disconnects from the battery. Then restore the MAN-TEST key to the normal position.

(c) *If the rectifier is disconnected from the battery,* proceed as follows.

(1) Operate the MAN-TEST key on the rectifier to the TEST position and allow approximately 1 minute for warmup.

(2) When the rectifier connects to the battery as indicated by the sound of the CA contactor operating, operate the RAISE key on the rectifier, as required, to increase the output of the rectifier. To decrease the output of the rectifier when it is supplying load, operate the LOWER key on the rectifier.

(3) To restore the rectifier to automatic operation, proceed as covered in 3.17(b).

J86273, J86295, and J86296 Rectifiers—

(d) Operate the TST-NOR-MAN key on the rectifier to the TST position. Then operate the RAISE or LOWER key on the rectifier, as required, to increase or decrease the current output of the rectifier.

(e) Before restoring the rectifier to automatic operation, lower the output to zero. Then restore the TST-NOR-MAN key to the NOR position.

KS-19210, KS-19211, KS-19214, and KS-19356 Rectifiers—

(f) Operate the AUTO-MAN switch on the rectifier to the MAN position. Then operate the RAISE or RAISE-LOWER switch on the rectifier to the RAISE position to increase, or the LOWER or RAISE-LOWER switch to the LOWER position to decrease the current output of the rectifier as required. Restore the switch to its NOR or normal position when the required output is obtained.

(g) Before restoring the rectifier to automatic operation, lower the current output to zero. Then restore the AUTO-MAN switch to the AUTO position.

KS-19212 and KS-19215 Rectifiers—

(h) Since a KS-19212 or KS-19215 rectifier cannot be switched from automatic to manual control without shutting off the rectifier, the following procedures are for KS-19212 and KS-19215 rectifiers which are shut off and are to be placed into operation under manual control. With the switches on the rectifier positioned as indicated in Table B, proceed as follows, performing all switching operations on the rectifier in the order given.

(1) To place the rectifier under manual control:

- Operate the TST-MAN-AUTO switch to the TST position.
- Operate the OFF-NOR switch to the NOR position.
- Operate the RAISE-LOWER switch, as required, to increase or decrease the current output of the rectifier.

(2) To restore the rectifier to automatic operation:

- Lower the rectifier output as much as possible with the RAISE-LOWER switch.
- Operate the OFF-NOR switch to the OFF position.
- Operate the TST-MAN-AUTO switch to the AUTO position.
- Operate the OFF-NOR switch to the NOR position.

KS-19213 Rectifier—

(i) Operate the TST-NOR key on the rectifier to the TST position. Then operate the RAISE or LOWER key, as required, to increase or decrease the current output of the rectifier.

(j) Before restoring the rectifier to automatic operation, lower the current output to zero. Then restore the TST-NOR key to the NOR position.

K. Manual Operation of Emergency Cell Switch

3.25 If manual switching is required, operate the emergency cell MAN-AUTO key on the battery control board to the MAN position. Switch the emergency cells in or out by operating the RAISE or LOWER key as required. If the emergency cell switch stops between positions, clear the trouble promptly. Remove the EM CELL CONT A and EM CELL CONT B fuse on the battery control board. The switch can now be operated safely by means of the hand crank. To accomplish this, insert the hand crank into the aperture (front top of switch) and crank rapidly cw to remove emergency cells or ccw to add cells. Do not stop cranking until contacts are fully engaged, as stopping between positions will damage the current limiting resistors. The contact position of the switch can be viewed through the window on the front cover.

***Caution:** Do not operate the switch more often than once every 5 minutes, otherwise the current limiting resistors may overheat and burn out.*

L. Recharging After Power Failure

3.26 *General*

(a) The 302A power plant is designed for recharging the emergency cells by the method known as charge by load. Under this method of charging, the output of certain charging units

is switched to the EM CELL bus bar so that the output current passes through the emergency cells and then to the main battery and/or the load (See Fig. 5). The number of charging units switched over for emergency cell charging depends on the charging rate and time required to restore the emergency cells to their proper voltage and on the amount of office load the plant is required to supply. When charging emergency cells, any trickle charger in use may remain connected.

(b) In plants provided with G-charging units alone or in combination with G-zero charging units, the current-controlled G3 through G10 units, where provided, are normally used for emergency cell recharging while the G1 and G2 units remain connected to maintain float voltage on the main battery.

3.27 An elapsed time alarm circuit provided on an optional basis is used for monitoring emergency cell switch off-normal operation. Whenever the emergency cell switch is off-normal, the 48V EM CELLS or 24V EM CELLS lamp will light and the elapsed timer (ET) starts timing. When the total length of time that the emergency cell switch was off-normal exceeds a preset length of time, the timer will operate and transmit a signal to the power audible alarm and alarm trunk circuits to provide a major alarm. When the emergency cell switch returns to the normal position, the major alarm will retire and a signal is transmitted to the power audible alarm and alarm trunk circuits to provide a minor alarm. The release of the minor alarm must be effected by the manual release of the elapsed timer. The total elapsed time before the elapsed timer (ET) operates may be adjusted from 0 to 3 hours depending on the amount of battery reserve available.

Note: The procedures covered in 3.28 through 3.31 are for 48-volt plants but are also applicable to 24-volt plants except that the voltages shall be halved.

3.28 ***If the power failure was of short duration during a light load period and only the first group (EM GR1) of emergency cells was switched into the battery circuit,*** permit the charging units to restore the main battery to float voltage. The motor-driven emergency cell switch will automatically return to its normal position. Then proceed as follows.

(a) ***In plants where one or more G3 through G10 charging units are provided*** and the last operating unit is a generator, or rectifier other than a KS-19212 or KS-19215, place the unit under manual control in accordance with 3.20 and 3.22 or 3.24 and lower its output until the unit disconnects from the battery. If the last operating unit is a KS-19212 or KS-19215 rectifier, operate the OFF-NOR switch on the rectifier to the OFF position. Then proceed as covered in (c) through (h).

Caution: Do not shut off or cause the last operating charging unit to disconnect until the output of the G2 unit has increased sufficiently to carry the load supplied by the last operating unit.

(b) ***In plants where G3 through G10 charging units are not provided*** and the G2 unit has disconnected from the battery, proceed as follows. For the G2 unit, other than a KS-19212 or KS-19215 rectifier, operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, NOR-STOP, ON-OFF, or POWER ON-POWER OFF switch to the OFF, STOP, or POWER OFF position and place the unit under manual control in accordance with 3.20 and 3.21 or 3.23. If the G2 unit is a KS-19212 or KS-19215 rectifier, operate the OFF-NOR switch on the rectifier to the OFF position. Then proceed as covered in (c) through (h).

(c) With the charging unit under manual control and disconnected from the battery or shut off as specified in (a) or (b), proceed as follows.

(1) ***If the unit is a generator,*** rotate the manual control handwheel and operate the knife switch on the generator control bay to the EM CELLS positions.

(2) ***If the unit is a rectifier, other than a KS-19212 or KS-19215 rectifier,*** operate the switch or switches specified in Table D for the rectifier to the position indicated for charging the EM GR1 emergency cells.

(3) ***If the unit is a current-controlled (G3 through G10) KS-19212 or KS-19215 rectifier,*** connect the unit for emergency cell charging and place the unit under manual control as follows. Perform each operation on the rectifier in the order given.

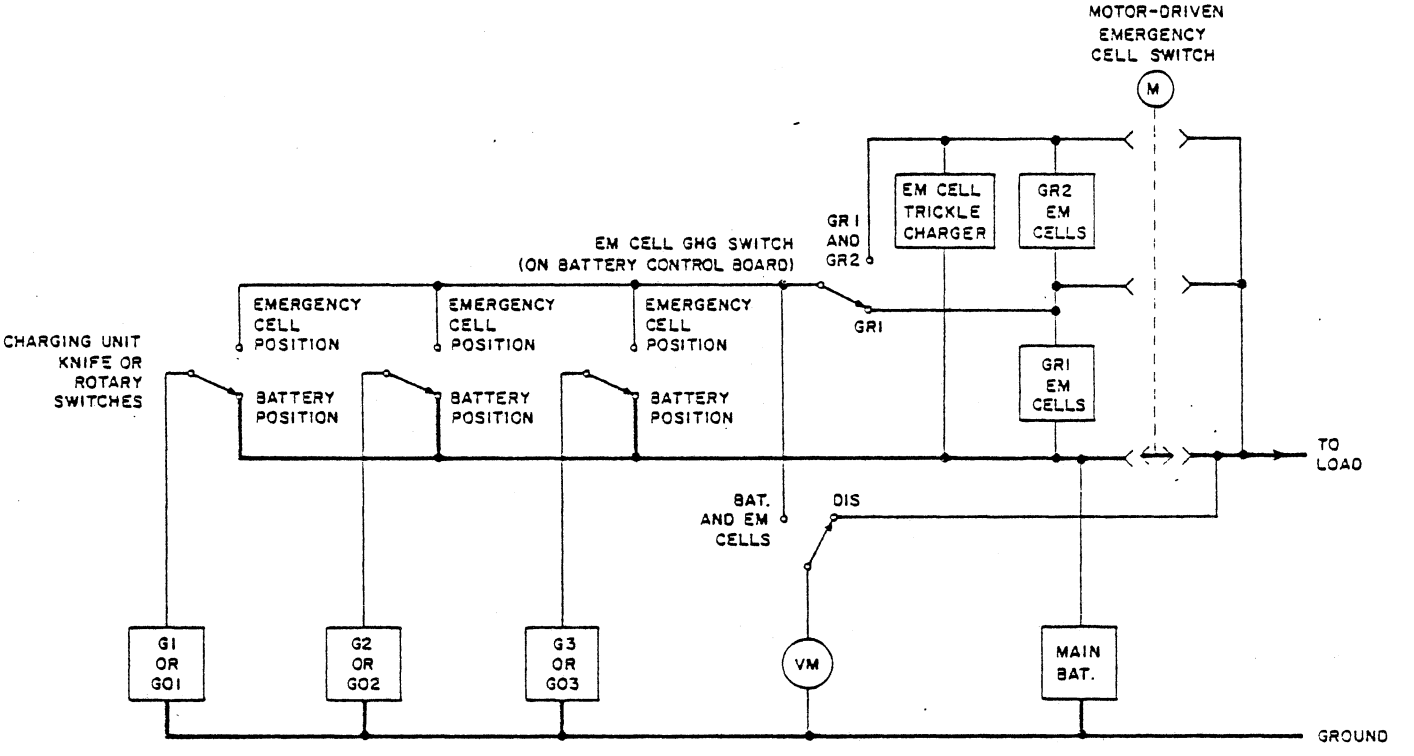


Fig. 5—Simplified Charging Circuit

TABLE D

RECTIFIER SWITCH SETTINGS FOR CHARGING EMERGENCY CELLS

			FOR CHARGING EM GR1 EMERGENCY CELLS	FOR CHARGING EM GR1 & GR2 EMERGENCY CELLS
RECTIFIER		OPERATE SWITCH	TO POSITION	TO POSITION
J86249 or KS-15689		S3	ARROW POINTED DOWNWARD	ARROW POINTED DOWNWARD
J86273 J86295 J86296		S1	GR1	GR1 & GR2
KS-19210 KS-19211		*S3	GR1	GR1 & GR2
KS-19213		CHG	EM CELL	EM CELL
		CS	EM CELL GR1	EM CELL GR1 & GR2
KS-19214		S1 S2	GR1 EM CELL	GR1 & GR2 EM CELL
KS-19356		S1	GR1	GR1 & GR2
KS-19790		S2 S3	EC EC	EC EC
KS-19791		S2	EC 57	EC 62
KS-19792		S1 S2	EC EC 57	EC EC 62
KS-19793		S2 S3	EC EC	EC EC
KS-20039		S2 S3	EC EC	EC EC
KS-20040	11 CELL PLANT	S1 S2	EC 12 CELLS	EC 13 CELLS
	12 CELL PLANT	S1 S2	EC 13 CELLS	EC 14 CELLS
KS-20489	23 CELL PLANT	S3	EC	EC

* This switch is labeled S3 on the KS-19210 L3; S1 for KS-19211 L4, L9, L11 and L12.

- Operate the SW2 switch to the OPEN position.
- Operate the SW1 switch to the EC position.
- Operate the TST-MAN-AUTO switch to the TST position.
- Operate the S4 switch to TST.
- Operate the OFF-NOR switch to the NOR position.
- Operate the RAISE-LOWER switch to the RAISE position and hold operated until the rectifier output voltage is approximately equal to the plant battery voltage. Then operate the SW2 switch to the EC position.
- Operate the RAISE-LOWER switch to the LOWER position and hold operated until the current output of the rectifier is approximately zero.

(4) ***If the unit is a voltage-regulated (G2) KS-19212 or KS-19215 rectifier,*** connect the unit for emergency cell charging and place the unit under manual control as follows. Perform each operation on the rectifier in the order given.

- Operate the SW2 switch to the OPEN position.
- Operate the SW1 switch to the EC position.
- Operate the TST-MAN-AUTO switch to the TST position.
- Operate the OFF-NOR switch to the OFF position and immediately operate the SW2 switch to the EC position.
- Operate the TST-MAN-AUTO switch to the MAN position.
- Operate the OFF-NOR switch to the NOR position.
- Rotate the MAN ADJ potentiometer cw to increase or ccw to decrease the current output of the rectifier, as required, when charging the emergency cells.

(d) Operate the EM CELL CHG knife switch on the battery control board of the plant to the GR1 position.

(e) Observe the voltage indication on the voltmeter at the top of the battery control board. Then depress the 48V and EM CELLS voltmeter keys while observing the voltage indication. The observed change in voltage is the voltage across the EM GR1 emergency cells and is referred to as the GR1 voltage.

