KS-5651 AND KS-5651-01 RECTIFIERS
ELECTRONIC CONTROL
OPERATING METHODS

1. GENERAL

1.01 This section covers the operation of a metallic-type rectifier using a saturable reactor control. It provides a regulated voltage for floating and charging central office 24- or 48-volt batteries in power plants. The rectifier is available in three ratings: 24 volts, 100 and 200 amperes, and 48 volts, 100 amperes direct current. The power required is 210-, 230-, or 250-volt, 3-phase alternating current. The rectifier is self-regulating and is suitable for use in room temperatures from 50° to 104°F (10° to 40°C).

Warning 1: Voltages inside the rectifier case are higher than those usually encountered in telephone power plants. Avoid all contact with terminals as high voltages are present. Do not allow a test pick to touch two metal parts at the same time as destructive and dangerous short circuits may occur.

Warning 2: The door switch behind the hinged control panel is provided for the protection of personnel and should not be made inoperative. Disconnect ac supply before opening covers or doors to work inside the rectifier. Even with the OFF or OPEN rotary switch in the neutral or OFF position, the studs of the switch are connected by unfused leads to the battery. With the ON-OFF key OFF and the OFF or OPEN rotary switch in the 24V1 or 48V1 or EM CELL position, there are additional connections protected from the battery only by the large charge fuse.

Caution: Do not use OFF or OPEN rotary switch to stop rectifier.

1.02 This section is reissued to add reference to the KS-20522 Controller and to generally update the section. This reissue does affect the Equipment Test List.

1.03 A metallic rectifier cell is an elementary rectifier having one positive electrode, one negative electrode, and one rectifying junction. A rectifying element is a circuit element which has the property of conducting current effectively in one direction only and may consist of a group of metallic rectifier cells connected in parallel or series arrangement, or both. The term rectifier stack, or varistor, used in apparatus coding includes one or more rectifier cells. Rectifying elements may be made up of one or more rectifier stacks or varistors. A rectifier is an assembly consisting of a rectifying element and associated auxiliaries such as transformers, filters, and switches. To avoid unbalance, a complete set of rectifier stacks or varistors in a configuration should be replaced even though only one rectifier stack may be defective.

1.03 This issue of the section is based on circuit schematic drawings SD-80969-01, Issue 1, Figs. 1, 2 or 6, and 3, and SD-81087-01, Issue 5, Figs. 1 and 2. For a detailed description of circuit operation, see the corresponding circuit description. If this section is to be used with equipment or apparatus reflecting later issue(s) of the drawing(s), 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.

1.04 Additional information on the operation and maintenance of individual pieces of apparatus such as instruments, keys, relays, switches, etc., is given in the corresponding Bell System Practices. All apparatus should be adjusted in accordance with these sections and the circuit requirements tables of the circuit drawings.

2. LIST OF TOOLS AND TEST APPARATUS

2.01 The only test apparatus required is the KS-14510 Volt-ohm-milliammeter.

3. OPERATION

A. Preparing To Start

3.01 When preparing to put the rectifier into service, check to see that:

(a) Rectifier key ON-OFF is in the OFF position and key TEST 1 is released.

(b) Correct transformer and reactor taps have been used for the power service voltage.

(c) Correct tubes are in the sockets.

(d) Hinged control panel is closed tightly so door switch is operated.

(e) Proper fuses are in place and the circuit breakers CONT, CBA, and CHG ALM, when provided, are closed.

(f) Potentiometers CCH, CCL, FLOAT ADJ, and MAN, and rheostat AH are turned completely counterclockwise (ccw).

(g) Potentiometer CCH is turned approximately 2/3 turn clockwise (cw) from the completely ccw position.

(h) Switch CHG-FLOAT is in the FLOAT position.

(i) Rotary switch OFF or OPEN is closed to the battery position desired.

B. Initial Adjustments

3.02 Before placing the rectifier in service, make the following adjustments observing the directions in 3.01.

(1) Operate key TEST 1.

(2) Turn rectifier key ON-OFF to ON position.

Note: Allow one minute for control tubes to heat.

(3) Slowly operate potentiometer MAN cw.

Requirement: Saturating current is indicated on ammeter SC; the output, once started, increases as the potentiometer is turned, and rated current output can be obtained.

