TRANSMISSION AND NOISE MEASURING SYSTEM

1U AMPLIFIER-RECTIFIER

(RANGE 35 TO 15,000 HERTZ)

DESCRIPTION

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1. GENERAL

1.01 This section describes the J64001U amplifier-rectifier panel. The panel is part of the combined Transmission and Noise Measuring System per SD-95900-01 provided at testboards, switching maintenance centers, D2 channel bank bays, and other locations. It is also part of the Transmission Measuring System per SD-59432-01 provided at voice-frequency patch bays, repeater bays, and packaged N carrier terminals; or, part of the Transmission Measuring System per SD-1G073-01 provided for private service systems at air-ground, A1 digital data, and private line testboards.

1.02 This section is reissued to include information on an improved version of the amplifier-rectifier panel which contains additional provisions for calibration adjustments. The new version can be identified by the presence of the CAL 2 and CAL 3 controls on the front panel (Fig. 1). Since this reissue covers a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 This reissue does not affect Equipment Test Lists.

1.04 The 1U amplifier-rectifier consists of a feedback amplifier and copper oxide varistor, the input and output of which are associated with the receiving portion of a transmission measuring system. The input of the amplifier is associated with the receiving jacks or keys of the measuring system and the output of the rectifier is connected by the measuring system to a suitable dB meter. During calibration and measurement, the relays mounted on the panel change the sensitivity and impedance of the amplifier-rectifier as directed by the control leads of the associated measuring circuit.

1.05 All transmission measurements made with the 1U amplifier-rectifier are direct readings in dB referred to 1 milliwatt (0 dBm). Sensitivity control arrangements in the associated measuring circuits provide a measuring range from −35 to +15 dBm at any frequency from 35 to 15,000 hertz. The amplifier-rectifier is capable of a range from −35 to +25 dBm but the upper range (+10 to +25 dBm) is not presently used by the associated measuring circuits. The measurements can be made on a 600-ohm terminated, 900-ohm terminated, or high-impedance bridging basis. The bridging impedance is about 60,000 ohms.

2. AMPLIFIER-RECTIFIER EQUIPMENT

2.01 The 1U amplifier-rectifier panel is usually located in a bay in or near the testing area. The principal equipment features of the panel (both versions) are shown in Fig. 2.

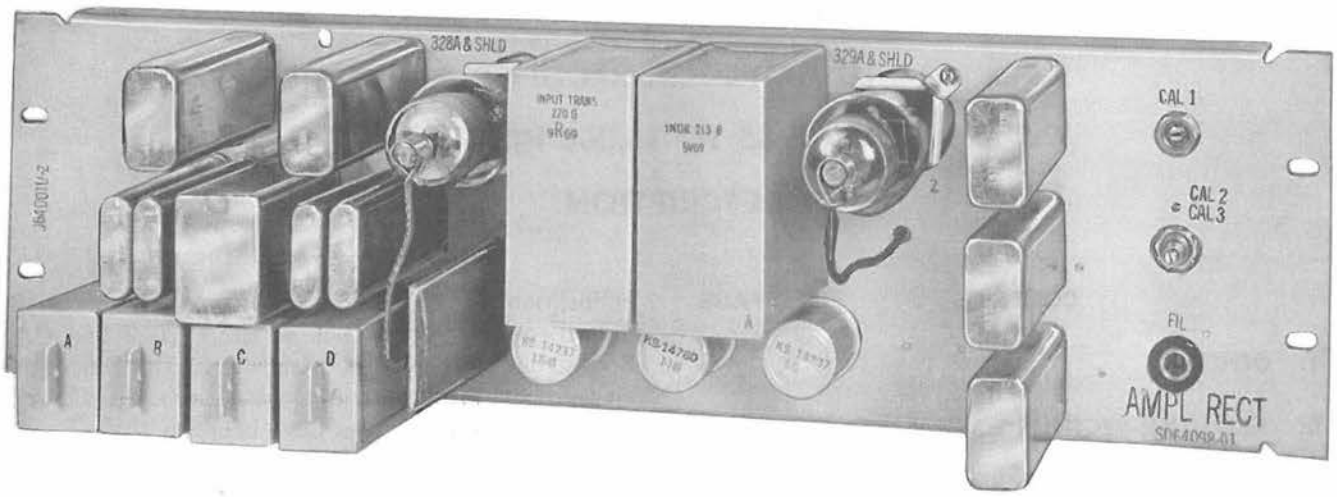


Fig. 1—J64001U Amplifier-Rectifier, Front View (Improved Version)

2.02 In the earlier version, the CAL potentiometer is accessible on the front of the panel and is used for adjusting the overall gain of the unit. It is adjusted by means of a screwdriver. Adjustable resistor S is located on the rear of the panel and is used for adjustment of readings above 0 dBm after the CAL resistor has been adjusted. It is adjusted by means of a slidewire resistor which is locked in place by a screw. In the new version, three potentiometers—CAL 1, CAL 2, and CAL 3—are front-panel mounted for accessibility. CAL 1 is the same as the CAL potentiometer in the earlier version and is used to calibrate the system at −16 dBm or any other frequently measured level in the B + 10 range. It is adjusted with a screwdriver. The other two (CAL 2 and CAL 3) are concentrically mounted. CAL 2 (the inner shaft) is a new control which is screwdriver controlled. It is used for calibrating the system at 0 dBm or any other frequently measured level in the B or B + 0 range. CAL 3 (the outer shaft) replaces the S resistor in the earlier version and is used to calibrate the system at +7 dBm or any other frequently measured level in the A range. It is adjusted by grasping the shaft with the fingers and turning it.