(f) Raise the current output of the charging unit under manual control, as required, to charge the EM GR1 cells. When the GR1 voltage increases to 5 volts, lower the output of the unit until the GR1 voltage is 4.4 volts. Repeat this procedure whenever the GR1 voltage increases to 5 volts.

(g) As the EM GR1 emergency cells approach a full charge, the GR1 voltage will increase more rapidly. When the output of the charging unit is approximately zero, the EM GR1 emergency cells are fully charged.

(h) When the emergency cells are fully charged, restore the EM CELL CHG knife switch on the battery control board of the plant to the GR1 position. Then operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, or NOR-STOP switch of the charging unit to the OFF or STOP position and restore the unit to normal automatic operation as covered in (i), (j), or (k).

(i) ***To restore the charging unit, other than a KS-19212 or KS-19215 rectifier, to normal automatic operation,*** proceed as follows. If the charging unit is a generator, restore the manual control handwheel to the BAT position and the knife switch to the 48V position. If the unit is a rectifier, restore the emergency cell charging switch or switches specified in Table D for the rectifier to the BAT or F position. Restore the switch specified in (h) for the charging unit to the NOR position. Then restore the charging unit to automatic operation in accordance with 3.21 through 3.24.

(j) ***To restore the current-controlled (G3 through G10) KS-19212 or KS-19215 rectifier to normal automatic operation,*** perform the following operations on the rectifier in the order given.

(1) Operate the SW2 switch to the OPEN position.

(2) Operate the SW1 switch to the F position.

(3) Operate the TST-MAN-AUTO switch to the TST position.

(4) Operate the OFF-NOR switch to the NOR position.

(5) Operate the RAISE-NOR-LOWER switch to the RAISE position and hold operated until the rectifier output voltage is approximately equal to the plant battery voltage. Then operate the SW2 switch to the BAT position.

(6) Operate the S4 switch to NOR.

(7) Operate the OFF-NOR switch to the OFF position.

(8) Operate the TST-MAN-AUTO switch to the AUTO position.

(9) Operate the OFF-NOR switch to the NOR position.

(k) ***To restore the voltage-regulated (G1 to G2) KS-19212 or KS-19215 rectifier to normal automatic operation,*** perform the following operations on the rectifier in the order given.

(1) Operate the SW2 switch to the OPEN position.

(2) Operate the SW1 switch to the F position.

(3) Operate the TST-MAN-AUTO switch to the TST position.

(4) Operate the OFF-NOR switch to the NOR position.

(5) Operate the SW2 switch to the BAT position.

3.29 ***If the power was restored during a heavy-load period and both groups of emergency cells (EM GR1 and EM GR2) were switched into the battery circuit and sufficient charging capacity is not available, it is very important that*** all working charging units be transferred from the battery bus to their emergency cell bus (Fig. 6). This is accomplished by manually operating the charging unit output switches from BAT to EC position or operating the generator knife switch on the generator control bay to the EM CELL position and verifying that the EM CELL CHG switch on the battery control board is in the GR1 and GR2 position. Failure to transfer the charging unit outputs to the EM CELL position would result in rapid depletion and possible reversal of the EM cells. Adjust the charging unit for EM cell charge-by-load as follows.

Caution: Before operating rectifier output switches or generator knife switches from BAT to EC position, it is necessary to operate the NOR-STOP, ON-OFF, or OFF-NOR key, for the charging unit being transferred, to the OFF or STOP position. Failure to do this could result in equipment damage or personal injury.

(a) ***If G3 through G10 current-controlled charging units are provided,*** starting with the highest numbered unit, adjust the unit for emergency cell charging in accordance with (1), (2), or (3). Then operate the EM CELL CHG knife switch on the battery control board of the plant to the GR1 and GR2 position and repeat procedures (1), (2), or (3) for each preceding current-controlled unit from the last unit downward. Perform all switching operations in the order given.

(1) ***If the unit is a motor-generator set,*** operate the NOR-STOP key on the generator control panel to the STOP position. Rotate the manual control handwheel and operate the knife switch on the control panel to the EM CELL position. Then restore the NOR-STOP key to the NOR position.

(2) ***If the unit is a rectifier, other than a KS-19212 or KS-19215 rectifier,*** operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, ON-OFF, or POWER ON-POWER OFF switch to the OFF or POWER OFF position. Operate the switches specified in Table D for the rectifier to the position indicated in the table for charging the EM GR1 emergency cells. Then restore the NOR-OFF, RECT OFF-NOR, ON-OFF, or POWER ON-POWER OFF switch to the NOR, ON, or POWER ON position.

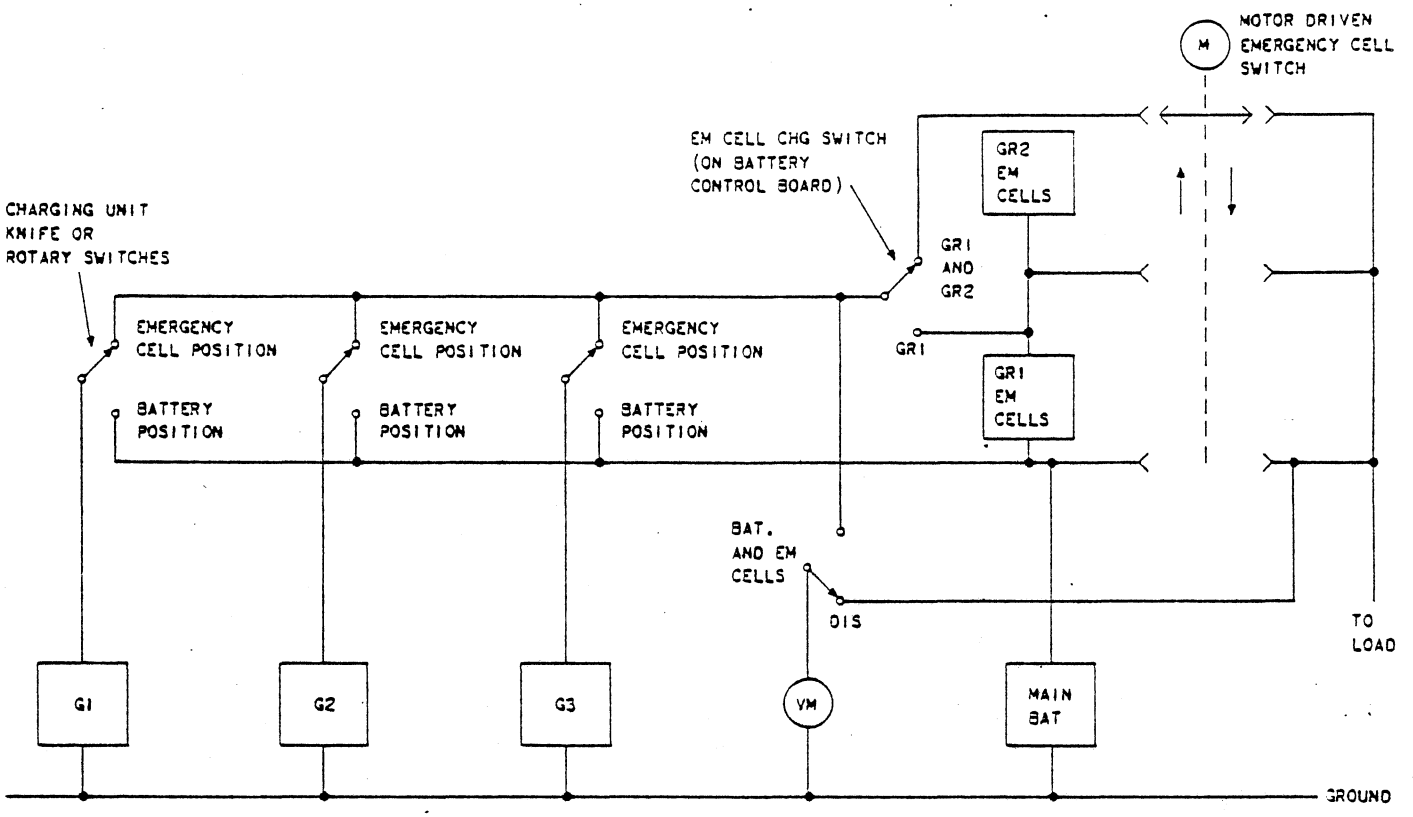


Fig. 6—GR1 and GR2 END Cell Charging Circuit

(3) ***If the unit is a KS-19212 or KS-19215 rectifier,*** proceed as follows. All switching operations are performed on the rectifier.

- Operate the OFF-NOR switch to the OFF position.
- Operate the SW2 switch to the OPEN position.
- Operate the SW1 switch to the EC position.
- Operate the TST-MAN-AUTO switch to the TST position.
- Operate the OFF-NOR switch to the NOR position.
- Operate the RAISE-LOWER switch to the RAISE position and hold operated until the rectifier voltage is approximately equal to the plant battery (including the EM GR1 emergency cells) voltage. Then operate the SW2 switch to the EC position.
- Operate the OFF-NOR switch to the OFF position.
- Operate the TST-MAN-AUTO switch to the AUTO position.
- Operate the OFF-NOR switch to the NOR position.

(b) ***If G-zero charging units are provided, adjust the GO1 unit and then each of the other G-zero units for emergency cell charging in accordance with (1), (2), or (3).***

(1) ***If the unit is a charge bay assembly,*** perform the following operations in the order given.

- Operate the ON-OFF key on each rectifier in the charge bay assembly to the OFF position.
- Operate the DC OUTPUT switch on the charge bay to the EM CELL position.

- Restore the ON-OFF key on each rectifier in the charge bay to the ON position.

(2) ***If the unit is a rectifier, other than a KS-19212 or KS-19215 rectifier,*** adjust the unit for emergency cell charging in accordance with (a)(2).

(3) ***If the unit is a KS-19212 or KS-19215 rectifier,*** perform the following operations on the rectifier in the order given for emergency cell charging.

- Operate the OFF-NOR switch to the OFF position.
- Operate the SW2 switch to the OPEN position.
- Operate the SW1 switch to the EC position.
- Operate the OFF-NOR switch to the TST position.
- Operate the OFF-NOR switch to the NOR position.
- Operate the SW2 switch to the EC position.
- Operate the OFF-NOR switch to the OFF position.
- Operate the TST-MAN-AUTO switch to the AUTO position.
- Operate the OFF-NOR switch to the NOR position.

(c) Adjust the G1 charging unit in accordance with (a)(1), (a)(2), or (a)(3) for charging the EM GR1 and GR2 emergency cells.

(d) Adjust the G2 charging unit in accordance with (a)(1), (a)(2), or (a)(3) for charging the EM GR1 and GR2 emergency cells.

(e) When the output voltage has increased sufficiently to cause the emergency cell switch to disconnect the load from the GR2 cells, operate the EM CEL CHG knife switch on the battery control board to the GR1 position.

(f) Continue charging the main battery and the GR1 cells until the output voltage again increases sufficiently to cause the emergency cell switch to return to its normal position. Restore all the charging units to normal operation in accordance with (g) through (i) in that order, except the last operating current controlled (G3 through G10) charging unit, where provided; or G2 charging unit, if a G3 through G10 unit is not provided. Then charge the GR1 and GR2 cells in accordance with 3.30.

(g) ***To restore the G1 or G2 charging unit to normal operation,*** proceed as follows.

(1) ***If the unit is a generator,*** operate the NOR-STOP key to the STOP position. Restore the generator manual control handwheel and knife switch to the BAT and 48V positions, respectively. Then restore the NOR-STOP key to the NOR position.

(2) ***If the unit is a rectifier, other than a KS-19212 or KS-19215 rectifier,*** operate the rectifier NOR-OFF, RECT OFF-NOR, OFF-NOR, ON-OFF, or POWER ON-POWER OFF switch to the OFF or POWER OFF position. Restore the emergency cell charging switch or switches specified in Table D for the rectifier to the BAT or F position. Then restore the NOR-OFF, RECT OFF-NOR, OFF-NOR, ON-OFF, or POWER ON-POWER OFF switch to the NOR, ON, or POWER ON position.

(3) ***If the unit is a KS-19212 or KS-19215 rectifier,*** operate the OFF-NOR switch to the OFF position. Then proceed in accordance with 3.28(j).

(h) ***To restore the G-zero charging units to normal operation,*** proceed as follows, starting with any one of the units, and repeating the procedure for each of the other G-zero charging units.

(1) ***If the unit is a charge bay assembly,*** operate the ON-OFF key on each rectifier in the charge bay to the OFF position. Restore the DC OUTPUT switch on the charge bay to the BAT position. Then restore the rectifier ON-OFF keys to the ON position.

(2) ***If the unit is a rectifier, other than a KS-19212 or KS-19215 rectifier,*** restore the rectifier to normal operation in accordance with (g)(2).

(3) ***If the unit is a KS-19212 or KS-19215 rectifier,*** operate the OFF-NOR switch to the OFF position and restore the rectifier to normal operation as specified in 3.28(k) for G1 and G2 rectifiers.

(i) ***To restore a G3 through G10 current-controlled charging unit to normal operation,*** proceed as follows.

(1) ***If the unit is a generator or rectifier, other than a KS-19212 or KS-19215 rectifier,*** place the unit under manual control in accordance with 3.20 and 3.22 or 3.24 and lower its output until the unit disconnects from the battery. Operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, NOR-STOP, ON-OFF, or POWER ON-POWER OFF switch to the OFF, STOP, or POWER OFF position. Then proceed in accordance with 3.28(i).

(2) ***If the unit is a KS-19212 or KS-19215 rectifier,*** operate the OFF-NOR switch on the rectifier to the OFF position. Then proceed in accordance with 3.28(j).

3.30 ***If both groups of emergency cells (EM GR1 and EM GR2) were switched into the battery circuit during the power failure and sufficient charging capacity is available,*** permit the charging units to restore the main battery to float voltage and thus cause the motor-driven emergency cell switch to return automatically to normal. Then proceed as follows.