Note: Some discharge of the battery or an artificial load may be necessary to obtain full-load current without exceeding the allowable voltage.

(4) Operate the potentiometer completed ccw to the NOR position.

(5) Release key TEST 1.

(6) Hold key TEST 2 operated and slowly operate potentiometer MAN cw, observing that rated current output can be obtained.

(7) Operate the potentiometer ccw to the NOR position.

(8) Operate and hold operated key TEST 3 and key CCH or CCL.

(9) Slowly operate potentiometer MAN cw, observing that rated output can be obtained.

(10) Operate the potentiometer completely ccw to the NOR position and release the keys.

C. Starting the Rectifier

3.03 In order to start the rectifier, proceed as follows.

(1) Operate the ON-OFF key to the ON position.

(2) Slowly operate potentiometer FLOAT ADJ cw until the output voltage is at the floating value.

3.04 ***Ammeter Relay Adjustment:*** Ammeter relay AR ordinarily should have the low contact set at 5 percent and the high contact set at 100 percent, as shown on the relay scale by the position of the respective indicating pointers.

Note: The KS-20522 controller has been developed to provide, in a solid-state unit, the same functions as contacts in the ammeter relays. The controller contains no moving parts or heated filaments; therefore it should provide more reliable service with far less maintenance than the mechanical contacts. The KS-20522 Controller is available as part

of a modification kit which includes mounting hardware, wire, installation and wiring information, and, where required, some minor external components. There will be a modification kit available for several different applications. For additional information, see Section 024-360-201 and SD-82023-01 and the associated circuit description.

D. Manual Control

3.05 Potentiometer MAN and resistor R8 in series form a voltage divider across the amplifier supply voltages. This provides an adjustable voltage for use in testing the various parts of the control circuit.

(a) With key TEST 1 operated, relay TR is released and the cathodes of the two series tubes V2 and V3 are connected to terminal 2 of potentiometer MAN. Adjustment of potentiometer MAN varies the grid bias on V2 and V3; controls the saturating current as desired, giving manual regulation; and provides a means of testing the series tubes withot the amplifiers.

(b) Key TEST 2 when operated, operates relay TR, connects cathode 3 of V5 to potentiometer MAN, and provides a means of testing manual regulation with the second stage amplifier of voltage regulation without the first stage or the current amplifier.

(c) Key TEST 3 when operated, operates relay TR, connects cathode 3 of V6 to potentiometer MAN, and provides a means of checking the operation of the second stage of current regulation without the first stage.

3.06 The OFF or OPEN rotary switch is provided to select one of two load or battery connections as, for example, the battery or the battery and emergency cells. It also serves as a disconnect switch.

3.07 Switch CHG-FLOAT changes the top connections on transformers T1 to T3. In the FLOAT position, adequate voltage is available for all normal operation. The CHG position provides additional voltage such as that for charging the main battery plus emergency cells. This switch should be operated to the proper position when the rectifier is stopped to operate rotary switch OFF or OPEN from the main battery to the emergency cell connection or the reverse.

3.08 Relay PH connects power to transformers T4 and T5 and is provided for use in automatic plants to preheat the control tubes in anticipation of starting the rectifier. This avoids delay in securing output when additional current is required to maintain the plant battery. When preheating is not required, it may be operated under control of key ON-OFF. Release of the door switch behind the hinged control panel will also release relay PH.

3.09 Contactor AC connects power to the rectifier transformers T1 to T3 and is under control of key ON-OFF and the door switch. Operation of contactor AC closes the control circuit of contactor CA, which automatically makes the connection between the battery and the rectifier, as the rectifier output voltage builds up on starting and normally closes when the voltage of the rectifier is about 20 or 44 volts for the 24- or 48-volt rectifier respectively.

D. Ammeter Relay Operation

3.10 Ammeter relay AR is internally connected in such a way that the current which flows through the high contacts to operate some control relay increases the current through the operating coil of relay AR and prevents chattering of the contacts. This increase in current also affects the value at which the contacts open. The current through the contacts should not exceed 30 milliamperes. The higher the current, the greater the separation between operate and release values (closing and opening of contacts). The lower the current, the greater the possibility of chatter.

