

**RECTIFIERS**  
**J86219B L1, L2, AND L3**  
**OPERATING METHODS**

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**1. GENERAL**

**1.01** This section covers the operation of the J86219B L1, L2, and L3 electron tube or semiconductor-type rectifiers using series tube control regulation.

**1.02** This section is reissued for the following reasons.

- (a) To omit the information on "How the Rectifier Works."
- (b) To omit the functional schematic, Fig. 1.
- (c) To add the information for semiconductor-type rectifiers.
- (d) To add Fig. 1 illustrating the J86219B L3 rectifier.
- (e) To bring the section up to date.

Since this reissue covers a general revision, the arrows ordinarily used to indicate changes have been omitted.

**1.03** The J86219B L1, L2, and L3 rectifiers are intended to provide a stable voltage plate supply for applications in the 45A transmission measuring equipment (J86045A), the LD-T2 radio systems, and "L" carrier equipment.

**1.04** The J86219B L1, L2, and L3 rectifiers are rated as follows.

AC INPUT

105 to 125 volts, 50-60 cycle single phase

DC OUTPUT (see notes)

300 volts, 0.6 ampere

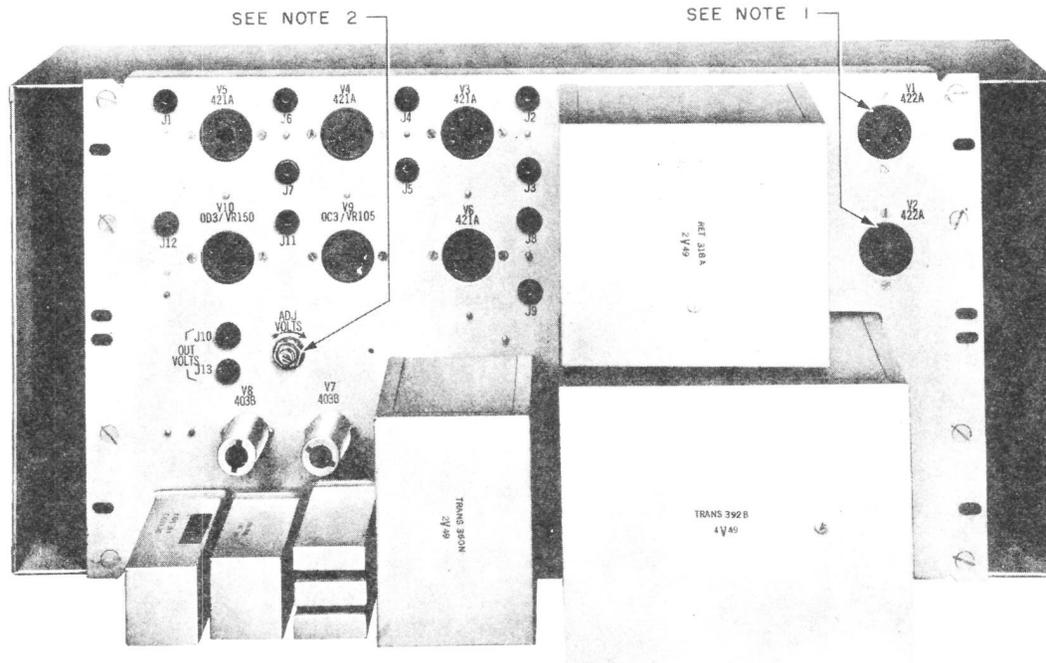
*Note 1:* The dc output voltage is adjustable from 240 to 310 volts. However, the output current is limited to 0.54 ampere at 240 volts.

*Note 2:* The maximum dc output current available is 0.4 ampere where the R33 resistor ("K" option) is provided in the circuit. See SD-81058-01.

*Note 3:* The dc output ripple is less than 2 millivolts rms with either the positive or negative side of the output grounded.

*Note 4:* The rectifiers are suitable for use in room temperatures from 50 F to 104 F (10 C to 40 C).