(a) Adjust the last operating current-controlled (G3 through G10) charging unit, where provided, or G2 charging unit, if a G3 through G10 unit is not provided, for emergency cell charging under manual control in accordance with 3.28(a) or (b) and (c). If the unit is a rectifier, other than a KS-19212 or KS-19215 rectifier, operate the switch or switches specified in Table D for the rectifier to the position indicated for charging the EM GR2 emergency cells.

(b) Operate the EM CELL CHG knife switch on the battery control board to the GR1 & GR2 position.

(c) Connect the Weston 931 voltmeter across the EM GR2 emergency cells. Raise the current output of the charging unit under manual control, as required, to charge the EM GR2 cells. When the voltage indication on the meter has increased to 5 volts, lower the output of the unit until the voltage is 4.4 volts. Repeat this procedure whenever the voltage increases to 5 volts.

(d) As the EM GR2 emergency cells approach a full charge, the voltage will increase more rapidly. When the output of the charging unit is approximately zero, the EM GR2 emergency cells are fully charged.

(e) When the EM GR2 emergency cells are fully charged, lower the output of the charging unit until it disconnects from the battery. Disconnect the voltmeter. If the unit is a rectifier, other than a KS-19212 or KS-19215 rectifier, operate the switch or switches specified in Table D to the positions indicated for charging the EM GR1 emergency cells. ▶Operate the EM CELL CHG knife switch on the battery control board to the GR1 position.◀ Charge the EM GR1 emergency cells and then restore the unit to normal automatic operation in accordance with 3.29 (g) through (i).

3.31 ***If the battery reserve becomes insufficient for starting the plant after a deep discharge to below emergency volt limits, the following procedure should be followed when emergency ac power or commercial ac power becomes available.***

(1) After it has been confirmed that the central office equipment is inoperative due to a low battery reserve, ***notify the supervisor and at his direction remove the discharge fuses.*** The removal of the office load generally allows the battery voltage to recover enough to start at least one charging unit.

(2) Using a portable voltmeter, check all of the batteries for reversal of polarity in accordance with Section 157-601-701. (See note.)

(3) Replace discharge fuses when the plant appears to function normally and all charging units are available.

Note: If one or more cells in a series becomes fully discharged while the remainder of the cells are still discharging, there will be a reversal, that is, a change of polarity on the discharged cells with adverse affects on the plates.

4. ROUTINE CHECKS AND ADJUSTMENTS

4.01 The purpose of performing routine checks is to determine whether or not all the features, indications, and alarms are functioning properly. The checking time and testing intervals should be based on local conditions and past experience. The power room alarms to other parts of the building when performing these checks may be shut off by operating the SERVCO key on the main control board to OFF.

4.02 Periodically when the emergency generator routines are performed, the power plant should be allowed to function automatically so that the charging units will shut down, emergency cells will operate, and, on restoration of power, the charging units will connect in the required manner.

CLEAN VENTILATING PASSAGES

4.03 Keep all ventilating passages unobstructed to ensure adequate cooling during operation. Inspect the control cabinets and charging unit cabinets for dust and foreign matter. Clean the inside of the cabinets in accordance with local instructions when the charging units are removed from service or when the plant is being checked on a routine basis.

VOLTMETER ACCURACY CHECK

4.04 To check the BAT voltmeter for accuracy, proceed as follows.

(1) Connect the KS-8039 volt-milliammeter across the terminals of the BAT voltmeter.

(2) Compare the indications of the BAT and KS-8039 meters. If the meters do not agree, adjust the zero adjusting screw as required on the BAT voltmeter.

(3) Place masking tape over the adjusting screw denoting the date the adjustment was made.

(4) Disconnect the KS-8039 volt-milliammeter.

CHECKING OPERATION OF G-ZERO RECTIFIERS NOT SUPPLYING LOAD

4.05 To check the operation of G-zero rectifiers, proceed as follows.

(1) Shut off one or more of the G-zero rectifiers supplying load to the plant by operating the NOR-OFF, RECT OFF-NOR, OFF-NOR, ON-OFF, or POWER ON-POWER OFF switch to the OFF or POWER OFF position.

Requirement: Each idle rectifier will pick up the load in turn.

(2) When all checks are complete, restore the switch or switches to NOR, ON, or POWER ON.

CHECKING OPERATION OF G1 THROUGH G10 CHARGING UNITS NOT SUPPLYING LOAD

4.06 To check the operation of G1 through G10 charging units, proceed as follows.

(1) Shut off one or more G-zero units (if provided), the operating G3 through G10 units, and the G1 or G2 unit, in that order, as required, in accordance with 3.10 through 3.19.

Requirement: Each idle G charging unit will pick up the load in turn.

(2) When all checks are complete, restore the G1 or G2, G-zero, and G3 through G10 charging units, in that order, as covered in 3.10 through 3.19.

Caution: If G-zero rectifiers are not provided, either the G1 or G2 unit must be kept in service at all times to maintain voltage regulation of the plant.

G1 AND G2 GENERATOR ADJUSTMENTS

Note: The G1 and G2 generator adjustment procedure which follows has been written with the intent to start at either A (Preliminary Preparations) or G (Voltage Regulator and Exciter Control Adjustments) and continue sequentially through all steps. Procedures to restore controls after each individual adjustment are eliminated.

A. Preliminary Preparations

4.07 Before adjusting the G1 and G2 generator, proceed as follows:

(a) If there are no charging units capable of voltage regulating the plant due to maladjustment or trouble; use available charging units, other than the one being adjusted to manually regulate the plant voltage at 24 volts for a 24-volt plant or 48 volts for a 48-volt plant.

Note: Manual operation of charging units is outlined in 3.20 through 3.24.

(b) Observe the plant voltage for about two minutes to assure that it is fairly stable. At this time, the plant is under manual regulation, and a large change in load could cause a high or low voltage condition. Regulate the plant manually as required to keep the voltage at either 24 or 48 volts.

B. Setting of Controls

4.08 The preliminary adjustments of the main control board, G1 or G2 generator control bay, and voltage regulator and exciter panel of the generator to be checked are as follows. (See Table A for normal automatic position of controls.)

(a) At the Main Control Board—

(1) Operate the GEN-REG MAN-AUTO key to the MAN position.

(2) Operate the EM CELL SW MAN-AUTO key to the MAN position.

(3) The FLOAT/CHG key should be in the FLOAT position.

(b) At the G1 or G2 Generator Control Bay—

(1) Operate the NOR-STOP key to the STOP position.

(2) Rotate the generator manual control handwheel fully cw.

(3) Open the generator knife switch.

(4) Operate the REG TEST-NOR key to the NOR position.

(5) Operate the CONT TEST-NOR key to the NOR position.

(6) Zero the AR or AR1 and the AR2 ammeters.

(c) At the Voltage Regulator and Exciter Control Panel for the G1 or G2 Generator—Operate the REG AUTO-MAN switch to the MAN position.

Warning: ***Never open or close the generator knife switch while the CA contactor is operated, as personal injury and commutator damage may result.***

C. CB Reverse Current and CC Relay Check

4.09 Check the CB reverse current relay as follows:

(1) Perform preliminary steps as outlined in 4.08(a) through (c).

(2) Block the CC relay operated on the generator control bay under test. (Block armature to the left facing front of relay.)

(3) Operate the CONT TEST-NOR key to the TEST position.

(4) Operate the NOR-STOP key to the NOR position. The motor-generator will rotate cw as viewed from the generator end.

(5) After the run contactor closes, slowly rotate the generator manual control handwheel ccw.

Requirement: The CB relay operates between 40 and 45 volts on the 65-volt generator or between 20 and 25 volts on the 33-volt generator. (Read voltages on the generator control bay voltmeter with the VM BAT/GEN key in the GEN position.

(6) Remove the block from the CC relay and replace cover.

(7) Rotate the generator manual control handwheel cw until the CA contactor and CB relay release. (No voltage limit)

4.10 Check the CC relay as follows.

(1) After the CA contactor has released, close the generator knife switch to the 24V or 48V position.

(2) Using the KS-14510 volt-ohm-milliammeter on the 60-volt dc scale, connect the positive lead to the armature contact and the negative

lead to the stationary contact of the CA contactor. (Do not obstruct the operation of the contactor ▸or short contacts of contactor.)◂

(3) Slowly rotate the generator manual control handwheel ccw until the meter indicates 1 volt. Then change to the 3-volt scale on the meter and readjust the handwheel to indicate 1 volt.

(4) Reverse the meter leads at the meter. ▸The meter will indicate a reverse deflection. (Do not short or ground the leads while reversing.)◂

(5) Very slowly rotate the handwheel ccw. The CA contactor will operate before the meter indicates 1 volt (that is, before the generator voltage is 1 volt higher than the battery voltage).

(6) Disconnect the KS-14510 volt-ohm-milliammeter.

(7) Remove the cover of the AR or AR1 ammeter relay, grasp the insulated lower end of the low-contact pointer and move the contact to the extreme left position.

(8) Slowly rotate the handwheel cw observing a below zero deflection of the AR and AR1 ammeter relay.

Requirement: The CA contactor and CB relay release before the reverse current (below zero reading) reaches 3 to 8 percent of the rated output of the generator.

Caution: ***Do not permit the reverse current to exceed the 8-percent value as excessive reverse current may affect future operation of the CB relay.***

(9) Operate the NOR-STOP key to the STOP position.

(10) Open the generator knife switch.

(11) Operate the CONT TEST-NOR key to the NOR position.

D. Ammeter Relay Adjustments

4.11 Adjust the ammeter relays as follows:

(1) Adjust the high contact of the AR or AR1 relay to close on a current equal to the full-ampere rating of the associated generator. The low contact shall be adjusted to close with a reverse current sufficient to deflect the pointer 1 to 2 percent of the generator rated ampere output below the zero reading. (See 1.15).

(2) Adjust the high contact of the AR2 relay to close on approximately 75 percent of the ampere rating of the generator with increasing load. The low contact shall be adjusted to close at 25 percent of full-load reading on descending load. (See 1.15).

E. Generator Manual Control Handwheel

4.12 ▸Set the position of the generator handwheel pointer as follows. The following operations are performed on generator control bay.

(1) Operate CONT TEST-NOR key to TEST.

(2) Operate STOP-NOR key to NOR (generator starts).

(3) After the run contactor closes, operate the REG TEST-NOR key to TEST position. Observe the generator voltage increases on the generator control bay voltmeter.

(4) Rotate handwheel ccw until generator voltage increases to approximately the rated value of 63 or 33 volts. Then, rotate the handwheel slowly cw to decrease the voltage to the following value.

- 11-cell battery—23 volts
- 12-cell battery—25 volts
- 23-cell battery—48 volts

Stop rotating the handwheel when the desired value is reached. If the value is passed, start over again and appproach more slowly. When the proper setting has been obtained, the position of the pointer of the handwheel should be marked with a line and stenciled BAT. If the board is already stenciled, loosen the set screws on the pointer and relocate the pointer to the stenciled position.

(5) Operate CONT TEST-NOR key to NOR.

(6) Operate REG TEST-NOR key to NOR.

(7) Operate NOR-STOP key to STOP.

F. Generator Cut-Off Relay Adjustments (G2 Generator Only Where Cut-Off Is Provided)

4.13 Adjust the generator cut-off relay as follows.

(1) Perform preliminary steps as outlined in 4.08(a) through (c) at the G2 generator.

(2) Close the generator knife switch to the 48V or 24V position. [See warning under 4.08(c).]

(3) Operate the CONT TEST-NOR key to the TEST position.

(4) Operate the NOR-STOP key to the NOR position.

(5) After the run contactor closes, rotate the GCR rheostat fully ccw.

(6) Rotate the generator manual control handwheel to raise the voltage of the G2 generator to 1 volt above the battery voltage.

(7) After the CA contactor operates, reduce the ampere output of the G2 generator to a value equal to 80 percent of the rating of the G1 generator.

(8) Slowly rotate the GCR rheostat cw until the GC relay releases.

(9) Rotate the G2 generator manual control handwheel to full load, then slowly decrease the output.

Requirement: The GC relay will release when the G2 generator output drops to 80 percent of the rating of the G1 generator.

G. Voltage Regulator and Exciter Control Adjustments

4.14 Adjust the voltage regulator and exciter control as follows:

GENERAL

(1) At this time the plant must be manually regulated at 24 volts for a 24-volt plant or 48 volts for a 48-volt plant.

Note: Manual operation of charging units is outlined in 3.20 through 3.24.

(2) Observe this voltage for about two minutes to assure it remains fairly stable. At this time the plant is under manual regulation, and a large change in load could cause a high or low voltage condition. Regulate the plant manually as required to keep the voltage at either 24 or 48 volts.

At the Main Control Board—

(1) Operate the GEN REG MAN-AUTO key to the MAN position.

(2) Operate the EM CELL SW MAN-AUTO key to the MAN position.

(3) The GEN REG FLOAT-CHG key should be in the FLOAT position.

At the G1 or G2 Generator Control Bay—

(1) Operate the NOR-STOP key to STOP.

(2) Operate the CONT TEST-NOR key to NOR.

(3) Operate the REG TEST-NOR key to NOR.

(4) The generator knife switch should be closed to the 24V or the 48V position.

Warning: ***Never open or close the generator knife switch while the CA contactor is operated, as personal injury and commutator damage may result.***

(5) Rotate the generator manual control handwheel to the BAT position.

(6) Operate the VM BAT-GEN key on the Generator Control Board to the GEN position.

At the Voltage Regulator and Exciter Control Panels for the G1 and G2 Generators—

(1) Operate the REG-AUTO-MAN switch to AUTO.

(2) Operate the LINE COMP NOR-TEST switch to NOR.

(3) Rotate the MAN potentiometer fully ccw.