4. ROUTINE CHECKS AND ADJUSTMENTS

4.01 Routine checks are intended to detect defects particularly in infrequently operated parts of the equipment, and insofar as possible, guard against circuit failures which may interfere with service. Tests and adjustments, other than those required by trouble conditions, should be made during a period when they will cause the least unfavorable reaction.

A. Routine Adjustments

4.02 ***Battery and Load Connection:*** The rectifier with its connecting plant control should be

completely automatic and require no routine adjustments if left connected to the battery and load. To connect the rectifier to the battery and load, proceed as follows.

(1) Close switch CHG-FLOAT to the desired position.

(2) Close rotary switch OFF or OPEN, connecting the rectifier with the battery and load.

(3) ***Caution: Never turn the rectifier on under automatic control before the battery or load is connected, because the rectifying cells may be punctured and fail.***

Operate the rectifier key to the ON position.

Requirement: The rectifier should start and build up output under control of associated equipment in the course of about one minute.

Note 1: The amount of current in the regulating coils of the reactors is indicated on ammeter SC.

Note 2: A typical value under normal operating conditions is in the order of 50 milliamperes, the extremes being about 10 to 250 milliamperes.

Note 3: The output voltage and current of the rectifier will be indicated on voltmeter VM and ammeter relay AR.

4.03 ***Testing With Load and Battery Disconnected:*** The rectifier may be tested with the load and battery disconnected, under manual operation, as follows.

Caution 1: The ouptut voltmeter should be under observation, and in the event it goes off scale, the rectifier should be instantly turned off.

Caution 2: Normally, potentiometer MAN can be advanced in a cw direction. The accompanying change in output voltage observed on the output voltmeter should not be allowed to go off scale.

(1) Operate potentiometer MAN fully ccw.

(2) Operate key TEST 1 before the load is disconnected.

(3) After testing, return all controls to their normal positions.

4.04 ***Boost Charging the Battery:*** Switch CHG-FLOAT will normally be in the FLOAT position (see 3.07). Usually, a boost charge of the battery can be made with the switch in the FLOAT position by using rheostat OVER CHG (see 4.07). The CHG position is required when the battery and emergency cells are charged in series. While regulation can be secured for normal operation with the switch in the CHG position, this is inadvisable as it results in a much poorer input power factor.

4.05 ***Voltage and Current Regulation:*** To check the operation of the voltage and current regulation circuits, proceed as follows.

(1) Operate rectifier key ON-OFF to the ON position.

(2) Slowly operate potentiometer FLOAT ADJ cw until the output voltage is at the floating value.

Note: Closing of the high contacts of relay AR should, through the connecting plant circuit, cause the operation of relay CCH, changing the control from voltage to current regulation.

(3) Make the transfer from voltage to current regulation by holding key CCH operated.

Note: This will cause the output current to drop.

(4) Operate potentiometer CCH slowly ccw until 103 percent of the full-load current output is secured, keeping the battery voltage close to the float value.

Note: If the associated plant is designed to change the current regulation to some part of full load under certain conditions, relay CCH will be released and relay CCL will be operated at the proper time. After operation of relay CCL, which can be secured by holding key CCL operated, potentiometer CCL should be adjusted (usually at floating voltage) to

the desired output, for example, 1/2 rated output current.

(5) Release relay CCL.

Note: This will put the rectifier back on voltage control.

(6) If necessary, readjust potentiometer FLOAT ADJ until the desired voltage is secured.

Note: The plant voltmeter should have been checked recently to be sure it is correct within ± 0.5 percent at the floating voltage.

(7) Return all keys to their normal positions.

4.06 ***Speed of Response Adjustment:*** To adjust the speed of response of the rectifier, proceed as follows.

Note: All keys must be in the normal position, and the external connecting circuit must be in full operation under control of its voltage monitoring element.

(1) Operate rheostat AH cw, increasing the speed of response to changes or fluctuations in load until the output becomes unstable.

(2) Operate the rheostat back until stability is secured and then turn it an additional 1/8 turn ccw unless the end of travel has already been reached.

4.07 ***Rheostat OVER CHG Adjustment:*** To adjust the rheostat OVER CHG, proceed as follows.

(1) Check that any plant circuit connecting terminal 7 to terminal 12 is open.

(2) Slowly operate the rheostat shaft cw until the desired charging voltage is secured.