**1.05** *Caution: Voltages inside the rectifier exceed 150 volts to ground. Avoid all contact with terminals. Do not allow a test pick to touch two metal parts at the same time or destructive and dangerous short circuits may occur. The door switch, when open, disconnects only one side of the power supply, so that some ac terminals may be alive or at service voltage to ground. The door switch, when furnished, is provided for the protection of personnel and should not be made inoperative. Disconnect the ac supply before opening covers to work inside the rectifier except as necessary to make tests.*



NOTE 1: SEMICONDUCTOR-TYPE RECTIFIERS ARE PROVIDED WITH ONE 34C RECTIFIER (CRI SILICON RECTIFIER) INSTEAD OF THE TWO 422A ELECTRON TUBES (V1 AND V2). THE 34C RECTIFIER IS INSTALLED IN AN OCTAL-TYPE TUBE SOCKET.

NOTE 2: THE J86219B L1 AND L3 RECTIFIERS ARE EQUIPPED WITH THE ADJ VOLTS CONTROL AS SHOWN. IN THE J86219B L2 RECTIFIER THE CONTROL IS ON THE WIRING SIDE OF THE PANEL.

**Fig. 1 – J86219B L3 Electron Tube-Type Rectifier — View With Tubes Removed**

1.06 Some J86219B L1, L2, and L3 rectifiers are equipped with either or both of the following features. See SD-81058-01.

- (a) F1 ac input fuse
- (b) S1 door switch

1.07 **J86219B L1, L2, and L3 Semiconductor-Type Rectifiers:** The CR2 silicon diode ("J" option) is provided in the circuit in rectifiers equipped with the CR1 silicon rectifier (34C rectifier). See SD-81058-01.

1.08 Keeping the ventilating passages and rectifying elements clean is especially important to avoid excessive heating.

1.09 Routine checks are intended to detect defects particularly in infrequently operated 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 made during a period when there will be a minimum interference with service.

1.10 The instructions are based on SD-81058-01. For detailed description of the operation, see the corresponding circuit description.

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

#### Semiconductor Conversion (34C rectifier)

1.12 The J86219B, List A conversion kit consists of the necessary equipment and wiring for field replacement of the V1 and V2 electron tubes with the 34C rectifier.

**Caution:** When the V1 and V2 electron tubes are being replaced in the field by the conversion kit, all procedures and adjustments covered in 3.01 and 3.02 must be followed before returning the rectifier to service.

## 2. TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
<b>TOOLS</b>	
—	Insulated Switch Holder (see 6.05)
—	3-Inch C Screwdriver
<b>TEST APPARATUS</b>	
KS-14510 L1	Volt-Ohm-Milliammeter
—	General Radio Co Type W5MT Variac, or equivalent
—	Electron-Tube Test Set

## 3. OPERATION

### Preparing to Start Initially

3.01 When preparing to put the unit into service initially, check that:

- (a) There is nothing in, on, above, or below the rectifier to interfere with operation or prevent free ventilation.
- (b) The correct ac power supply voltage is used. Use the KS-14510 voltmeter for measuring the voltage.

**Caution:** When using any portable instrument, the leads should be carefully examined to make sure the insulation is undamaged. The leads should be properly connected to the instrument before making any contact with the circuit to be tested. If connections are to be changed from one instrument range to another, the power 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.

(c) The ac power supply connections to the TS1 terminal strip and the connections between the terminal strip and the T1 and T2 transformers are correct for the options or features provided.

(d) The "K" option (R33 resistor) is wired in the circuit where "M" option is not used. See SD-81058-01.

- (e) Either the positive or negative side of the output is grounded, if minimum output ripple voltage is required.
- (f) The correct electron tubes are in the sockets.
- (g) In semiconductor-type rectifiers, the CR1 silicon rectifier (34C rectifier) is properly installed in the socket and check that the CR2 diode ("J" option) is wired in the circuit.
- (h) The following correct size fuses, as required, are available.
  - (1) AC power supply fuse (not in the rectifier).
  - (2) F1 fuse.
- (i) The ADJ VOLTS potentiometer screwdriver control is in the maximum counterclockwise position.