(4) Adjust CON CUR H potentiometer fully cw.

(5) Adjust CON CUR L potentiometer fully cw.

(6) Adjust ADJ VOLTS potentiometer fully ccw.

(7) Adjust CHG potentiometer fully ccw.

(8) Adjust CUR REG potentiometer fully ccw.

(9) Adjust ANTI-HUNT 1 potentiometer to midrange.

(10) Adjust LINE COMP potentiometer to midrange.

(a) *Float and Charge Adjustments—*

(1) Using the 30-volt scale setting for 24-volt plants or 75-volt scale setting for the 48-volt plant, connect the KS-8039 voltmeter across the REG + and REG – pin jacks on the voltage regulator and exciter control panel. (Use the 141 cord tips with voltmeter leads.)

Note: Unless otherwise specified, all voltage readings are to be made with the KS-8039 meter.

(2) Operate the NOR-STOP key to the NOR position (generator starts).

(3) After the run contactor closes, slowly rotate ADJ VOLTS potentiometer cw until the CA contactor just operates connecting the unit to the line. This will occur when the generator output voltage is approximately 1 volt higher than the plant voltage or about 25 or 49 volts.

Note 1: This adjustment is critical and must be done very slowly to allow capacitors to charge or the machine may connect at very high current and shut down because of overload.

Note 2: If the generator output voltage hunts during these adjustments, rotate the ANTI-HUNT 1 potentiometer (see Fig. 3) as required to stop the hunting. ▮The ANTI-HUNT 2 potentiometer at the rear of the control panel has been factory set at the value of 200,000 ohms and should not need to be changed.◀

(4) Without exceeding the full capacity of the unit, slowly rotate the ADJ VOLTS potentiometer cw until the plant is floating at the following values.

- 49.9 volts for 23 cells
- 26.04 volts for 12 cells
- 23.9 volts for 11 cells

Note: It may be necessary to increase the output of a manual unit to keep the unit under test from exceeding full capacity. Allow at least 5 minutes to permit battery voltage to stabilize.

(5) Insulate the 4T and 5T contacts of the RT relay. (Contacts count left to right facing front of relay.)

(6) Without exceeding the full capacity of the unit, slowly rotate the CUR REG potentiometer cw until the voltage indicated on the KS-8039 voltmeter increases to 1 volt above battery voltage. (It may be necessary to increase the output of one of the units operating under manual control to keep the unit under test from exceeding full capacity.)

(7) Remove the insulation from 4T and 5T contacts of the RT relay. The battery will return to float voltage.

Note: If the plant has been modified for solid state G-zero operation (SD-81148-01; Fig. 6; ZW option), skip (8) through (10).

(8) Operate the GEN REG FLOAT-CHG key on the main control board to the CHG position.

(9) Without exceeding the full capacity of the unit, slowly rotate the CHG potentiometer cw until the battery voltage increases to the following float voltage values:

- 50.6 volts for 23 cells
- 26.4 volts for 12 cells
- 24.2 volts for 11 cells

(It may be necessary to increase the output of one of the units operating under manual control to keep the unit under test from exceeding full capacity.)

(10) Operate the GEN REG FLOAT-CHG key on the main control board to the FLOAT position. (Battery restores to float voltage.)

CC Test Circuit Not Provided—

Note 1: When a CC Test Circuit is not provided, the test procedure can be performed as outlined in (b) through (d) while the plant is still set up for manual operation. An alternative procedure would be to construct a portable constant current test circuit (see Fig. 7). Perform the test, using the portable test circuit, as outlined in "CC Test Circuit Provided".

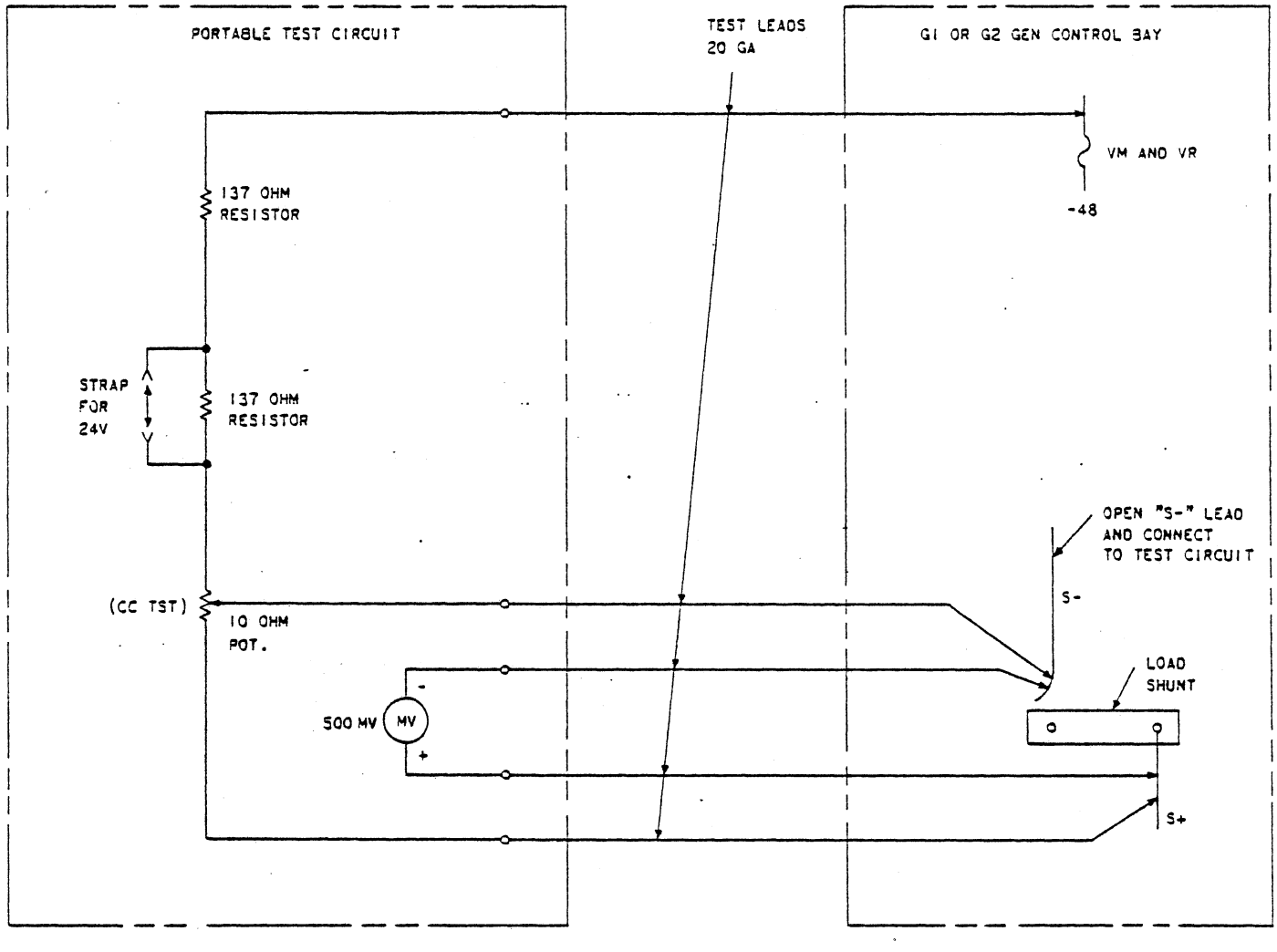


Fig. 7—Constant Current Test Circuit

Note 2: Where the voltage regulator is not equipped with the CC test circuit, an external millivoltmeter with the proper scale, such as, a 35-type test set can be connected to read load currents in excess of 100 percent. (See Table E.) If a 35-type test set is used, select a low scale so that the current drawn by the test set does not exceed 20 milliamperes and thus cause calibration error due to wiring resistance. Connect the dc millivoltmeter to the SH+ and SH− test jack on the voltage regulator (0.8 volt is equivalent to 300 millivolts).

TABLE E

LOAD PERCENTAGES AND VOLTMETER READINGS

CC TEST MILLIVOLTMETER READING		
LOAD IN PERCENT	FOR 750-AMPERE GENERATORS	FOR ALL OTHER GENERATORS
75	176	188
77	181	193
79	186	198
85	200	213
100	235	250
105	246	262
110	258	275
115	271	288
120	282	300
125	293	310
150	352	375

(b) *Droop and Line Compensation Adjustments—*

(1) Operate the REG TEST-NOR key to the TEST position.

(2) Operate the CONT TEST-NOR key to the TEST position.

(3) Insulate 4T and 5T contacts of RT relay and the NO (Normally Operated) spring of A segment of the REG TEST-NOR key in the voltage regulator and exciter circuit. Battery voltage will increase approximately 1 volt. Increase the load from 95 to 100 percent of the generator rating. Adjust the CON CUR H potentiometer ccw until the battery voltage is maintained at the float voltage. If periodic swings of the output-current meter are observed, rotate the ANTI-HUNT 1 potentiometer slowly cw until the swings decrease to a minimum. If necessary, rotate the ANTI-HUNT 2 potentiometer (inside voltage regulator) slighly cw to stop hunting.

Note: The ANTI-HUNT 2 potentiometer should never be adjusted to less than 200,000 ohms.

(4) Operate the LINE COMP switch and observe the value to which the output current returns after the initial change. If the output does not recover, release the LINE COMP switch and rotate the LINE COMP potentiometer slightly ccw. Readjust the CON CUR H potentiometer to maintain float voltage. Repeat operations of the LINE COMP switch and adjustment of the LINE COMP and CON CUR H potentiometer until operation of the LINE COMP switch causes approximately +2 percent change in output. Remove the insulation from contacts of RT relay and the REG TEST-NOR key. Rotate CON CUR H potentiometer fully cw.

(5) Recheck the float voltage, current regulation, and charge voltage values in accordance with (a)(7) through (14). Increase the load slowly until the generator output reaches 110 percent of its rated output. Then rotate the CON CUR H potentiometer ccw until the output drops to 105 percent of its rating. Since part of the load is now being supplied from the battery, its voltage should decrease. Maintain the generator output at 105 percent by adjusting the CON CUR H potentiometer while the voltage is decreasing to:

48.9 volts for 23 cells

25.5 volts for 12 cells

23.15 volts for 11 cells

Leave the CON CUR H potentiometer at the setting which gives 105 percent output at the above voltage.

(c) *CON CUR L Adjustment—G1 Generator Only*

(1) Remove the load to reduce the generator output to zero. Then block CR and CRL relays operated. This raises the generator

voltage 1 volt above the float value. Add load slowly up to 80 percent of the generator rated output. Rotate the CON CUR L potentiometer ccw until the generator output drops to 75 percent of its rated output. Since part of the load is now being supplied by the battery, voltage should decrease. Watch the battery voltage as it drops and, when it reaches the float voltage, quickly adjust the CON CUR L potentiometer further ccw so that the generator is delivering 75 percent of its rated output at float voltage. Remove the block from CR and CRL relays.

Note: The setting of the CON CUR L potentiometer should be as close as possible to 75 percent of the full-load rating of the machine without permitting variable load to cause false starting of the second machine. Make this adjustment when load variation is at a minimum.

(d) ***Verification of Adjustments***

(1) Decrease the load to 50 percent of the generator rating and readjust the ADJ VOLTS potentiometer to the float voltage, if necessary. Increase the load slowly to 105 percent of the generator rating and observe that the high contact of AR1 ammeter relay makes before the voltage drops below:

49.0 volts for 23 cells

25.5 volts for 12 cells

23.4 volts for 11 cells

(2) Increase the load to 120 percent of the generator rating and observe that the generator output does not exceed 120 percent of the rating when the battery has decreased to 2.0 volts per cell.

(3) If periodic swings of the generator output occur as the voltage is decreasing to 2.0 volts per cell, rotate the ANTI-HUNT 2 potentiometer (inside voltage regulator) slowly cw until the hunting almost stops. [See note under (b)(3)]. Then adjust the ANTI-HUNT 1 potentiometer until the hunting stops. With G1 and G2 operating in parallel, it may be necessary to make further adjustments of the ANTI-HUNT 1 or ANTI-HUNT 2 potentiometer.

Note: The ANTI-HUNT 2 potentiometer should never be adjusted to less than 200,000 ohms.

(4) Operate the NOR-STOP key on the generator panel to the STOP position.

Note: All remaining adjustments are to be made off the line. Except for the unit being adjusted, the plant may be restored to normal automatic operation as outlined in Table A to voltage regulate the plant at float voltage. If no other voltage regulating units are operational at this time, the plant may be left in the manual mode at 24 or 48 volts during the remaining adjustments.

CC Test Circuit Provided—

Note 1: The CC test circuit furnished with generators with voltage regulators consists of a CC TST millivoltmeter (0 to 500 millivolts), a CC TST key, and a CC TST potentiometer, which is used to apply a voltage to the shunt leads of the voltage regulator to simulate output current. For instance, to simulate 105 percent load, operate the CC TST key to the TST position, and then rotate the CC TST potentiometer so that the CC TST millivoltmeter indicates 246 millivolts for 750-ampere generators or 262 millivolts for all other generators. This will affect the regulating circuit in the same way as an actual load. Table E shows load percentages and corresponding millivoltmeter readings.

Note 2: With the CC TST key operated to the NOR position, the millivoltmeter is bridged across the ammeter relay shunt and may be used as an indication of the output current. In this case the millivoltmeter should read 235 millivolts for full load on the voltage regulator for 750-ampere generators or 250 millivolts for full load on the voltage regulator for all other generators. See Table E.

(e) ***OL Relay Adjustment—***

(1) Verify that the NOR-STOP key on the generator panel is in the STOP position.

(2) Open the generator knife switch.

(3) Rotate the OLR potentiometer fully cw and CC TST potentiometer fully cw.