Note 1: This adjustment must be made slowly enough to avoid closing the high contacts of relay AR.

Note 2: Connections for external equipment are provided so that this rheostat may be short-circuited during floating operation. In this way, both floating and charging can be secured by relay or key control in the plant without changing the adjustment of the associated potentiometer or rheostat.

(3) Final adjustment should be made with less than half rated current.

4.08 ***Overload Adjustment:*** To make overload adjustments, proceed as follows.

Note: The circuit should be energized with all rheostats in the extreme ccw position and all keys normal except the ON-OFF key.

(1) Operate MAN TEST key to TEST.

(2) Apply a raise signal by operating the RAISE key spring combination.

Note: The output current will rise to a point determined by the operation of OL relay and will then be reduced to a point determined by a release value of the OL relay.

(3) During the slow oscillation of the output current, operate rheostat A cw until an external millivoltmeter across terminals 2-3 or the AR shunt indicates a maximum load, during the cycle of 110 percent of rated full load current.

(4) Hold this setting for some minutes in order to adjust for any initial drift which may occur.

Note: The output voltage may be any convenient value during this adjustment.

B. Routine Checks

4.09 ***Check Vacuum Tubes:*** Periodically check the condition of the vacuum tubes. In general, the only only items likely to become defective with use are the tubes V1 to V6. These of course are subject to aging but should have long life. The tubes can be tested as follows.

(a) Where facilities for the manual control of the input voltage, such as the emergency alternator, are available, reduce the input voltage to the minimum for the particular installation in accordance with Table A.

(1) Allow voltage to remain at minimum for about 3 minutes, meanwhile observing the output.

TABLE A

NOMINAL	MINIMUM
210	193
230	212
250	230

(2) If the rectifier is operating in parallel with other charging equipment, see that it continues to carry its share of the load.

(3) If the rectifier is carrying the entire load on the battery, see that the battery voltage remains within the limits specified in local job information.

(4) Check in accordance with (b) all vacuum tubes in rectifier which do not regulate within limits.

(b) When necessary after a check per (a), or where facilities for such a check are not available, check the vacuum tubes with whatever vacuum tube tester is available, in accordance with the section for that tester.

4.10 ***Check Relays:*** The relays should be inspected occasionally for adjustment and condition of contacts, making sure that they are in accordance with the circuit requirements and sections which apply.

4.11 ***Replacing Potentiometers and Rheostats:*** Control potentiometers and rheostats are totally enclosed and should be replaced if they become defective in any respect.

4.12 ***Replacing Rotary Switch:*** The KS-15119 rotary switch is totally enclosed and should be replaced if it becomes defective in any respect.

4.13 ***Clean Ventilating Passages:*** Keep the ventilating passages and rectifier cells clean to prevent excessive heating.

4.14 ***Check Output Voltage:*** Transformers T1 to T3 have aging taps 2 and 3, the connection when new being at tap 1. This tap should not be changed to the next tap 2 or 3 until the rated output can no longer be obtained from the rectifier and until a thorough check has been made to be sure there are no other troubles. If rated output can be secured with manual control, it will indicate that the transformer taps do not need to be changed.

5. TROUBLES

Point-to-Point Voltages

Note: If one of the possible causes in the Trouble Chart or the use of the point-to-point voltage tables does not lead to the location of the trouble, it is advisable to make point-to-point resistance measurements with the circuit completely deenergized, comparing the measurements with the values shown on the SD circuit drawing so that such faults may be found.

5.01 Point-to-point voltages are intended for use when unsatisfactory operation is encountered, in which case they may prove useful in locating the cause. They are not operating requirements to be checked in routine and are not needed while the rectifier is operating satisfactorily. As given in Table B, they are approximate and typical of a rectifier connected to normal power supply, adjusted to the float voltage of the battery, and no load.

5.02 High voltages are present within the rectifier and every precaution should be observed to avoid any contact with exposed metal parts or terminals when the rectifier is in operation.

Caution: When using any portable instrument, the leads should be carefully examined to make sure the insulation is undamaged. The leads should be connected at the instrument before making contact with the circuit to be tested. If connections are to be changed from one instrument range to another, the alternating current should first be disconnected from the equipment being tested, or if test picks are being used, they should be removed from the equipment under test.

