

**RECTIFIERS**  
**J86240A AND J86240B**  
**OPERATING METHODS**

CONTENTS	PAGE
1. GENERAL . . . . .	1
2. LIST OF TOOLS, TEST APPARATUS, AND MATERIALS . . . . .	2
3. OPERATION . . . . .	2
4. ROUTINE CHECKS AND ADJUSTMENTS . . . . .	3
Float Voltage Adjustments . . . . .	3
Overcharge and Anti-Hunt Adjustments . . . . .	4
Constant Current Transfer Control Adjustments—Relay-Type Control . . . . .	4
Constant Current Transfer Control Adjustments—Electronic-Type Control . . . . .	5
63-Type Resistor Insulation Check . . . . .	6
5. TROUBLES . . . . .	6
General . . . . .	6
Trouble Chart . . . . .	7
Point-to-Point Voltages . . . . .	9

**1. GENERAL**

**1.01** The J86240A and J86240B full-wave regulated rectifiers, designed for use in telephone plants and especially for the TD2 Radio System, are suitable for floating and charging from 55- to 70-cell storage batteries. The J86240A rectifier is used primarily with the 410A, 410B, and 420A power plants, while the J86240B is used with the 425A, 425B, and 426A power plants. The rectifier unit has a charging capacity of 8 amperes dc when equipped with tube-type thyratrons and a charging

capacity of 9 amperes dc when equipped with semiconductor-type thyratrons at float voltages from 106 to 152 volts. The rectifiers operate from a single-phase ac power service of 200 to 250 volts  $\pm 5$  percent at 60 Hz  $\pm 2$  percent. Primary taps are provided on the T1 [and T5 (MD)] input transformers to match the variations of ac line voltages. Secondary taps are provided on the T1 transformer (M or N wiring) for the connection of the number of cells in the battery string. The rectifiers are nearly identical in operation; however, the J86240A rectifier is used for 130 volts positive (negative side grounded) or 130 volts negative (positive side grounded). The J86240B rectifier is used when the negative terminal is 130 volts positive with respect to ground, and the positive terminal is 250 volts positive with respect to ground.

**1.02** This section is reissued to completely revise the operating and adjusting procedure and to delete the initial starting procedure. Since this is a general revision, arrows ordinarily used to indicate changes have been omitted. This reissue does affect the Equipment Test List.

*Caution: Voltages inside the rectifier are higher than normally encountered in telephone power plants. Avoid all contacts with terminals. Do not allow a test pick to touch two metal parts at the same time as dangerous and destructive short circuits may occur. Remove all ac and dc charge and regulation fuses associated with the rectifier before working inside the unit, except as necessary to make tests.*

**1.03** Semiconductor-type rectifiers of early design were equipped with KS-15968 solid-state thyratrons and semiconductor-type rectifiers of later design are equipped with KS-19699 solid-state thyratrons. The J86240A L10 electron tube replacement equipment is available to replace the 354A electron tubes with the KS-19699 L1 or L4 solid-state thyratrons in the J86240A rectifier, and

**SECTION 169-613-301**

the J86240B L2 electron tube replacement equipment is available to replace the 354A electron tube with the KS-19699 L1 or L4 solid-state thyratrons in the J86240B rectifier.

**1.04** An electronic current-limiting feature is optional in the J86240A rectifier. The J86240A L8 applique equipment is available to add to the J86240A rectifier.

**1.05** The instructions in this practice are based on the following circuit schematic drawings. For a detailed description of operation, see the corresponding circuit descriptions.

SD-81076-01 Rectifier Circuit—Automatic Regulation—Electron Tube Type—130 Volts, 8 Amperes; Semiconductor Type—130 Volts, 9 Amperes DC J86240A

SD-81077-01 Rectifier Circuit—Automatic Regulation—Electron Tube Type—130 Volts, 8 Amperes; Semiconductor Type—130 Volts, 9 Amperes DC J86240B

SD-81563-01 Solid-State Thyatron For J86207, -40, -51 Rectifiers KS-15968

**1.06** For more detailed information on operation and maintenance of individual equipment or apparatus, refer to the appropriate Bell System Practices.