(4) The cover must be on the OL relay. Connect the KS-14510 volt-ohm-milliameter, using the 60-volt scale, Neg. lead to the No. 1 contact of the OL relay and Pos. lead to frame ground to observe the operation of the OL relay. Voltmeter reading indicates the released position (contacts count from right to left in rear).

(5) Operate the CONT TEST-NOR key to the TEST position.

(6) Operate the REG TEST-NOR key to the TEST position.

(7) Operate the NOR-STOP key on the generator control panel to the NOR position (generator starts).

(8) After the run contactor closes, operate the CC TST key to the TST position and hold operated.

(9) If the OL relay is not operated, rotate the OLR potentiometer slowly ccw until the OL relay operates.

(10) Slowly rotate the CC TST potentiometer ccw until the OL relay releases.

Note: Operation of the OL relay will operate a generator failure alarm.

Requirement: The release value of the OL relay should be between 120 and 125 percent of generator full-load rating as indicated on the CC TST millivoltmeter. See Table E for millivoltmeter readings.

(11) Rotate the OLR potentiometer ccw if the release value of the OL relay exceeds 125 percent of generator rating and cw if it is less than 120 percent. Then with the CC TST potentiometer, reoperate (cw) and release (ccw) the OL relay, adjusting the OLR potentiometer until the release value of the OL relay is within limits.

(12) Release the CC TST key.

(13) Rotate the CC TST potentiometer fully ccw.

(14) Allow the OL relay to cool for at least 5 minutes and recheck the release value as outlined in (8) through (13).

(15) Operate the CC TST key to the TST position and hold operated.

(16) Slowly rotate the CC TST potentiometer cw and check that the OL relay operates.

Requirement: The OL relay should operate before 150 percent of the rated load is reached. See Table E for millivoltmeter readings.

(17) Release the CC TST key and rotate the CC TST potentiometer fully ccw.

(18) Allow the OL relay to cool for at least 5 minutes and recheck the operate value as outlined in (15) through (17).

(19) Disconnect the KS-14510 volt-ohm-milliammeter.

Note: Reset the generator failure alarm by operating the NOR-STOP key to STOP, then to NOR.

(f) *Droop Point CON CUR H Adjustment—*

(1) Rotate the generator manual control handwheel on the generator control bay fully cw from the BAT position so the manual setting does not prevent setting the droop adjustment.

(2) After the run contactor closes, adjust the ADJ VOLTS potentiometer as necessary to obtain float voltage (26.04 volts or 49.9 volts).

(3) Operate the CC TST key to the TST position and hold operated during adjustments [(c)(4) through (e)(4)].

(4) Rotate the CC TST potentiometer cw until the CC TST millivoltmeter indicates 250 millivolts for the 750-ampere generators or 265 millivolts for all other generators.

(5) Rotate the CON CUR H potentiometer ccw until the generator output voltage

decreases 2 volts for the 48-volt plants or 1 volt for the 24-volt plants (as observed on the KS-8039 meter) at the millivolt setting stated in (4).

Note: Due to the interaction between controls, it will be necessary to alternate between the CC TST potentiometer and the CON CUR H potentiometer to obtain the required voltage droop stated in (5) at the required millivolt setting stated in (4).

(g) *Line Compensation Check—*

(1) Operate the LINE COMP NOR-TEST switch to the TEST position and hold operated.

Requirement: The CC TST millivoltmeter should increase to approximately 254 millivolts for 750-ampere generators or 270 millivolts for all other generators.

(2) If correct millivolt reading is obtained, omit (3) and (4). Restore LINE COMP NOR-TEST switch to the NOR position.

(3) If the millivolt reading does not change at all, or if it does not raise to the required reading, rotate the LINE COMP potentiometer slightly ccw, affecting the CC TST millivolt reading in a raise direction.

(4) If the millivolt reading raises higher than the required reading, rotate the LINE COMP potentiometer slightly cw affecting the CC TST millivolt reading in a lower direction.

(5) Restore the LINE COMP NOR-TEST switch to the NOR position.

(6) Return to step (4) of Droop Point CON CUR H adjustment and repeat all steps until the CC TST millivoltmeter changes from 250 to 254 millivolts for the 750-ampere generators or from 265 to 270 millivolts for all other generators when the LINE COMP NOR-TEST switch is operated to the TEST position.

(h) *Check of Droop Point Adjustment—*

(1) Rotate the CC TST potentiometer fully ccw, then slowly rotate it cw until the CC TST millivoltmeter indicates 225 millivolts for 750-ampere generators or 240 millivolts for all other generators.

Requirement: The output voltage remains approximately constant as indicated by the KS-8039 voltmeter.

(2) Continue rotating the CC TST potentiometer until the CC TST millivoltmeter indicates 250 millivolts for 750-ampere generators or 265 millivolts for all other generators.

Requirement: The generator output voltage decreases 2 volts for 48-volt plants or 1 volt for 24-volt plants (voltage droop).

(3) Continue rotating the CC TST potentiometer slowly cw until the generator output voltage decreases to:

- 46 volts for 23 cells
- 24 volts for 12 cells
- 22 volts for 11 cells

During this time the output indicated on the CC TST millivoltmeter should not exceed 275 millivolts for 750-ampere generators or 288 millivolts for all other generators.

(4) Release the CC TST key and rotate the CC TST potentiometer fully ccw.

(i) *CON CUR L Adjustment (G1 Generator Only, Where Generator Cutoff Is Not Provided)—*

(1) Block the CR and CRL relays on the generator control bay operated.

(2) Operate the CC TST key and hold operated during entire adjustment.

(3) Slowly rotate the CC TST potentiometer cw until the CC TST millivoltmeter indicates a load equivalent to 79 percent for 48-volt generators or 77 percent for 24-volt generators. See Table E for millivolt meter readings.

(4) Rotate CON CUR L potentiometer ccw until the generator output drops to 75 percent of its rated output.

Requirement: The generator output voltage drops at least 1 volt.

(5) Release the CC TST key and rotate the CC TST potentiometer fully ccw.

(6) Remove the blocks from the CR and CRL relays.

(j) *Final Adjustments*

(1) Return the generator manual control handwheel to the BAT position.

(2) Restore all keys and switches for normal automatic operation as outlined in Table A.

(3) With the unit on the line and voltage regulating the plant, readjust as required the ADJ VOLTS potentiometer for float voltage.

(4) By removing from the line or reducing the output of other generators, force the unit under test to increase to its full output (constant current high). Be careful not to lower plant voltage below working limits. Adjust ANTI-HUNT 1 potentiometer as required for minimum hunting on CC TST millivoltmeter or SC meter.

G3 THROUGH G10 GENERATORS

4.15 With the keys, switches, and generator manual control handwheel on the generator control bay of the generator to be adjusted positioned as indicated in Table A, check each generator as follows.

A. CB Reverse Current and CC Relay Check

4.16 Check the CB reverse current relay as follows.

(1) Perform preliminary steps as outlined in 4.08(a) through (c).

(2) Operate the NOR-STOP key to the STOP position.

(3) Rotate the generator manual control handwheel fully cw.

(4) Open the generator knife switch.

(5) Block the CC relay operated.

(6) Operate the NOR-STOP key to the NOR position. The motor-generator will rotate cw as viewed from the generator end.

(7) Slowly rotate the generator manual control handwheel ccw.

Requirement: The CB relay operates before 45 volts are reached on the 65-volt generator or before 25 volts are reached on the 33-volt generator (read voltages on the generator control bay voltmeter).

(8) Remove the block from the CC relay.

(9) Rotate the generator manual control handwheel cw until the CA contactor and CB relay release.

4.17 Check the CC relay as follows.

(1) After the CA contactor has released, close the generator knife switch to the 24V or 48V position.

(2) Using the 60-volt dc scale of the KS-14510 volt-ohm-milliammeter, connect the positive lead to the armature contact and the negative lead to the stationary contact of the CA contactor. (Do not obstruct the operation of the contactor or short the contacts of the contactor.)

(3) Slowly rotate the generator manual control handwheel ccw until the meter indicates 1 volt. Then change to the 3-volt scale on the meter and readjust the handwheel to indicate 1 volt.

(4) Reverse the voltmeter leads at the meter. The meter will indicate a reverse deflection. (Do not short or ground the leads while reversing.)

(5) Slowly rotate the handwheel ccw. The CA contactor will operate before the meter indicates 1 volt (that is, before generator voltage is 1 volt higher than the battery voltage).

(6) Disconnect the KS-14510 volt-ohm-milliammeter.

(7) Remove the cover of the AR or AR1 ammeter relay; grasp the insulated lower end of the

low-contact pointer; and move the contact to the extreme left position.

(8) Slowly rotate the handwheel cw, observing a below zero deflection of the AR or AR1 ammeter relay.

Requirement: The CA contactor and CB relay release before the reverse current (below zero reading) reaches 3 to 8 percent of the rated output of the generator.

Caution: Do not permit reverse current to exceed the 8 percent value as excessive reverse current may affect future operation of the CB relay.

(9) Operate the NOR-STOP key to the STOP position.

(10) Open the generator knife switch.

(11) Operate the CONT TEST-NOR key to the NOR position.

(12) Set the AR, AR1, and AR2 relay contact positions as outlined in 4.11(1) and (2).

(13) Restore all keys, switches, and the handwheel for normal automatic operation as outlined in Table A.

(14) Repeat 4.16 and 4.17 on all remaining G3 through G10 generators as required.

B. Motor-Driven Rheostat Adjustments

4.18 To adjust the motor-driven rheostat, proceed as follows.

(1) Operate the NOR-STOP key to the STOP position and allow approximately 2 hours for the generator to cool.

(2) After cooling period, operate the NOR-STOP key to the NOR position.

(3) Operate the LOWER key continuously until the RL relay releases (ALL RESISTANCE IN position).

(4) Operate the RAISE key until the generator is operating at full rated-ampere output at the voltage shown as follows (read voltage by operating VM key on the generator control panel to the BAT position):

- 54.1 volts for 23 cells
- 28.2 volts for 12 cells
- 25.9 volts for 11 cells.

(5) When the generator reaches full output, operate the LOWER key, slowly decreasing the output (allow time for the battery voltage to decrease). Continue operating the lower key until the AR or AR1 ammeter relay just closes its lower contact with the battery voltage shown as follows:

- 48.3 volts for 23 cells
- 25.2 volts for 12 cells
- 23.1 volts for 11 cells.

(6) Operate the NOR-STOP key to the STOP position.

(7) Open the generator knife switch.

(8) With the rheostat arm in the position of (5), set the B limit switch operating lever against the limit switch so that the contacts just open, and then clamp the lever in place. This position of the motor-driven rheostat is the ALL RESISTANCE IN position.

C. OL Relay Adjustments

4.19 To adjust the overload relay, proceed as follows.

(1) Operate the NOR-STOP key to the STOP position.

(2) Rotate the generator manual control handwheel fully cw.

(3) Open the generator knife switch.

(4) The cover must be on the OL relay when adjusting the OLA and OLR potentiometers. Connect the KS-14510 volt-ohm-milliammeter, using the 60-volt scale, to the No. 1 contact of the OL relay and frame ground to observe the

operation of the OL relay. Voltmeter reading indicates the released position.

(5) Move the high contact of the AR or AR1 relay so that it does not make contact when the generator is delivering full load-ampere rating.

(6) Connect a millivoltmeter across the AR or AR1 ammeter relay shunt at the same point as the connections for the winding of the OL relay. An external millivoltmeter with the proper scale, such as the 35-type test set, can be connected to indicate load currents in excess of 100 percent. (See Table E).

Note: If a 35-type test set is used, select a low scale so that the current drawn by the test set does not exceed 20 milliamperes and thus cause calibration error due to wiring resistance. Connect the dc millivoltmeter to the SH+ and SH− test jacks on the voltage regulator (0.3 volt is equivalent to 300 millivolts).

(7) Operate the generator knife switch to the 24V or 28V position.

(8) Operate the TST-NOR and NOR-STOP keys to the NOR position.

(9) Rotate the generator manual control handwheel to raise the output to the full-ampere rating of the generator.

(10) Read the voltage drop on the millivoltmeter, then increase the output until the millivoltmeter indicates 110 percent (258 millivolts for 750-ampere generators or 275 millivolts for all other generators). (See Table E.)

(11) Slowly rotate the OLA potentiometer ccw until the OL relay operates, as indicated by the KS-14510 volt-ohm-milliammeter.

(12) Rotate the generator manual control handwheel to decrease the output indicated on the millivoltmeter to 105 percent of full-load rating. (See Table E.) Observe that the OL relay does not release.

(13) Continue rotating the generator manual control handwheel to decrease the output of the generator until 85 percent is indicated on the millivoltmeter and the OL relay releases. (See Table E.)

(14) If the OL relay does not release at 85 percent of generator rated output, cut the strap between the OLA and OLR rheostats. Then, with the generator at 85 percent of the full rated output, slowly rotate the OLR potentiometer cw until the OL relay releases.

(15) Recheck the operation of the OL relay as follows.

(a) Raise output of generator to 105 percent of full load. OL relay does not operate.

(b) Raise output of generator to 115 percent of full load. OL relay operates.

(c) Decrease output of generator to 105 percent. OL relay remains operated.

(d) Decrease output of generator and check that the OL relay releases at 85 percent or higher.

(16) Operate the NOR-STOP key to the STOP position and disconnect the millivoltmeter and the KS-14510 volt-ohm-milliammeter.

(17) Reset the high contact of the AR or AR1 relay.

(18) Restore all keys, switches, and the handwheel for normal automatic operation as outlined in Table A.

G1 AND G2 RECTIFIERS

4.20 The keys, switches, and circuit breakers on each rectifier, where provided, are set to the normal automatic positions as indicated in Table B. Except for the following adjustments, no further methods of this section for the G1 and G2 rectifiers are required.