5.03 Readings should be made with a KS-14510 voltmeter. The output of the rectifier will not be appreciably affected by connecting the voltmeter leads to the circuit elements. In general, door switches are not intended for use in disconnecting power, but for convenience, they may be so used

during the infrequent taking of point-to-point voltages.

Table B—Point-to-Point Voltages

5.04 Viewed from the rear, the socket terminals, starting from the key-way or blank position, are numbered clockwise. Before taking the voltage readings, perform the following operations:

(1) Shut down the rectifier by operating the ON-OFF key to the OFF position.

(2) Operate the 24V- or 48V-EM CELL rotary switch to the OFF or OPEN position.

(3) Operate the FLOAT-CHG switch to the FLOAT position.

(4) Check that circuit breakers CONT and CHG ALM are on.

(5) Operate the TEST 1 key to the TEST 1 position.

(6) Operate the OFF key to the NOR or ON position.

(7) Carefully rotate the MAN potentiometer in a cw direction until the output voltage reaches:

49.5 volts for 23 cells
25.75 volts for 12 cells
23.65 volts for 11 cells

5.05 After the readings have been taken and the trouble has been found, return all controls to their normal operating position.

Trouble Chart

5.06 Should any of the troubles develop covered in the Trouble Chart, it is suggested that the possible causes be checked. If trouble is not found, look for loose or open connections or short circuits due to foreign matter lying across wiring terminals. A loose connection generally causes heating. Any one of the troubles may be caused by an open or short circuit, or by an aging or drift in the constants of some faulty component.

TABLE B – POINT-TO-POINT VOLTAGES

Panel Meter Readings: SAT. CURRENT = 15 MILLIAMPERES
OUTPUT VOLTAGE = 49.5 VOLTS
OUTPUT CURRENT = 0 AMPERE

METER CONNECTIONS		METER SETTING	RANGE	READING
TEST POINT	TEST POINT	AC OR DC	(VOLTS)	(VOLTS)
Contactor AC				
T1	T2	AC	300	208
T2	T3	AC	300	208
T1	T3	AC	300	208
L1	L2	AC	300	208
L2	L3	AC	300	208
L1	L3	AC	300	208
Power Fuses				
F1	F2	AC	300	208
Rectifier Stack				
AC Supply				
AC1	AC2	AC	60	40
AC2	AC3	AC	60	40
AC1	AC3	AC	60	40
Pin Jacks				
S–	S+	DC	†60	15.8
S–	SP	DC	—	Over 600
S+	SP	DC	—	Over 600
S+	P	DC	300	120
B	GND	DC	300	273
P	GND	DC	300	148
B	P	DC	300	128
Transformers				
T1 — Term. 1	Term. 6	AC	300	132
Term. 7	Term. 8	AC	60	40.7
Term. 8	Term. 9	AC	12	6.8
Term. 7	Term. 9	AC	60	47.2
T2 — Term. 1	Term. 6	AC	300	133
Term. 7	Term. 8	AC	60	40.2
Term. 8	Term. 9	AC	12	6.8
Term. 7	Term. 9	AC	60	47.2
T3 — Term. 1	Term. 6	AC	300	130
Term. 7	Term. 8	AC	60	39.8
Term. 8	Term. 9	AC	12	6.7
Term. 7	Term. 9	AC	60	45.2
T4 — Term. 1	Term. 2	AC	300	208
Term. 2	Term. 3	AC	60	20
Term. 1	Term. 3	AC	300	228
Term. 5	Term. 6	AC	—	Over 600
Term. 6	Term. 7	AC	—	Over 600
Term. 5	Term. 7	AC	—	Over 600
Term. 8	Term. 9	AC	300	109
Term. 10	Term. 11	AC	12	5
Term. 12	Term. 13	AC	12	6.2
T5 — Term. 1	Term. 2	AC	300	208
Term. 3	Term. 4	AC	60	50
Term. 4	Term. 5	AC	600	450
Term. 3	Term. 5	AC	600	500
T6 — Term. R	Term. BL	AC	300	86
Term. G-W	Term. BL-W	AC	12	4.95

†*Warning: The dc windings (7-8) of saturable reactors L1, L2, and L3 may have ac voltages of over 1000 volts under trouble conditions.*

TABLE B – POINT-TO-POINT VOLTAGES (Cont)