**1.07** The abbreviations cw and ccw used herein refer to clockwise and counterclockwise, respectively.

**2. LIST OF TOOLS, TEST APPARATUS, AND MATERIALS**

CODE OR SPEC NO.	DESCRIPTION
<b>TOOLS</b>	
418A	5/16- and 7/32-Inch Open Double-End Flat Wrench
KS-6320	Orange Stick
—	3-Inch C Screwdriver

CODE OR SPEC NO.	DESCRIPTION
<b>TOOLS</b>	
—	Blocking Tools as Required (Use and apply as covered in 069-020-801.)

<b>TEST APPARATUS</b>	
KS-14510	Volt-Ohm-Milliammeter

<b>MATERIAL</b>	
—	Abrasive Paper—Garnet, 4/0 or Flint, Extra Fine B Plastic Sleeve, Size 133, Red Stripe

**3. OPERATION**

**3.01 Starting the Rectifier:**

- (1) The AUTO-MAN (D) combined switch and rheostat is in the AUTO position.
- (2) Apply the input power by operating the AC switch to the ON position and wait for the GR relay to operate in about 33 to 65 seconds.

**Note:** When starting the tube-type rectifier with room temperatures between 14° and 50° F, the tubes will probably not deliver output current after the TD relay operates until the tube filaments are warmed from 2 to 20 minutes.

- (3) After the rectifier starts, adjust the FLOAT potentiometer as required to obtain an output voltage of the rectifier equal to the battery float requirement.
- (4) If the battery is not at float voltage, operate the AC switch to the OFF position and follow procedure outlined in 4.04.

**3.02 Stopping the Rectifier:**

- Operate the AC switch to the OFF position.

**3.03 Manual Control of the Rectifier:**

- (1) Operate the AC switch to the OFF position.
- (2) Rotate the AUTO-MAN (D) switch-rheostat from the AUTO position slowly cw until a click indicates it is in the MAN position with all the resistance in.

*Note:* The MAN position disables voltage droop and constant current circuits.

- (3) Operate the AC switch to the ON position and wait for the GR relay to operate in about 33 to 65 seconds.
- (4) After the rectifier starts, rotate the AUTO-MAN (D) switch-rheostat slowly cw. Observe that the charging current increases, indicated by the A ammeter. The RA relay should operate at approximately 4 amperes output. Continue to rotate the AUTO-MAN (D) switch-rheostat cw until the desired output current is attained.
- (5) Rotate the AUTO-MAN (D) switch-rheostat slowly ccw and observe that the RA relay releases at 1.5 amperes. Further rotate the AUTO-MAN (D) switch-rheostat ccw to the MAN position (minimum output).
- (6) Snap the AUTO-MAN (D) switch-rheostat to the AUTO position to place the rectifier in normal automatic operation.

**4. ROUTINE CHECKS AND ADJUSTMENTS**

**4.01** Routine checks are intended to detect defects, particularly in infrequently operating parts of the equipment, and insofar as possible to guard against circuit failures which interfere with service. Checks and adjustments, other than those required by trouble conditions, should be performed during a period when there will be a minimum interference to service.

**4.02** Periodically check the output float voltage on the associated power plant voltmeter when the unit is operating on voltage control. If the voltage does not appear correct, readjust the rectifier float voltage as outlined in 4.04. Periodically

observe the output current on the A ammeter when the unit is operating on current control. If the current is not approximately the usual value, with the battery at float voltage, readjust the constant current transfer control as outlined in 4.07 and 4.08 or 4.09 and 4.10.

**4.03** As often as local experience demands, inspect the relays for adjustment and condition of contacts to make sure that they are in accordance with the circuit requirements and sections that apply.

**Float Voltage Adjustments**

**4.04** *To adjust the float voltage, proceed as follows.*

- (1) Operate the AC switch to the OFF position.
- (2) Operate the AUTO-MAN (D) combined switch and rheostat to the MAN position with the control rotated as far ccw as possible without snapping the switch-rheostat to the AUTO position.

*Note:* The first 15 degrees of cw rotation of the AUTO-MAN switch-rheostat snaps from the AUTO to the MAN position at maximum resistance. The remaining 85 degrees of cw rotation reduces the resistance to zero and raises the output current.