(a) The plant voltmeter should indicate a battery float voltage value of:

- 49.9 volts for 23 cells
- 26.0 volts for 12 cells
- 23.9 volts for 11 cells.

(b) If the float voltage is not as specified in (a), adjust the output voltage potentiometer,

as follows on the rectifier to obtain the proper voltage. Allow at least 5 minutes for the battery voltage to stabilize after adjustment.

RECTIFIER	POTENTIOMETER
J86249	* COARSE ADJ VOLTS
J86273	* ADJ VOLTS COARSE
J86295	* ADJ VOLTS COARSE
J86296	* ADJ VOLTS COARSE
KS-15689	* COARSE ADJ VOLTS
KS-19210	VOLT ADJ
KS-19211	VOLT ADJ
KS-19212	VOLT ADJ
KS-19213	VOLT ADJ
KS-19214	VOLT ADJ
KS-19215	VOLT ADJ
KS-19356	VOLT ADJ

* To obtain a finer adjustment of the rectifier output voltage, adjust the ADJ VOLTS FINE or ADJ VOLTS potentiometer on the rectifier.

(c) After the proper float voltage adjustment is obtained, operate the GEN REG FLOAT-CHG key on the main control board of the plant to the CHG position.

(d) The plant voltmeter should indicate a battery charge voltage of:

- 50.6 volts for 23 cells
- 26.7 volts for 12 cells
- 24.6 volts for 11 cells.

If the charge voltage is not as specified, adjust the CHG or CHG ADJ potentiometer on the rectifier to obtain the proper voltage.

(e) After the proper charge voltage adjustment is obtained, restore the GEN REG FLOAT-CHG key on the main control board to the FLOAT position.

(f) Restore the rectifier NOR-OFF, RECT OFF-NOR, or OFF-NOR switch to the OFF position.

(g) ***Ammeter Relay Adjustment*** (See 1.15)—For the G1 and G2 rectifiers listed in (1) through (3), adjust the AR1 and AR2 ammeter relays in each rectifier to close their contacts as follows.

(1) J86249 or KS-15689 Rectifier—Adjust the AR1 ammeter relay to close its low contacts at 5 percent and its high contacts at 90 percent of the rated output current capacity of the rectifier.

(2) J86273, J86295, J86296, or KS-19214 Rectifier—Adjust the AR1 ammeter relay to close its low contacts at 2 percent and its high contacts at 100 percent of the rated capacity of the rectifier.

(3) KS-19212 or KS-19215 Rectifier—Adjust the AR1 ammeter relay to close its low contacts at 5 percent and its high contacts at 95 percent of the rated capacity of the rectifier.

(4) Adjust the AR2 ammeter relay in the G1 and G2 rectifiers to close its low contacts at 25 percent and its high contacts at 75 percent of the rated output current capacity of the rectifier.

(h) ***Current Limiting Circuit and Load Signal Limit Adjustments***—KS-19210, KS-19211, KS-19213, and KS-19356 Rectifiers—If a KS-19210, KS-19211, KS-19213, or KS-19356 rectifier is provided as the G1 and/or G2 unit, adjust the low and high current limiting circuit to limit at 5 and 95 percent of the rated output current capacity of the rectifier and the low and high load signal limits at 25 and 75 percent in accordance with Bell System Practices covering the operating methods for the rectifier.

G3 THROUGH G10 RECTIFIERS

4.21 Except for the following adjustments, no further adjustments other than those covered in the Bell System Practices for operating methods for the rectifier are required for the G3 through G10 rectifiers.

(a) ***On G3 through G10 rectifiers, other than KS-19210, KS-19211, KS-19213, and KS-19356 rectifiers,*** adjust the AR or AR1 ammeter relay to close its low contacts at 2 percent and its high contacts at 100 percent of the rated output current capacity of the rectifier (see 1.15).

(b) ***On G3 through G10 KS-19210, KS-19211, KS-19213, and KS-19356 rectifiers,*** set the minimum and maximum load signal limits at 2 and 100 percent, respectively, of the rated output

current capacity of the rectifier in accordance with the Bell System Practices for operating methods for the rectifier.

G-ZERO RECTIFIERS

4.22 Each G-zero rectifier provided is ready for operation as specified in the Bell System Practices covering the operating methods for the rectifier. The keys, switches, and circuit breakers on each rectifier and/or charge bay assembly, where provided, are set to the normal automatic position as indicated in Table B. Then, if necessary, check the output voltage to float the battery at 2.17 volts per cell as indicated by the plant voltmeter on the battery control board. Perform the check during a period when the amount of office load is greater than 50 percent of the rated output current capacity of the rectifier to be checked.

(1) Shut off the G2 charging unit, if provided.

(2) Check that the rectifier is operating at approximately 50 percent of its rated output current capacity.

(3) Check whether the plant voltmeter indicates a battery float voltage of:

- 49.9 volts for 23 cells
- 26.0 volts for 12 cells
- 23.9 volts for 11 cells.

If not, adjust the rectifier in accordance with the Bell System Practices covering the operating methods for the rectifier.

(4) If only one G-zero rectifier is provided, no further adjustment of the rectifier is required. Restore the G2 charging unit to service.

(5) If more than one G-zero rectifier is provided, shut off the adjusted rectifier and repeat the procedure in (1) through (3) as required.

(6) After adjusting each of the additional rectifiers, restore the G2 charging unit to service.

Note: The ideal adjustment would be to have each G-zero rectifier share the load equally but, because of the extreme accuracy of the voltage regulating circuits, equal load sharing is not practical. Adjust the G-zero units when the rectifiers are in the voltage regulating mode.

TWO-STEP MOTOR-GENERATOR

4.23 A replaced 48-volt motor-generator taken from either G1 or G2 position may be reconnected as a 2-step current unit in any position from G3 through G10. Two of these units may be used in the plant. Normally, a 2-step unit will connect at 60 percent and step to 100 percent when the voltage regulated unit (G1 or G2) reaches full load and again reduces to 60 percent when the voltage regulating unit reaches one quarter of the rated output. This arrangement is used only when reuse of the motor-generator set is intended and G1 and G2 is replaced with a regulated 302A type rectifier. Normally, additions to plants for increased capacity use G-zero circuitry with voltage regulated 302B type rectifiers.

Note: The G1 or G2 2-step machine monitors its own output voltage; therefore the ADJ VOLTS potentiometer on the regulator should be set about 1 volt higher than the float voltage. After the machine connects to the load, the CUR REG potentiometer is inoperative. The CHG potentiometer may then be used in addition to the ADJ VOLTS potentiometer as a vernier adjustment.

(1) The following adjustments will change from the original setting (Table A) when the unit was either the G1 or G2 unit.

(a) Set the CHG potentiometer for the following indications.

- 51.1 volts for 23 cells
- 26.9 volts for 12 cells
- 24.7 vols for 11 cells

(b) Adjust the CON CUR L potentiometer for 60 percent indication.

(2) If there is an operating current-controlled unit after the 2-step current unit, operate the NOR-STOP key on the 2-step unit to the NOR position. The 2-step unit will start and assume the load of the current-controlled unit which will shut down. If this load is not 60

percent of the rated output of the unit, place a current-controlled unit immediately preceding the 2-step unit on the TEST position and manually decrease its output to shift the load to the 2-step unit.

(3) If there is no operating current-controlled unit after the 2-step unit, the unit will not start. Place a current-controlled unit immediately preceding the 2-step unit on the TEST position and manually decrease its output until the voltage regulating G1 or G2 unit goes to full output. This will start the 2-step unit and assume part of the load of the voltage regulating unit.

(4) If there is not a current-controlled unit preceding the 2-step unit and the office load is greater than the G1 capacity, the G2 unit will be running and the G1 unit will be either in constant current low (75 percent) or constant current high (100 percent).

(a) If the G1 unit is in the low mode, mark the setting of its CCL potentiometer and then rotate it ccw to reduce the output of G1 and increase the output of G2. When G2 reaches full load, the G1 unit will increase its output to 100 percent, the 2-step unit will start, and the G2 unit will drop back.

(b) If the G1 unit is in the high mode, mark the setting of the CCH potentiometer and then rotate it ccw to reduce the output of G1 and increase the output of G2. When G2 reaches full load, the 2-step unit will start and the G2 unit will drop back.

(5) Adjust the CCL potentiometer on the 2-step unit for exactly 60 percent of load.

Note: If the CCL potentiometer does not affect the amount of load, adjust the CHG potentiometer and/or the ADJ VOLT potentiometer.

(6) Operate the LINE COMP NOR-TEST switch on the VOLTAGE REGULATOR to the TEST position and hold operated for about 3 seconds. The output current should increase 5 percent.

(a) If the output current decreases, rotate the LINE COMP NOR-TEST potentiometer ccw, then rotate the CCL potentiometer cw for the 5 percent increase.

(b) If the output current increases, rotate the CCL potentiometer ccw, then rotate the LINE COMP NOR-TEST potentiometer cw for the 5 percent increase.

(7) Recheck the adjustment by operating the LINE COMP NOR-TEST switch for about 3 seconds.

(8) Shift the load to the G2 unit until it reaches full output. The OX relay in the 2-step unit operates and the output will rise to 100 percent, with the G2 unit dropping back to 40 percent. Increase the load on G2 by one of the methods previously outlined in (2) through (4). The CCH potentiometer on the 2-step unit may have to be adjusted for the 100 percent load point.

(9) Reduce the output of the G2 unit to 25 percent and observe that the 2-step unit decreases to the 60 percent point. This is accomplished by manually increasing the output of the current-controlled units, or if the G1 unit had been reduced with the CCH potentiometer, turn the CCH potentiometer on the G1 unit cw to the original marked position.

(10) Reduce the output of the G2 unit to zero and observe that the 2-step unit shuts down. This is accomplished by manually picking up the load on the units preceding the 2-step unit.

(11) Restore the potentiometers in the G1 unit to the normal marked positions and restore the plant to normal automatic operation.

EMERGENCY CELL TRICKLE CHARGERS

4.24 Adjust the output voltage of the KS-15678 L18 rectifier in accordance with Section 169-265-301 to float the emergency cells at 2.17 volts per cell. When adjusting the output of the KS-15678 L18 rectifier, simultaneously adjust the autotransformer on each J86220 rectifier so that the current output of the KS-15678 L18 rectifier is approximately 2 amperes. Rotating the autotransformer cw or ccw will decrease or increase respectively, the output current of the KS-15678 L18 rectifier.

FUSE ALARMS

4.25 Test all fuse failure alarms and indicators periodically as covered in 4.26 through 4.29 and Table F. The operator should analyze the test indication shown in Table F prior to applying the test voltage or test ground to ascertain whether the test would shut down essential equipment. If such is the case, it may be desirable to postpone the tests until a lighter load period.

4.26 *35-Type Fuse:* Test 35-type fuse alarms and indicator lamps using the W1AF cord. The test can usually be made by connecting the test battery or ground to the alarm bar or stud under the fuse. Note that the alarm operates when the connection is made.

4.27 *70-Type Fuse:* Test the 70-type fuse alarm as follows.

Note: The later design of fuse caps for 70-type fuses contain an aperture or slot adjacent to the hole for the colored bead, providing access to the alarm test point (see Fig. 8). The new P-344900 fuse cap assembly is for use on non-modular fuse block (18A, 19A, and 21A) and the P-11F667 fuse cap assembly is for use on modular fuse blocks (22 through 27-type). This style cap should be used when testing fuse alarms.

Caution: Due to possible fuse and/or equipment damage, the former procedure of testing fuse alarms by inserting a 411C tool or a 266C tool (wire burnisher) held in a 265C tool (contact burnisher holder) beside the colored bead on older fuse caps without the slot or aperture, should be discontinued.

(1) Prepare the alarm test cord by connecting one end of the W1AY testing cord to the 141 cord tip and 720A voltage pickup tool. (The KS-6278 connecting clip may be used to replace the 720A voltage pickup tool). On the opposite end of the W1AY testing cord, connect the 411C test tool (see Fig. 9).

(2) Install the 720A voltage pickup tool in a spare 70-type fuse position. (If the 720A tool is not available, obtain the same polarity voltage supply by connecting a KS-6278 connecting clip with the W1AY testing cord to the positive or negative bus bar.

Caution: Test only the fuses associated with the same polarity voltage supply.

(3) With the tip of the 411C tool (attached to the battery connected W1AY cord) touch the exposed alarm test point on the fuse cap for one fuse.

Note: Tests made at the individual fuse cap check the contact between the fuse cap and the alarm bus bar. On modular-type fuse blocks, there is also an aperture in the corner of the block to test directly to the alarm bus bar (see Fig. 8).

Requirement: The alarm operates when the connection is made.

(4) Remove the 411C tool from the fuse cap.

Requirement: All alarms are silenced.

(5) Repeat (3) for each fuse.

(6) Remove the 720A tool from the spare fuse position. (If the KS-6278 connecting clip is used, disconnect the clip from the bus bar.)

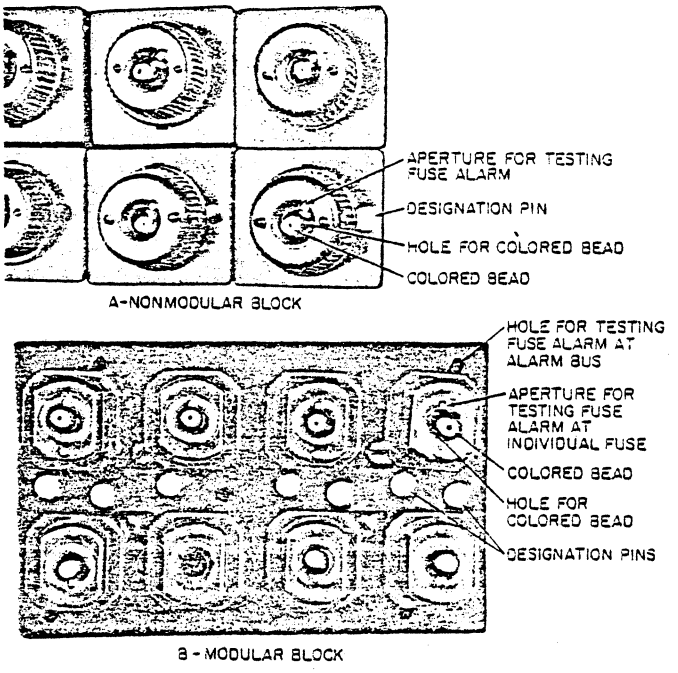
4.28 *Fuse Alarms—Alarm Fuse Shunting a Larger Fuse:* Remove the alarm-type fuse. With the W1AY cord equipped with two 411C test picks, connect one and then the other alarm fuse terminal to the fuse alarm stud or bar. Note each time that the alarm operates. Replace the alarm-type fuse.