Panel Meter Readings: SAT. CURRENT = 15 MILLIAMPERES
OUTPUT VOLTAGE = 49.5 VOLTS
OUTPUT CURRENT = 0 AMPERE

METER CONNECTIONS		METER SETTING	RANGE	READING
TEST POINT	TEST POINT	AC OR DC	(VOLTS)	(VOLTS)
Inductors				
L1 — Term. 1	Term. 4	AC	300	62
Term. 1	Term. 4	AC	300	62
Term. 5	Term. 6	DC	—	0
Term. 7	Term. 8	DC	†12	5.3
L2 — Term. 1	Term. 4	AC	300	62
Term. 1	Term. 4	AC	300	62
Term. 5	Term. 6	DC	—	0
Term. 7	Term. 8	DC	†12	5.3
L3 — Term. 1	Term. 4	AC	300	62
Term. 1	Term. 4	AC	300	62
Term. 5	Term. 6	DC	—	0
Term. 7	Term. 8	DC	†12	5.3
Rectifying Elements				
RV3 — Term. 1	Term. 2	DC	300	61
Term. 2	Term. 3	DC	300	81
Term. 1	Term. 3	DC	300	142
RV4 — Term. 2	Term. 2	AC	300	150
Term. 1-1	Term. 3-3	DC	300	148
RV5 — Term. 1	Term. 2	DC	300	128
Potentiometers and Rheostats				
AH — Term. 1	Term. 2	DC	—	0
CCH — Term. 1	Term. 2	DC	—	0
Term. 2	Term. 3	DC	60	42.7
Term. 1	Term. 3	DC	60	42.7
CCL — Term. 1	Term. 2	DC	—	0
Term. 2	Term. 3	DC	3	1.4
Term. 1	Term. 3	DC	3	1.4
FLOAT-				
ADJ — Term. 1	Term. 2	DC	12	8.2
Term. 2	Term. 3	DC	12	7.8
Term. 1	Term. 3	DC	60	16
MAN — Term. 1	Term. 2	DC	12	6.3
Term. 2	Term. 3	DC	300	216
Term. 1	Term. 3	DC	300	223
OVER-CHG				
Term. 1	Term. 2	DC	12	11.2
Resistors				
R1		AC	300	203
R2		AC	300	161
R3		DC	60	36.8
R4		DC	60	39.8
R5		DC	300	95
R6		DC	60	24
R8		DC	60	44.3
R9		DC	300	138
R10		DC	300	80
R11		DC	60	30.8
R12		DC	60	35

†*Warning: The dc windings (7-8) of saturable reactors L1, L2, and L3 may have ac voltages of over 1000 volts under trouble conditions.*

TABLE B – POINT-TO-POINT VOLTAGES (Cont)

Panel Meter Readings: SAT. CURRENT = 15 MILLIAMPERES
OUTPUT VOLTAGE = 49.5 VOLTS
OUTPUT CURRENT = 0 AMPERE

METER CONNECTIONS		METER SETTING	RANGE	READING
TEST POINT	TEST POINT	AC OR DC	(VOLTS)	(VOLTS)
Resistors (Cont)				
R13		DC	60	30
R15		DC	300	147
R16		DC	60	52.5
R17		DC	60	40.2
R18		DC	3	1.4
R19		DC	0.3	0.035
R21		DC	—	0
R22		DC	—	0
R23		DC	—	0
R24		DC	—	0
R25		DC	60	19
R27		DC	300	190
R28		DC	60	29.5
R29		DC	60	46.2
R30		DC	300	75
R32		DC	60	16
R36		DC	3	0.4
Capacitors				
C1		DC	60	16
C2		DC	3	0.45
C3		DC	12	2.6
C5		DC	300	120
C6		DC	300	120
C8		DC	60	15
C9		DC	12	8
C10		DC	600	315
C12		DC	300	121
C13		DC	300	150
C15		DC	300	85
C18		DC	300	128
Tubes				
V1 — Term. 2	Term. 8	AC	12	5
Term. 2	Term. 4	DC	—	Over 600
Term. 2	Term. 6	DC	—	Over 600
V2 — Term. 2	Term. 7	AC	12	6.2
Term. 8	Term. 3	DC	—	Over 600
Term. 8	Term. 4	DC	—	Over 600
Term. 8	Term. 5	DC	300	120
V3 — Term. 2	Term. 7	AC	12	6.1
Term. 7	Term. 3	DC	—	Over 600
Term. 7	Term. 4	DC	—	Over 600
Term. 7	Term. 5	DC	300	122
V4 — Term. 2	Term. 5	DC	300	148
V5 — Term. 7	Term. 8	AC	12	6.15
Term. 3	Term. 1	DC	60	15
Term. 3	Term. 2	DC	60	25
Term. 6	Term. 4	DC	12	8.1
Term. 6	Term. 5	DC	300	112
V6 — Term. 7	Term. 8	AC	12	5.9
Term. 3	Term. 1	DC	12	2.6
Term. 3	Term. 2	DC	300	160
Term. 6	Term. 4	DC	3	0.43
Term. 6	Term. 5	DC	60	52.5