- (3) Apply the input power by operating the AC switch to the ON position and wait for the GR relay to operate. In tube-type rectifiers the V1 and V2 tubes will glow.
- (4) After the rectifier starts, rotate the AUTO-MAN (D) switch-rheostat cw until the rectifier is charging at the desired rate. Do not permit the output to exceed 8 amperes for tube-type rectifiers or 9 amperes for semiconductor-type rectifiers as indicated by the A ammeter.
- (5) When the battery is charged to its floating value, adjust the FLOAT potentiometer as required to obtain 30 to 40 volts as indicated by the RV voltmeter.

*Note:* The RV voltmeter indicates the grid voltage of the V3 control tube and aids in the adjustment and maintenance of the rectifier.

(6) Snap the AUTO-MAN (D) switch-rheostat to the AUTO position and then make a final adjustment of the regulated voltage with the FLOAT potentiometer. The voltage indicated on the RV voltmeter is normally between 10 and 40 volts depending on the load and line voltage.

**Caution:** *Never snap the AUTO-MAN (D) switch-rheostat to the AUTO position if the RV voltmeter indicates less than 25 volts, as this indicates that the battery voltage is low and the rectifier might overload if the overload circuit has not been adjusted.*

(7) If *electronic current-limiting is not provided*, the RC amber lamp indicates when the rectifier is operating on a constant current basis.

(8) If *electronic current-limiting is provided*, the RC amber lamp will light only when the connected plant fails to shut down the rectifier when it is overloaded.

**Note:** The rectifier automatically transfers from voltage regulation to current regulation when the output exceeds a predetermined value. The transfer point can be selected at any current within 6 to 9 amperes for tube-type rectifiers or 6 to 10 amperes for semiconductor-type rectifiers.

(9) If the RV voltmeter reading is unstable or if the rectifier hunts from current to voltage regulation, it may be necessary to adjust the anti-hunt, AH, potentiometer as outlined in 4.06.

#### Overcharge and Anti-Hunt Adjustments

##### 4.05 Overcharge Adjustment:

- (1) To avoid disturbing the float adjustment, open the external short circuit around the OC rheostat and block the associated relay in the connecting power plant.
- (2) With the rectifier operating automatically on voltage control (RC lamp not lighted), rotate the OC rheostat cw to produce a full-load output, but not enough to operate the OL relay. Do not allow the battery voltage to exceed the

nominal overcharge value of 2.2 or 2.3 volts for each cell, as specified, for the connecting plant.

(3) Proceed to 4.06.

##### 4.06 Anti-Hunt Adjustment:

(1) Rotate the AH rheostat ccw until the RV voltmeter is affected; then turn it cw about one-quarter turn. If rectifier is unstable, readjust the AH potentiometer further cw. If no hunting is present when the AH rheostat is fully cw, leave it in that position.

(2) Remove the block from the associated relay in the connecting power plant if placed in 4.05(1).

**Note:** The AH potentiometer may require further adjustment when the R2 CUR LIM potentiometer is adjusted in 4.09.

#### Constant Current Transfer Control Adjustments—Relay Type Control

##### 4.07 OL Relay Adjustment:

(1) Operate the AUTO-MAN (D) switch-rheostat to the MAN position and rotate the control cw to obtain the transfer value of the current desired, which may be any value between 6 and 9 amperes for tube-type rectifiers or 6 and 10 amperes for the semiconductor-type rectifiers.

(2) Maintain the desired transfer value, and slowly rotate the OL rheostat control ccw until the OL relay just operates.

**Requirement:** The TR relay operates, lighting the RC lamp to indicate regulated current.

(3) Rotate the AUTO-MAN (D) switch-rheostat ccw until the OL relay releases. The TR relay remains locked operated.

(4) Proceed to 4.08.

##### 4.08 Constant Current Adjustment:

(1) Perform 4.07.

(2) With the TR relay locked operated, rotate the AUTO-MAN (D) switch-rheostat cw until the A ammeter indicates any desired output up

to 8 amperes for the tube-type rectifiers or 9 amperes for semiconductor-type rectifiers [see 4.07(1)].

- (3) Rotate the CC potentiometer as required until the RV voltmeter indicates between 30 and 40 volts.
- (4) Snap the AUTO-MAN (D) switch-rheostat to the AUTO position.
- (5) Readjust the CC potentiometer as required.

**Requirement:** The CC potentiometer may be adjusted to secure any output which is less than the setting of the OL relay (see 4.07).