4.29 *Fuse Alarms—Circuits Supplied Through an Alarm-Type Fuse:* Connect one test pick of the W1AY cord to the terminal at the side of the fuse. Momentarily connect the other test pick of the cord to the associated alarm stud or bar. Note that the alarm operates.

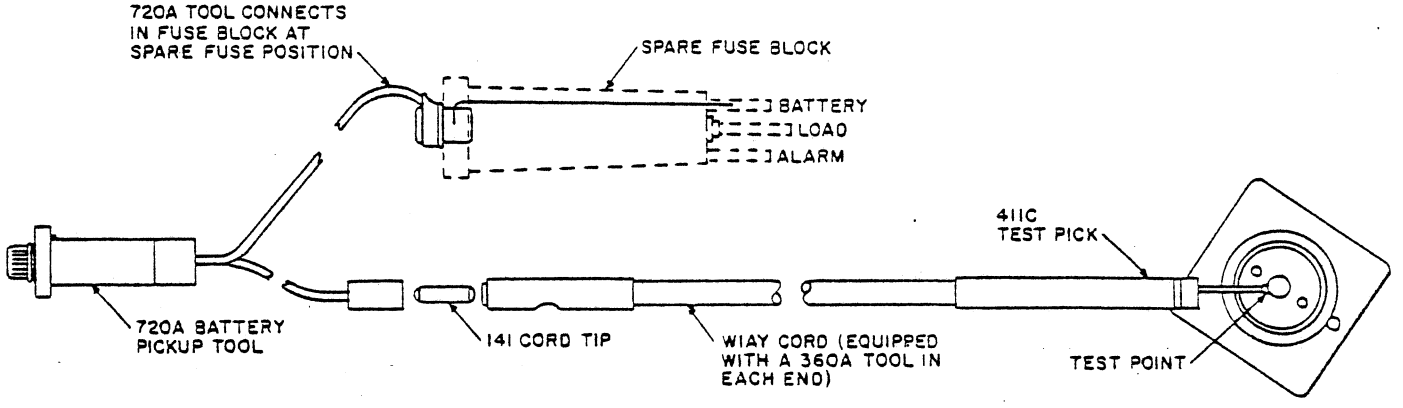
CHARGING UNIT FAILURE ALARM

4.30 *G1 Through G10 Charging Units:* Each charging unit should be checked periodically for the associated failure alarms as follows.

(a) If the charging unit is operating, remove it from service as described in 3.09 and 3.11



◗Fig. 8—Typical 70-Type Fuse Arrangement◖



◗Fig. 9—Fuse Alarm Testing Cord-Tool Connection◖

through 3.19, but do not disconnect the unit from the plant battery.

(b) Carefully remove the ac input supply fuses for the unit or operate the associated switch or circuit breaker to its OFF position.

(c) If the unit to be checked is a rectifier, restore the keys and switches on the unit to the positions indicated in Table B and operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, or POWER ON-POWER OFF switch to the NOR, ON, or POWER ON position. If the unit is a generator, restore the keys and switches on the generator control bay to the position indicated in Table A.

(d) Block operated the relay for the unit to be checked as follows.

(1) G1 Unit—With the generator cut off, block operated the RS2 relay in the charge control circuit of the plant. Without the generator cut off, it is not necessary to block any relay.

(2) G2 through G10 Units—Block operated the corresponding ST relay in the charge control circuit of the plant.

(e) The GEN FAIL, RCT FAIL, or RECT FAIL lamp on the unit under test will light. After a delay of about 3 minutes, the GEN FAIL lamp on the main control board and the PWR lamp in the emergency engine room on the main control board will light.

(f) Shut off the GEN FAIL and PWR lamps and the audible alarm by operating the ACO key on the main control board. The GEN FAIL GD lamp on the main control board will light.

(g) When the check is completed, remove the block from the RS2 or ST relay. Operate the NOR-OFF, RECT OFF-NOR, OFF-NOR, NOR-STOP, or POWER ON-POWER OFF switch to the OFF, STOP, or POWER OFF position. Remount the ac supply fuses or operate the ac supply switch or circuit breaker to restore the ac power to the unit. Then restore the unit to service in accordance with 3.09 through 3.19.

(h) *G1 and G2 Charging Units Provided With CC Test Circuit*—Shutdown of the G1 or G2 unit due to overload should also be checked as follows.

(1) Operate CC TST or TEST key to the TST or TEST position.

(2) Rotate CC TST or TEST potentiometer cw until overload (OL or OLA) relay operates and causes the unit to shut down.

Note: If the unit reaches 150 percent of its rated output without shutting down, stop the unit by operating the NOR-OFF, RECT OFF-NOR, OFF-NOR, NOR-STOP, or POWER ON-POWER OFF switch to the OFF, STOP, or POWER OFF position and check the overload relay circuit of the unit.

(3) The RCT FAIL, RECT FAIL, or GEN FAIL lamp of the unit under test should light.

(4) After a delay of about 3 minutes, the GEN FAIL lamp on the main control board and the PWR lamp in the emergency engine room will light, and the minor alarm will sound.

(5) Operate the ACO key on the main control board to shut off the audible alarm and extinguish the GEN FAIL and PWR lamps. Operation of the ACO key will light the GEN FAIL GD lamp on the main control board.

(6) Restore the CC TST or TEST potentiometer to the extreme ccw position and the CC TST or TEST key to the NOR position to restore the unit to normal operation.

4.31 *G-Zero Rectifiers:* Periodically check the rectifier failure alarm for each G-zero rectifier as follows.

(a) Shut off the rectifier to be checked by operating the rectifier NOR-OFF, OFF-NOR, or POWER ON-POWER OFF switch to the OFF or POWER OFF position.

(b) Restore the rectifier to service by operating the NOR-OFF, OFF-NOR, or POWER

ON-POWER OFF switch to the NOR or POWER ON position and observe that the RECT FAIL lamp on the rectifier lights and remains lighted until the rectifier is supplying load.

(c) After checking the alarm for each rectifier, apply ground to the CMD or RFA terminal on one of the G-zero rectifiers as covered in (d) to check the rectifier failure alarm circuit of the plant.

(d) Using the W1AF cord equipped with one 411C test pick and one 365 connecting clip, apply ground to the CMD or RFA terminal on one of the G-zero rectifiers. After a delay of about 3 minutes, the GEN FAIL lamp on the main control board and the PWR lamp in the emergency engine room will light, and the minor alarm will sound. Operate the ACO key on the main control board to extinguish the lamps and silence the alarm. Operation of the ACO key will light the GEN FAIL GD lamp on the main control board. Remove the ground to extinguish the lamp.

VOLTAGE CONTROL ALARMS

4.32 Periodically check the voltage alarm circuits in accordance with 4.33 through 4.37. The following procedures are common to both the 24- and 48-volt plants.

4.33 ***Test Set Connections to High-, Low-, and Float-Voltage Alarms:*** Set the locking levers of the No. 1 through No. 4 keys on the 35-type test set to the open position. Move all resistance sliders to the extreme right position. Remove the connection on the center contact of each voltage relay as it is tested. Using the 2W17A cord with the 365 clips, connect the T and R terminals of the 35-type test set across the test link of the voltage relay being tested (see the circuit requirements table for test link). Connect the R terminal of the test set to the positive G side of the test link.

(a) Position the controls of the 35-type test set as follows:

CONTROL	POSITION
BAT & GRD CO Key	Operated
REV Key	Normal
VM Key	Normal
G Switch	Open

Connect dry cells (in series) to BAT and GRD terminals of the test set as required (estimate 1 1/2 volts per cell) to operate the voltage relay to its high contact (see circuit requirements table). Connect the GRD terminal of the test set to the positive terminal of the dry cells and connect the BAT terminal of the test set to the negative terminal of the dry cells.

(b) Close the locking lever of the No. 3 key and move the No. 3 resistor slides to their extreme left position. Close all resistance knife switches to remove all fixed resistance. Under this condition, the test set has its least resistance and the dry-cell battery is out of the circuit.

(c) Place the test set into the circuit by carefully removing the test link associated with the voltage relay under test. Care should be taken not to open the circuit through the voltage relay or to change the current flowing to cause any violent operation of the relay as this may prevent a case of contact trouble from being detected in this test.

4.34 ***High-Low Voltage (HLV) Relay:*** Test the low voltage and high voltage contacts of the HLV relay in the following manner.

(a) *Low Voltage Test*

(1) Connect the KS-8039 volt-milliammeter, set to the 30 VOLTS DC range for the 24-volt plant or set to 75 VOLTS DC range for the 48-volt plant, across the terminals of the HLV relay.

(2) Slowly move the No. 3 sliders to the right. This introduces resistance and lowers the voltage across the low contacts of the HLV relay. Note the approximate point at which the low-voltage alarm should come in (see circuit requirement table) and the

audible and visual signals operate (EM CELL SW lamp and major alarm).

Note: If the voltage across the HLV relay is not lowered enough to operate the low contacts of the HLV relay when both No. 3 sliders have reached the extreme right, slide them fully back to the left. Then cut in 25,000 ohms by opening one or more of the No. 3 knife switches and slowly moving the No. 3 sliders to the right.

(3) Operate the BAT & GRD CO key on the 35-type test set to its normal position.

(b) *High Voltage Test*

(4) Move the No. 3 sliders to their extreme right position. From the reading on the KS-8039 volt-milliammeter, determine whether the voltage has been reduced sufficiently to add the test battery without causing the high contact to make (see circuit requirements table). Estimate the test battery voltage at 1 1/2 volts per cell.

Note: If the voltage has not been reduced sufficiently, add additional resistance by opening one or more No. 3 knife switches as required to get the necessary reduction in voltage.

(5) Slowly move the No. 3 sliders toward the left. This removes resistance from the circuit and raises the voltage across the high contacts of the HLV relay. Note the approximate point at which the high-voltage audible and visual signals operate (EM CELLS SW lamp and major alarm).

Note: If the voltage across the HLV relay is not raised enough to operate the high contacts of the HLV relay when both No. 3 sliders have reached the extreme left, slide them fully back to the right. Then cut out 25,000 ohms by closing one or more of the No. 3 knife switches and slowly move the No. 3 sliders to the left.

(6) Operate the BAT & GRD CO key on the 35-type test set to the operated position.

(7) Replace the test link to the voltage relay and replace the connection on the center contact of the relay.

(8) Disconnect the 35-type test set and remove the KS-8039 volt-milliammeter.

4.35 ***Float-Voltage (FV) Relay:*** Using the method described in 4.34(a), check the low-voltage alarm contact of the FV voltage relay. When the low-voltage contact closes, the PWR lamp in the emergency engine room will light and a minor alarm will sound. If an HV timer is provided, these signals will operate after a 3-minute delay. To check the dc timed float alarm, if provided, repeat the low-contact closure of the FV voltage relay with the HV1 relay blocked nonoperated. In about 3 minutes the V FLOAT ALM lamp will light. Remove the HV1 relay block. Using the method described in 4.34(b), check the high-voltage alarm contact of the FV voltage relay. Operation of alarms for high-contact closure is the same as that for low-contact closure. When the tests are completed, operate the BAT & GRD CO key on the test set and reconnect the test link to the voltage relay. Then remove the test equipment.

4.36 ***High-Voltage (HV) Relay:*** Check the low- and high-voltage contacts of the HV voltage relay as follows.

(a) Check the low-voltage contacts, using the method covered in 4.34(a). This will simulate a failure of the VC fuse and cause shutdown of the G1 and G2 units or of all charging units, according to the option furnished in the plant. Do not make this test when temporary loss of the G1 and G2 charging units will cause service reaction.

(b) Check the high-voltage contacts, using the method covered in 4.34(b) and observe the following.

(1) The VCO lamp (24V or 48V) on the main control board will light. If the HV timing motor is provided, the VCO lamp will light after a 3-minute delay.

(2) G1 and G2 or all charging units will shut down according to the option furnished in the plant.

(3) The PWR lamp in the emergency engine room will light and the major alarm bell should sound.

(c) When the tests are completed, operate the BAT & GRD CO key on the test set and reconnect the test link to the voltage relay. Then remove the test equipment.

(d) Operate the VCO RLS key (24V or 48V) to return the circuit to normal.

EMERGENCY CELL ALARM LAMP

4.37 In accordance with 3.09 through 3.19, where provided, shut off one or more of the G-zero rectifiers, the G3 through G10 charging units, and G1 and G2 charging units in that order, to lower the plant discharge voltage slightly below the float voltage and to light the FLOAT ALM lamp. The emergency cell switch in the discharge circuit will operate to the GR1 position and light the −V EM CELLS lamps. Upon restoring the charging unit(s) to regular operation, the emergency cell switch will return to normal. With the float alarm retired, the RLS key may be depressed to extinguish the −V EM CELLS lamp.

Note: The lighted −V EM CELLS lamp leaves a record of emergency cell usage to indicate possible need of charge by load.