TABLE B – POINT-TO-POINT VOLTAGES (Cont)

Panel Meter Readings: SAT. CURRENT = 15 MILLIAMPERES
OUTPUT VOLTAGE = 49.5 VOLTS
OUTPUT CURRENT = 0 AMPERE

The following readings are for auxiliary rectifier equipment which is furnished when no external battery is connected.

METER CONNECTIONS		METER SETTING	RANGE	READING
TEST POINT	TEST POINT	AC OR DC	(VOLTS)	(VOLTS)
Transformer T7				
Term. 1	Term. 4	AC	300	247
Term. 5	Term. 8	AC	300	71
RV1				
Term. 2	Term. 4	AC	300	61
Term. 1	Term. 3	DC	60	46.5
Pin Jacks				
REG+	REG–	DC	60	49.5
Capacitors				
C4		DC	12	10.7
C7		DC	300	Approx. 125
C11		DC	60	13
Resistors				
R26		AC	300	16.3
R31		AC	60	24.5

TROUBLE	POSSIBLE CAUSE	TROUBLE	POSSIBLE CAUSE
No dc output current	Power failure.		Open CONT breaker or fuse.
	Blown ac supply fuse. F1, F2, or CHG fuse.		Relay TR released.
	Door switch behind hinged control panel open.	Low dc output current Low saturating current	Potentiometer FLOAT ADJ out of adjustment.
	Failure of tube V1, V2 and V3, or V5, or V6 if on current control.		Line voltage more than 8 percent low.
	Shorted capacitor C31 to C60.		Tube V2 or V3 failure.
	FLOAT ADJ potentiometer out of adjustment.		Tube V1, V2, V3, V5, or V6 low emission, aged.
	No saturating current. Relay PH or CT not operated.		Aged voltage reference tube V4.
	Contactor AC or CA not operated.		Rheostat AH not set correctly to keep up with load changes.
			Relay CCL operated.

TROUBLE	POSSIBLE CAUSE
Rated output current not obtainable with saturating current maximum under MAN control	One of three line leads open or high resistance at some contact in line circuit.
	Switch CHG-FLOAT on FLOAT when charging, especially emergency cells.
	Rectifier cells' high resistance due to aging.
High dc output current High saturating current	Potentiometer FLOAT ADJ out of adjustment.
	Line voltage more than 8 percent high.
	Aged varistor RV3.
	Unbalance in ac line voltages.
	Similar taps not used on all reactors and transformers.
	Three ac voltages applied to rectifying element (terminals AC1 or AC2, AC2 to AC3, AC3 to AC1) differ by more than 5 percent.
	Rheostat AH not set correctly to keep up with load changes.
	Fuse in lead to terminal 28 blown.
	Relay CCH operated.
High dc output current with saturating current minimum under MAN control	Switch CHG-FLOAT on CHG instead of FLOAT.
	Line voltage more than 8 percent high.
Output excessively noisy	Three ac voltages applied to rectifying element (terminals AC1 to AC2, AC2 to AC3, or AC3 to AC1) differ by more than 5 percent.
	Filter capacitors aged or defective.
	Filter capacitor connections loose or open.
*Output voltage varying	Rheostat AH set too high.

*Step changes in load, encountered in certain applications, will cause fluctuation of the load voltage at too high a rate for the regulating circuit to follow and of too great a value for the battery of the installation to hold close voltage limits. This should not be interpreted as erratic operation of the rectifier.