**Caution:** *The CC potentiometer should never be adjusted unless the TR relay is operated and the AUTO-MAN (D) switch-rheostat is in the AUTO position.*

- (6) Release the TR relay by separating 10-11T contacts of the TR relay with an orange stick.

#### Constant Current Transfer Control Adjustments—Electronic Type Control

**Note:** The electronic current-limiting circuit provides a controlled maximum output current without operating the OL and TR relay, and without the use of the CC potentiometer. If the electronic current-limiting circuit fails, or the R2 CUR LIM potentiometer setting is too high, the OL relay will operate at the output current setting of the OL rheostat. Operation of the OL relay operates the TR relay, which in turn operates a relay in the associated power plant to shut down the rectifier and light the amber RC lamp.

#### 4.09 Electronic Current-Limiting Adjustment:

- With the rectifier under automatic control and carrying a sufficient load to cause operation of the electronic current-limiting circuit, adjust the R2 CUR LIM potentiometer control counterclockwise to limit the output current at the specified value as determined by the associated power plant requirements. The adjustment should be made at a voltage approximately 4 to 5 volts below float voltage.

(See Note 1.) The adjusted value should not exceed 8 amperes for rectifiers equipped with V1 and V2 electron tubes, and 9 amperes for rectifiers equipped with solid-state thyatrons.

**Note 1:** If at the time of adjustment it is not practicable to lower the battery voltage, the R2 CUR LIM potentiometer may be set at float voltage and should not exceed 7.5 amperes for V1 and V2 electron tube rectifiers or 8.5 amperes for V1 and V2 solid-state thyatron rectifiers.

**Note 2:** The load required during adjustments may be obtained by adjusting the plant load, by using a dummy load, by reducing the output of associated rectifiers in the connecting plant, or by discharging the battery and making the adjustment while the battery is being recharged. For use of test load, see Section 171-123-101.

**Note 3:** If hunting occurs, it may be necessary to readjust the R2 CUR LIM potentiometer and the AH rheostat as follows. Adjust the R2 CUR LIM control to the point at which hunting starts and adjust the AH control for minimum hunt. Readjust the R2 CUR LIM and the AH controls as required (see 4.06).

**Note 4:** The R2 CUR LIM potentiometer is controlled from the rear of the rectifier unit. The AH and OL screwdriver controls are located on the front of the rectifier under the front cover.

#### 4.10 OL Relay Adjustment:

- (1) Operate the AUTO-MAN (D) switch-rheostat to the MAN position and rotate the control cw to obtain the value of the current desired, which may be any value between 7 and 9 amperes for tube-type rectifiers or 7 and 10 amperes for semiconductor-type rectifiers [see 4.09(5)].
- (2) Maintain the output current value, and slowly rotate the OL rheostat control ccw until the OL relay just operates.

**Requirement:** The TR relay operates, which in turn operates a relay in the associated power plant to shut down the rectifier and activate visual and audible alarms.

**Note:** By blocking the TR relay nonoperated before adjusting the OL rheostat, rectifier shutdown and the ensuing alarms may be avoided.

- (3) Snap the AUTO-MAN (D) switch-rheostat to the AUTO position.

### 63-Type Resistor Insulation Check

4.11 Some 63-type resistors (C, S, T, U, V, W, X, Y, and Z) used in rectifiers of early design were wound on spools having metal tubing cores cemented to phenol fiber spoolheads. Since the resistors are mounted on a metal panel, insulation breakdown between the resistor winding and ground can produce sufficient heat to start a fire. Add insulation between the resistor mounting screw and the metal tubing core as follows.

- (1) Shut down the rectifier by operating the AC switch to the OFF position.
- (2) Remove all ac fuses and the dc charge and regulation fuses associated with the rectifier.
- (3) Unfasten and remove the front cover.
- (4) Unfasten and swing open the two door-type halves of the meter panel and check visually to determine the kind of 63-type resistors assembled in the rectifier.

**Note:** The S, T, U, V, W, X, Y, and Z resistors are mounted in two stacks of four on the inside of the left-hand door. In some cases, 63-type resistors of early and later design may be assembled in a stack. It will be necessary to remove the plastic guard to gain access to the stacks. The C resistor is mounted on the inside of the right-hand door.