COUNTERCELL VOLTAGE CONTROL ALARMS

4.38 The countercells are used to provide 24 volts from a 48-volt plant when the current requirement for 24-volt supply does not exceed 100 amperes. Periodically check the operation of the countercell switching circuit as covered in 4.39 and 4.40.

4.39 *Voltage Check*

(a) Read the 24V DISCH voltage on the plant voltmeter.

(b) Block operated the H relay just long enough to check that one countercell has been added to the circuit (G1 contactor operates) and the voltage has fallen accordingly. Remove block. The circuit will automatically return to normal.

4.40 *Alarm Check*

(a) Insulate the top contacts 4 and 5 of the L relay and the top contacts 1 and 2 of the H relay in the countercell switching circuit.

(b) Block operated the H relay.

(c) Keep the relay blocked operated for about 3 minutes. The −V CEMF CELL lamp will light; the major alarm will sound; and the PWR lamp in the emergency engine room will light.

(d) Remove the block from the H relay and block operated the L relay.

(e) Wait for about 3 minutes until the indications described in (c) are observed.

(f) Remove the block from the L relay and the insulation from the L and H relay contacts.

ALARM MULTIPLE

4.41 The alarm multiple should be checked to be sure that major and minor alarms from other locations in the building will give corresponding audible alarms in the power room when the ALM MULT key, located on the main control board, is in the ON position.

5. TROUBLES

5.01 Plant troubles listed are only those in connection with the charge control circuit which connects or disconnects units of charging equipment and the controls which switch countercells or emergency cells in or out of the discharge circuit. Troubles in units of equipment, such as motor-generator sets, rectifiers, and regulators, are covered in the respective Bell System Practices.

5.02 The generator rheostats are adjusted at the time of installation. Rheostats may require subsequent readjustment where generator-rated output current cannot be maintained. Other than this, generator rheostats should not require readjustment unless disturbed, such as the replacement of a rheostat or parts of a rheostat.

5.03 *Motor-Driven TD1 and TD2 Timers:* If no instructions are given, no maintenance of KS-8560 motor-driven timers is required. The timers should be replaced if they stick in the operated position or if the operating time is less than 1-1/2 minutes or more than 4 minutes.

Caution: ***Before replacing a battery charge or emergency cell charge fuse, shut off all of the charging units by operating the NOR-OFF, RECT OFF-NOR, OFF-NOR, NOR-STOP, ON-OFF, or POWER ON-POWER OFF switch to the OFF, STOP, or POWER OFF position to prevent the generators or rectifiers from starting when the blown alarm fuse is removed. After replacing the charge fuse and alarm fuse, restore the keys to their NOR or ON position, starting with the G1 and G2 charging units.***

The following list shows all alarm lamps in alphabetical order together with their functions. Action to be taken is also indicated in some cases.

LAMP	FUNCTION AND ACTION
ABS FA	Alarm battery supply fuse alarm (see notes).
CBS FA	Control battery supply fuse alarm and voltage control fuse failure (see notes).
CEMF CELL	Countercell switching circuit trouble.
CHG & MISC FA	Charge and miscellaneous fuse alarm (see notes).
DISCHG FA	Discharge fuse alarm (see notes).
EM CELL	Indicates emergency cell switch has operated.
EM CELL SW	Emergency cell switch alarm.
ENG RECT FAIL	Indicates failure of rectifier used to charge emergency diesel engine batteries.
FLOAT	Float-voltage alarm. Operate ACO key.
FLOAT VOLT GD	FLOAT VOLT alarm has been cut off by operation of ACO key.
GEN FAIL (on the generator control bay)	Control fuse or charging unit failure.
GEN or RECT FAIL (on main control board)	Charging unit failure. Operate ACO key.
GEN FAIL GD	GEN FAIL alarm has been cut off by operation of ACO key.
GEN PAN FA	Generator panel fuse alarm. Look for blown fuse on generator panels. If no GEN FAIL lamp is lighted, check panel of first non-operating machine (see notes).
PABS FA	Power alarm battery supply fuse alarm (see notes).
PWR	Trouble in power room.
RCT or RCT FAIL (on the rectifier)	Rectifier failure.
VCO	High central office voltage. Operate VCO RLS key to cancel alarm. If alarm comes in again, check for cause.

Note 1: Where alarm fuses are in parallel with supply fuses, replace the blown supply fuse first and then the alarm fuse.

Note 2: Some plants have a DFL lamp at the tip of each battery discharge fuse panel which gives a visual signal of any fuse failure in that bay.

5.04 ***Trouble Chart:*** The troubles and possible causes listed as follows are not necessarily all-inclusive but are merely indicative of some of the difficulties that may be encountered when the plant is not operating normally. In the case of visual alarms, the operator can tell the trouble location by the designation of the lamp on the generator bay, rectifier bay, or main control board. In the case of fuse alarms, Table F will assist the operator in locating the difficulty.

TROUBLE	POSSIBLE CAUSE
(a) Battery float voltage high or low	ADJ VOLTS potentiometer on voltage regulator and exciter for G1 or G2 generator out of adjustment. Tube failure in voltage regulator and exciter.
	AUTO-MAN key on main control board in MAN position.
	Failure of motor-driven rheostat in G1 or G2 generator set.
	Voltage adjusting potentiometer on G1, G2, or G-zero rectifier out of adjustment.
	Battery trouble.
(b) Battery float voltage high	FLOAT-CHG key on main control board in CHG position.
(c) Battery float voltage low	Motor-generator or rectifier fails to start.
	Load exceeds connected rectifier and/or generator capacity.
	Motor-generator or rectifier shut off.
	Charging units stopped (see note). C, CHG, or VM & VR fuse blown.
	Power failure or blown ac fuse.
(d) Discharge voltage high	Control failed to switch emergency cells out of circuit.
(e) Discharge voltage low	Control failed to switch emergency cells into circuit.
(f) 24-volt discharge bus voltage high or low when obtained from a 48-volt plant through countercells	Control circuit failed to switch countercells in or out.
(g) Rectifier has no output	Check for trouble in rectifier as covered in respective BSP Section.
(h) Emergency cell-switch alarm operates with battery voltage within proper limits	Trouble in emergency cell switch control circuit.
(i) Battery voltage low and emergency cell switch does not operate	Emergency cell MAN-AUTO switch on main control board in MAN position.
	Trouble with EM CELL relay.
(j) Discharge fuse alarm operates	Check for operated discharge fuse.
(k) Charge and miscellaneous discharge fuse alarm operates	Fuse blown, either battery or emergency cell charge, rectifier charge fuse, or miscellaneous discharge fuse (see caution under 5.03).
(l) Alarm battery supply fuse alarm or control battery alarm operates	Either alarm battery supply or control battery supply fuse on main control board blown.
(m) Generator panel fuse alarm operates	Fuse blown on generator panel (see note).

TROUBLE	POSSIBLE CAUSE
(n) General failure alarm operates and all charging units are stopped	Service failure or blown fuse in main supply to power service distributing cabinet.
(o) Generator failure alarm operates with one generator stopped when it should be running	Blown service fuse or defective generator motor starter or start control circuit. If the start control circuit is defective, the generator should start when the TEST key on current-controlled sets or the CONT key on voltage-controlled sets is operated to the TEST position with STOP key in NOR position. Shutdown due to overload (see note).
(p) Generator starts but does not build up sufficient voltage to connect to load	No field or defective regulation circuit.
(q) Generator takes too long to connect to load	FR relay on current-controlled generator operates at too low voltage or does not make proper contact to short-circuit field rheostat.
(r) Set operates properly but alarm comes in too quickly	Faulty time delay relay in alarm circuit.
(s) Rectifier not operating when it should be operating	Blown service fuse or AC line contactor not operated (see note). Trouble in rectifier. Check rectifier as covered in respective BSP section. If charge control circuits are defective, the rectifier can be operated manually as described in 3.19 through 3.23.

Note: Charging units that have shut down will not restart until the NOR-OFF, RECT OFF-NOR, OFF-NOR, STOP-NOR, ON-OFF, or POWER ON-POWER OFF switch has been switched to OFF, STOP or POWER OFF and then restored to NOR, ON, or POWER ON.

TABLE F

FUSE FAILURE ALARM INDICATIONS

FUSE LOCATION	FUSE DESIGNATION	TEST PROCEDURE	INDICATION
Charging Generators 1 and 2 — 24-volt Circuit Breaker Panel	GEN CONT	Place 24 volts on alarm stud.	Note 1
	CHG FA	Place GND on alarm stud.	Note 1*
	C	Place 24 volts on alarm stud.	Note 1*
	CBA1	Place 24 volts on EM CELL auxiliary contact.	EM CELL lamp lights
	CBA2	Place 24 volts on BAT auxiliary contact.	BAT lamp lights
	VM & VR	Place 24 volts on alarm stud.	Note 1*
Charging Generators 1 and 2 — 48-volt Circuit Breaker Panel	GEN CONT	Place 48 volts on alarm stud.	Note 1
	CHG FA	Place GND on alarm stud.	Note 1*
	C	Place 48 volts on alarm stud.	Note 1*
	CBA1	Place 48 volts on EM CELL auxiliary contact.	EM CELL lamp lights
	CBA2	Place 48 volts on BAT auxiliary contact.	BAT lamp lights
	VM & VR	Place 48 volts on alarm stud.	Note 1*
Charging Generators 3 to 10 — 24 volts	GEN CONT 6.25A	No test required.	None
	GEN CONT 1/2A	Place 24 volts on alarm stud.	Note 1
	CHG FA	Place GND on alarm stud.	Note 1
	C	Examine visually.	None
	CBA1	Place 24 volts on EM CELL auxiliary contact.	EM CELL lamp lights
	CBA2	Place 24 volts on BAT auxiliary contact.	BAT lamp lights
	VM	Place 24 volts on alarm stud.	Note 1
Charging Generators 3 to 10 — 48-volts	GEN CONT 6.25A	No test required.	None
	GEN CONT 1/2A	Place 48 volts on alarm stud.	Note 1
	CHG FA	Place GND on alarm stud.	Note 1
	C	Examine visually.	None
	CBA1	Place 48 volts on EM CELL auxiliary contact.	EM CELL lamp lights
	CBA2	Place 48 volts on BAT auxiliary contact.	BAT lamp lights
	VM	Place 48 volts on alarm stud.	Note 1
Main Control Board (see Note 9)	24V CBS Strip	Place 24 volts on alarm bar.	Note 2
	48V CBS Strip	Place 48 volts on alarm bar.	Note 2
	PARS Strip(s)	Place test voltage on alarm bar. Use 24 volts on 24-volt plant.	
		Use 48 volts on 48-volt and combined plants.	Note 3
	24V REG VC	Place 24 volts on alarm stud.	Note 2
	24V REG G1	Place 24 volts on alarm stud.	Note 2 — Transfer to Charging Unit 2
	24V REG G2	Place 24 volts on alarm stud.	Note 2 — Transfer to Charging Unit 1
	48V REG VC	Place 48 volts on alarm stud.	Note 2
	48V REG G1	Place 48 volts on alarm stud.	Note 2 — Transfer to Charging Unit 2
	48V REG G2	Place 48 volts on alarm stud.	Note 2 — Transfer to Charging Unit 1

* Set will not restart until NOR-STOP key has been operated to STOP and returned to NOR.

TABLE F (Cont)

FUSE LOCATION	FUSE DESIGNATION	TEST PROCEDURE	INDICATION
Battery Control Board and Emergency Cell Control Panel (see Note 4)	BAT CHG XA EM CELL CHG XA EMC G1 15A EMC G2 15A EMC G1 15A EMC G2 15A REG — 15A EM CELL SW CONT A and B EMC VM 3A VM 3A	No test required.	None A reading indicates fuse is not blown.
	BAT CHG 1 2A EM CELL CHG 1/2A EMC G1 1 2A EMC G2 1 2A EMC G1 1 2A EMC G2 1 2A REG 1 2A EM CELL SW CONT A and B 1/2A	On 24-volt plant, place 24 volts on alarm stud. On 48-volt plant, place 48 volts on alarm stud.	Note 5 Note 5 Note 6 Note 6 Note 6 Note 6 Note 7 Note 7
24-volt Fuses	CO FIRE DRILL 24VR RING PWR BD 24V CBS EMG ALM PABS ABS	Place 24 volts on alarm stud. Place 24 volts on alarm stud. Place 24 volts on alarm stud. Place 24 volts on alarm stud. Place 24 volts on alarm stud. Place 24 volts on alarm stud. Place 24 volts on alarm stud.	Note 7 Note 7 Note 7 Note 7 Note 7 Note 8 Note 8
48-volt Fuses	EMG ALM 24V CEMF RING PWR BD 48V CBS PABS ABS	Place 48 volts on alarm stud. Place 48 volts on alarm stud. Place 48 volts on alarm stud. Place 48 volts on alarm stud. Place 48 volts on alarm stud. Place 48 volts on alarm stud.	Note 7 Note 7 Note 7 Note 7 Note 8 Note 8

Notes:

1. GEN PAN FA lamp lights on main control board; PWR lamp in emergency engine room lights; minor alarm bell rings; associated generator stops and transfers control to next set.
2. CBS lamp lights on main control board; PWR lamp in emergency engine room lights; major alarm bell rings.
3. PABS FA lamp lights on main control board; rings alarm battery supply signal bell.
4. All fuses shown do not appear on all plants. Check those which apply to the plant being checked.
5. GR relay operates to stop generators 1 and 2.
6. CHG & MISC lamp lights on main control board; PWR lamp lights in emergency engine room; minor alarm bell rings.
7. DISCH lamp lights on main control board; PWR lamp lights in emergency engine room; major alarm bell rings.
8. ABS FA lamp lights on main control board; rings alarm battery supply signal bell.
9. 70-type G0- fuses on 24V or 48V REG strip are not connected to alarms and therefore no test is required.