**Note:** The potentiometer control is on the wiring side of the panel in the L2 rectifier and on the apparatus side of the panel in the L1 and L3 rectifiers.

- (j) All external connections are made in accordance with the SD- drawing covering the associated circuit of which the unit is a part.
- (k) In rectifiers equipped with a cover and the S1 door switch, the cover is clamped down tightly to operate the switch properly.

#### Initial Adjustments

**3.02** Proceed as follows.

- (a) Use the KS-14510 voltmeter connected across the J10 and J13 test jacks with the negative jack in the meter to the J13 jack. See Fig. 1.
- (b) Install the proper ac fuses, as required, to connect the ac input power.

**Note:** The dc output voltage will develop in approximately 10 seconds and build up to the stable regulated value within 2 to 3 minutes.

- (c) Adjust the ADJ VOLTS screwdriver control clockwise to secure the output voltage as required. The voltage is indicated on the KS-14510 voltmeter.

**Note:** Where the rectifier is equipped with a door switch, it is necessary to keep the switch operated while making the adjustment. See 6.05.

- (d) After completing the adjustment, remove the meter. Replace and fasten the covers that were removed.

#### Routine Adjustments

**3.03** The rectifier has no disconnecting switches and is connected to both ac power and the load when the ac input fuse or the F1 fuse, where provided, is in place. If it is necessary to take a rectifier out of service, remove the fuse. To restart, replace the fuse.

**Note:** The F1 fuse, where provided, is on the wiring side of the panel under the cover.

**3.04** Whenever any electron tube or the 34C rectifier (CR1 silicon rectifier) is replaced, the output voltage should be checked and readjusted if necessary.

#### 4. ROUTINE CHECKS

##### 4.01 *Electron Tubes*

- (a) ***Electron Tube Check Using the General Radio W5MT Variac or Equivalent:*** An overall check of the rectifier to determine whether one or more tubes is aged or defective should be made periodically, as follows.

**Note:** The period between checks must be determined by experience to avoid possible failure before the next check.

- (1) Remove the F1 ac input fuse (where furnished) in the rectifier or the ac input fuse in the common supply to the bay in which the rectifier is located.
- (2) Using two KS-14510 voltmeters, or equivalents, connect one meter across the ac input terminals of the rectifier and the other meter across the J10 and J13 test jacks (dc output) of the rectifier. J13 jack is negative.
- (3) Connect the variac common input and output terminal to the unfused ac input terminal of the rectifier and the other variac terminal to the load side of the fuse mounting of the removed fuse.
- (4) Adjust the dc output voltage of the rectifier, as required, for normal load.

(5) Using the variac, decrease the ac input voltage to 105 volts. If the dc output voltage drops 1 volt or more under these conditions, one or more of the tubes is aged or defective and they should be checked as covered in (b) and (c).

**(b) V3 through V6 Series Electron Tubes and R5 through R12 Cathode Resistors**

(1) The voltage drop over the parallel combination of the V3 through V6 duotriode electron tubes, under control of their respective grid voltages, regulates the output voltage of the rectifier. The R5 through R12 cathode resistors aid in keeping the load divided evenly between the eight parallel sections of these tubes. As the tubes and resistors age, regulation of the output will be affected. The J2 through J12 pin jacks are provided for measuring the voltage drops across the individual cathode resistors.

(2) Whenever the series tubes are suspected of having aged, measure the voltage drops across the R5 through R12 cathode resistors using the KS-14510 voltmeter as follows. Connect the negative jack in the meter to the J10 jack. Connect the positive jack in the meter to the J2 through J12 jacks in sequence for the R5 through R12 resistors in sequence. Calculate the average voltage drop for the eight resistors. When the individual voltage measurement across a resistor is 20 percent above or below the calculated average voltage, replace the tube in the resistor circuit. Replace the resistor when the resistance measurement check of the resistor indicates a value outside the limits specified on the SD drawing.