- (5) Using the 418A wrench and 3-inch C screwdriver, remove the mounting screws, nuts, and washers. Take care not to drop or lose any of the parts.
- (6) Move the stack of resistors forward to clear the mounting bracket, bending from the wiring slightly, as necessary.
- (7) When the stack consists of all four 63-type resistors having metal tubing cores, the plastic sleeve should be one piece and extend

through the fiber washers at both ends of the assembly. Cut off excess sleeving as required.

- (8) When the stack consists of both early (metal tubing core) and later (nylon spool) design 63-type resistors, only the metal tubing core type of resistor should be insulated. It will be necessary to cut the plastic sleeve to the required length to extend through the metal tubing core and the adjacent fiber washers of the resistors in a stack.

- (9) With the plastic sleeve in place, reassemble the parts in the original positions.

- (10) Move the stack back into the original position and remount it on the bracket.

- (11) When the C resistor (mounted separately) has a metal tubing core, proceed to insulate the mounting screw in a similar manner as covered for a resistor in a stack.

- (12) When the insulation procedure has been completed, close and fasten the panel halves and replace and fasten the front cover.

- (13) To restore the rectifier to service, install the fuses that were removed and operate the AC switch to the ON position.

## 5. TROUBLES

### General

5.01 If trouble is encountered with the rectifier, first decide whether to locate trouble with the unit operating or not. The rectifiers have been designed to make parts accessible for testing with power on, and all parts with potentials over 150 volts to ground have been covered or guarded. Generally, trouble can be located quicker with the equipment energized. If the trouble is of a nature to cause excessive output, limit operation to short periods while making measurements. In case any parts overheat, shut the unit down immediately.

5.02 Short life of rectifying tubes may be due to insufficient time delay for heating of filament, dirty or corroded surface on the anode or anode cap or insufficient tension on the cap, or, dirty contacts on the tube socket. The prongs on the tube base and the springs in the socket should be burnished. Clean the anode cap surface with

abrasive cloth. Tubes are the only items likely to become defective with use.

**5.03** If the regulating circuit appears to be in trouble, turn the D switch-rheostat from AUTO to MAN position. If charging current can be controlled manually, then the trouble is in the regulating circuit.

**5.04** If voltmeter RV reads less than 10 volts with manual control at float voltage, turn FLOAT potentiometer from one extreme to the other. If RV voltmeter responds only slightly, replace tube V4. If voltmeter makes no response, replace tube V6. If there is still no response replace tube V4. Irregular output or "kicks" on the A ammeter may be caused by a defective V6 tube. Readjust the float voltage outlined in 4.04.

**5.05** Replace control potentiometers and time delay relay TD if they become defective.

**Trouble Chart**

**5.06** Following is a list of troubles and possible causes. If the trouble is not found using the list, try the point-to-point voltages in Table A. If point-to-point voltages fail to locate the trouble, then de-energize the equipment and make resistance tests, comparing the measurements with the schematic drawing.

TROUBLE	POSSIBLE CAUSE
(a) No dc output current	Power failure Blown ac supply fuse or charge fuse Failure of tube V1, V2, (or their replacement units), V3 or V5 FLOAT potentiometer out of adjustment (see 4.04) AC contactor open due to open AC switch, open in plant control Failure of GR relay to operate Failure of TD time delay relay Aged varistors GR relay contacts fail to open short on capacitor V

TROUBLE	POSSIBLE CAUSE
(b) Low dc output current	FLOAT potentiometer out of adjustment (see 4.04) Failure of tube V1 or V2 (or their replacement units), (voltmeter RV near zero) Line voltage more than 5 percent low CC potentiometer out of adjustment on current control (see 4.08) Tube V4 defective R2 CUR LIM potentiometer incorrectly adjusted (see 4.09)
(c) High dc output current, charge fuse blown	CC potentiometer out of adjustment on current control (see 4.08) Failure of V3, V4 and/or V6 tubes Defective V1 or V2 tubes (or their replacement units), (current cannot be reduced to 10 percent with manual control) OL rheostat out of adjustment; rectifier unit operating on voltage and should be on current control; failure of relay OL to operate (see 4.07 or 4.10)
(d) Output excessively noisy	Defective capacitor U Retard coil L1 or L5 short or partially short-circuited Defective V1 and V2 tubes (or their replacement units), or arcing at sockets
(e) Output voltage varying	AH rheostat incorrectly set Defective V6 tube (see 4.06)
(f) Output surge at starting	Flashover of V1 or V2 tubes