**(c) Electron Tubes Other Than V3 through V6 Tubes:** Routine checks of the other electron tubes can be made using any available electron tube tester, in accordance with the information for the tester, to determine when a tube is poor and needs to be replaced.

**4.02** Electrolytic capacitors should be maintained in accordance with Section 032-110-701.

**5. TROUBLES**

**5.01 V9 and V10 Electron Tubes:** The voltage drops across the cold cathode tubes increase with age. When the ADJ VOLTS potentiometer control has been turned to the following positions and regulation of the dc output voltage cannot be maintained, replace the tubes as specified.

POTENTIOMETER CONTROL POSITION	REPLACE TUBE
Max clockwise	V9
Max counterclockwise	V10

**5.02** The ADJ VOLTS potentiometer is totally enclosed and requires no maintenance and should be replaced if it becomes defective in any respect.

**Trouble Chart**

**5.03** Should any of the following troubles develop, it is suggested that the possible causes listed be checked. If the 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 following troubles may be caused by an open or short circuit or by an aging or drift in the constants of some faulty component. If one of the possible causes listed below or the use of the point-to-point voltage table 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 drawing, so that such faults may be found.

TROUBLE	POSSIBLE CAUSE
(a) No output voltage	Failure or disconnection of the input power Blown or missing ac supply fuse and/or F1 fuse Failure of V1 and/or V2 electron tubes (or CR1 silicon rectifier) Shorted filter capacitors Defective transformers Defective or open door switch

TROUBLE	POSSIBLE CAUSE
(b) Low output voltage	Low input power voltage
	Excessive load on rectifier output
	Breakdown of any or all filter capacitors
	Defective transformers
(c) High output voltage	Defective V1 and/or V2 electron tubes (or CR1 silicon rectifier)
	Aged V3 through V6 electron tubes. See 4.01(b)
	Defective V7, V8, V9, and/or V10 electron tubes
	Incorrect adjustment of ADJ VOLTS control
(d) Erratic output voltage	High input power voltage
	Defective transformers
	Defective V7, V8, V9, and/or V10 electron tubes
	Incorrect adjustment of ADJ VOLTS control
(d) Erratic output voltage	Fluctuating input power voltage
	Intermittent open or short in any component
	Defective connections
	C5, C7, C8, C9, and/or C10 capacitors open
	Flicker in V9 and/or V10 electron tubes

## 6. POINT-TO-POINT VOLTAGES

**6.01** As long as the rectifier operates satisfactorily, point-to-point voltage values are not needed and are not operating requirements to be checked in routine. In case the rectifier output cannot be obtained, they may be useful in locating defects or trouble conditions.

**6.02** High voltages to ground are present within the rectifier and every precaution should be observed to avoid any bodily contact with exposed metal parts or terminals when the rectifier is in operation or not in operation but connected to the input power source.

**6.03** The time required for the output voltage to stabilize to the regulated value after the input power is connected is approximately 3 minutes.

**6.04** The readings given in the table are approximate and typical for a J86219B electron tube rectifier adjusted as indicated in 6.06. The readings are measured with a KS-14510 meter. Connecting the meter to observe readings does not appreciably affect the rectifier output.

*Caution: When using any portable instrument, the leads should be carefully examined to make sure the insulation is undamaged. The leads should be properly connected to the instrument before making any contact with the circuit to be tested. If connections are to be changed from one instrument range to another, the power 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.*

**6.05** The KS-14510 meter is provided with both test clip leads and test pick leads. Where there are door switches, the test clip leads should be used in making connections to leave the maintenance man free to observe the meter and operate the door switch. When it is necessary to operate a door switch while using a test pick lead, the door switch should be operated with some insulating material to avoid grounding one hand. This insulating material may be a stick 5 or 6 inches long with a depression in one end into which the door switch plunger fits. The depression is to prevent the stick from accidentally slipping off the switch plunger.

*Caution: The door switch does not disconnect both sides of the input power so that the terminals of the door switch as well as the transformers primary terminals may be at voltage-to-ground.*

**TABLE OF POINT-TO-POINT VOLTAGES**

**6.06** The rectifier should be connected to a 115-volt, 60-cycle input power supply and adjusted at the point of regulation for a 300-volt, 0-ampere output.

*Caution: Disconnect the alternating current supply before working on the unit except when necessary to make tests. The voltage readings shown in the table are for a typical rectifier in good working condition. A defective rectifier with the power connected may have quite different voltages from those shown. Therefore, it may be desirable to use a higher voltage range on the meter until readings indicate the proper range to use for the defective condition. Re-*

*move the ac fuses before removing any protective guards under the cover. A defect in the rectifier may leave a high voltage charge on a capacitor and other parts of the circuit with the power off (door switch released). The electron tube filaments may be connected to power even with the door switch released.*

**6.07** For making point-to-point measurements, it will be necessary to remove both front and rear covers of the rectifier or the covers of the equipment bay in which the rectifier is mounted. See Fig. 1. When the tests are completed, replace and fasten the covers that were removed. Where the door switch is used, check that the cover is clamped down tightly to operate the switch properly.

VOLTAGES FOR J86219B ELECTRON-TUBE RECTIFIER WITH "K" OPTION WIRING (R33)								
VOLTAGE ACROSS	MEASUREMENT MADE				KS-14510 METER			
	FROM		TO (See Note 1)		SCALE AC OR DC	RANGE (volts)	NOTES	READING (volts)
	APP	TERM.	APP	TERM.				
Output	Jack	10	Jack	13	DC	300		298
C1 and C2 or C3 and C4	Jack	1	Jack	13	DC	600	2,3	555
L1	L1	1	L1	2	DC	12		0.7
R5	Jack	2	Jack	10	DC	3		0.15
R6	Jack	3	Jack	10	DC	3		0.15
R7	Jack	4	Jack	10	DC	3		0.15
R8	Jack	5	Jack	10	DC	3		0.15
R9	Jack	6	Jack	10	DC	3		0.15
R10	Jack	7	Jack	10	DC	3		0.15
R11	Jack	8	Jack	10	DC	3		0.15
R12	Jack	9	Jack	10	DC	3		0.15
R21	Jack	1	TP	2	DC	600		320
R23	Jack	10	V7	6	DC	60		13.5
R24	Jack	10	V7	1	DC	300		105
R26	Jack	11	V8	6	DC	12		1.8
R27	Jack	11	Jack	13	DC	300		192
R29	Jack	12	Jack	13	DC	300		147
T1	T1	1	T1	2	AC	300	3	113
T1	T1	3	T1	4	AC	600	3	530
T1	T1	4	T1	5	AC	600	3	530
T2	T2	1	T2	2	AC	300		115
T2	T2	3	T2	4	AC	12		6.4
T2	T2	5	T2	7	AC	12		5.1
T2	T2	8	T2	9	AC	12		6.3
V3 Grids	Jacks	2 or 3	TP	2	DC	300	4	63
V4 Grids	Jacks	4 or 5	TP	4	DC	300	4	63
V5 Grids	Jacks	6 or 7	TP	6	DC	300	4	63
V6 Grids	Jacks	8 or 9	TP	8	DC	300	4	63
V9	Jack	11	TP	3	DC	300		102
V10	Jack	10	Jack	12	DC	300		147

**Notes:**

1. "To" terminal should be connected to the negative jack of the meter.
2. The voltage reading across each individual C1, C2, C3, or C4 capacitor should be approximately one-half of this reading.
3. In rectifiers where "M" option is wired in the circuit (see SD-81058-01) these voltage readings should be approximately 1 percent higher.
4. Each V3, V4, V5, and V6 electron tube has two grid voltage readings.