SECTION 169-613-301

TROUBLE	POSSIBLE CAUSE	TROUBLE	POSSIBLE CAUSE
(g) Ac or dc fuses blown	Failure of GR relay contacts to short capacitor V (voltmeter RV fails to read at least 50 before relay GR operates)	(j) Output voltage high; current constant at CC potentiometer adjustment; and RC lamp lighted (Electronic current-limiting feature not furnished)	TR relay fails to release at command of connecting plant
(h) Hunting from current to voltage	AH rehostat too far clockwise (see 4.06) OL rheostat set to operate relay OL at too low an output control compared to the output current on current control. Relay OL should operate on an output current about 1 ampere more than the output current on current control (see 4.07 or 4.10).	(k) V1 and V2 electron tubes; short tube life	Defective sockets R2 CUR LIM potentiometer control set too high (see 4.09) Line voltage more than 5 percent high or low
(i) No constant current control	Defective K resistor Blown F1 and/or F2 fuses CC and/or R2 CUR LIM potentiometers out of adjustment Incorrect phasing of T6 transformer windings		

**TABLE A**  
**POINT-TO-POINT VOLTAGES**

				VOLT-OHMMETER		READING	
FROM		TO (SEE NOTE)		SCALE AC OR DC	RANGE VOLTS	J86240A	J86240B
APP.	TERM.	APP.	TERM.				
T2	7	T1	3	DC	300	143	129
V6	7	V6	3	DC	300	98	98
Cap. X	Top	Cap. X	Bot.	DC	300	91	89
Cap. W	+	V6	7	DC	300	288	288
T1	1	T1	3	AC	300	218	220
	2		3	AC	300	184	184
	3		4	AC	300	184	184
	3		5	AC	300	218	220
T2	3	T2	4	AC	300	70	70
	4		5	AC	300	70	70
	6		7	AC	3	2.36	2.36
	7		8	AC	3	2.36	2.36
	9		10	AC	12	9.3	9.2
	11		12	AC	12	6	6
T3	2	T3	6	AC	300	82	93
T4	3	T4	4	AC	300	240	240
	4		5	AC	300	240	240
	6		7	AC	12	5.8	5.8

**NOTE:** To terminal should be connected to — jack of the KS-14510 volt-ohm-millammeter.

### Point-to-Point Voltages

**5.07** Point-to-point voltages are used only to locate defective parts or isolate troubles, using the KS-14510 volt-ohm-millammeter.

**Caution:** *High voltages to ground are present within the rectifier unit; every precaution should be observed to avoid contact with exposed terminals when the rectifier is in operation.*

**5.08** Access for taking these voltage measurements is obtained as follows.

- (1) Unfasten and remove the front cover which exposes the adjusting potentiometers.
- (2) Unfasten and swing open the two door-type halves of the panel for access to tubes or other apparatus.

(3) When voltage checks are completed, close and fasten the panel halves and replace and fasten the front cover.

**5.09** When using any portable instrument, examine the leads to make sure the insulation is undamaged. Connect the leads at the instrument before connecting the leads to the circuit. If instrument ranges are to be changed, disconnect the test leads from the circuit before changing the meter range.

**5.10** The voltages given in Table A are for typical rectifiers operating on a 210-volt 60-Hz power source and are adjusted as follows:

J86240A                      7.5 amperes out at 137 volts dc  
(63-cell battery)

J86240B                      7.5 amperes out at 122 volts dc  
(56-cell battery)

*Note:* RV voltmeter at the above conditions should be 12 volts for J86240A and 7 volts for J86240B.

5.11 The performance of the current-limiting circuit may be checked using the KS-14510 volt-ohm-milliammeter connected across terminals 1 and 2 on the rectifier TS2 terminal strip. Table B lists the voltages which should be obtained for different output currents of the rectifiers.

TABLE B

RECTIFIER OUTPUT DC AMPERES	DC VOLTS ACROSS TERMINALS 1-2 TS 2 TERMINAL STRIP
2	34 — 42
4	58.5 — 71.5
6	85.5 — 104.5
8	112.5 — 137.5