2.03 The FIL jack provides a means of measuring the filament current of the electron tubes. Adjustable resistors A and B are used in regulated 24-volt battery offices to adjust the filament current at specified battery voltages.

2.04 Two electron tubes are used in the amplifier-rectifier. Each is encased in a shield which is grounded to the panel by means of contact clips. The flexible grid wires are connected to the grids of the tubes on the front of the panel by means of grid caps.

2.05 Three electrolytic bypass capacitors are used in the circuit and each is insulated from the panel.

2.06 Four relays are provided on the panel. Each is controlled by the associated measuring system. Relay A is a 2-winding relay which can be operated, by application of either battery or ground, to provide a 600-ohm termination. Relays B, C, and D control the effective amplification and measuring range of the system.

2.07 Some of the early versions of the 1U amplifier-rectifier were provided with an internal high-pass filter which could be wired in by exercise of option Y of SD-64098-01. This filter has no use in any present application of the amplifier-rectifier since a key-controlled external high-pass filter is included in the associated measuring system, where required. It is desirable to verify that the internal filter (option Y) has been disconnected in all 1U amplifier-rectifiers in service. Failure to remove this filter will result in errors during frequency-response measurements.

3. AMPLIFIER-RECTIFIER CIRCUIT

3.01 The principal circuit features of the two versions of the J64001U amplifier-rectifier circuit are shown in Fig. 3 and 4.

3.02 The input circuit is used for transmission measurements on a 600-ohm terminated, 900-ohm terminated, or high-impedance bridging basis. When the measurement is on a 600-ohm terminated basis,relay A in the amplifier-rectifier may be operated to provide the 600-ohm termination for the circuit being measured. For some applications, a 600- or 900-ohm termination is provided externally in the associated transmission measuring circuit. In such cases, the amplifier-rectifier is operated on a bridging basis and relay A is not operated. For 900-ohm measurements, the external termination consists of a voltage divider so designed that the results of the measurements are read directly in dBm without the need for corrections. A single adjustment is adequate when the measuring system is arranged to test both 600- and 900-ohm circuits.

3.03 The input transformer is balanced and shielded against longitudinal effects. The secondary winding is tapped and, in combination with adjustable resistor S or CAL 3 and relay D, provides a means of changing the overall gain by 25 dB. Relay D in the released position closes a path to the full secondary winding to provide gain for measurements below 1 milliwatt. The overall gain adjustment in the earlier version is made with the CAL potentiometer. In the new version, the gain adjustment with an input in the −25 to −10 dBm range is made with the CAL 1 potentiometer (relay B operated). With none of the relays operated, the CAL 2 potentiometer adjusts the gain for an input in the −15 to 0-dBm range. Relay D in the operated position closes a path to the tap of the secondary winding to provide reduced gain for measurements above 1 milliwatt. Resistor S or CAL 3 is used to adjust the gain under this condition, after the CAL (or CAL 1 and CAL 2) potentiometer has been adjusted.

3.04 The amplifier circuit employs two heater-type electron tubes of the multigrid type, operating from the regular 24- or 48-volt office battery supply. The tubes are impedance coupled with grid bias voltages obtained from the filament and plate battery supplies. The output of the amplifier is supplied to the rectifier through a blocking capacitor to prevent the flow of direct current from the plate supply to the rectifier unit.

3.05 Negative feedback from the rectifier circuit reduces the gain bias of the input stage. With this arrangement, the effective overall gain of the amplifier is materially reduced and a large amount of gain stability is obtained. By operation of relay B or C, the amount of negative feedback is reduced and the overall gain increased by 10 or 20 dB. These relays, in combination with relay D as discussed in 3.03, provide means for changing the measuring range of the amplifier-rectifier in fixed 10-dB steps.

3.06 The measuring range relays B, C, and D are controlled by sensitivity keys, dial switches, or jack contacts located at the test positions where measurements are made. When relays B, C, and D are operated, either singly or in combination, the changes in the feedback path and transformer tap connection alter the amplifier gain and measuring range as shown in Table A.

TABLE A

RELAY(S) OPERATED	CHANGE IN AMPL GAIN (dB)	MEASURING RANGE (dBm)
C	+20	−35 to −20
B	+10	−25 to −10
None	0	−15 to 0
B and D	−15	0 to +15
D	−25	+10 to +25 (Not used. See 1.05)

3.07 Subsequent to calibration adjustment, gain variations resulting from electron tube deterioration, battery voltage changes, etc., are minimized by the stabilizing action of the feedback circuit. Accuracy is stated in 6.01.

4. OUTPUT METER

4.01 The output meter is connected to the rectifier output by the associated measuring system. A projection-, bracket-, or panel-mounted type meter can be used. The meters are electrically equivalent. The meter resistance is about 180 ohms and the full-scale current is approximately 1.5 milliamperes.

4.02 The meter has two 15-dB scales, each with approximately uniform dB divisions and

0.2-dB subdivisions. The A scale (usually red) is marked 0 to 15. It is used with the 1U panel for transmission measurements of gains or levels above a milliwatt and with the 1W noise amplifier-rectifier panel for noise measurements above reference noise. The B scale (black) is marked 15 to 0 and is used for transmission measurements of losses or levels below a milliwatt. The total measurement, in dB above or below 0 dBm, is the arithmetic sum of the meter reading plus the designation on the jack or on the operated sensitivity key or dial switch.

5. OPERATION

5.01 Access to the input of the 1U amplifier-rectifier and control of its sensitivity and input impedance is provided by the connecting transmission measuring circuits, such as SD-95900-01, SD-1G073-01, SD-59432-01, or similar circuits. The connecting circuits also switch the output of the rectifier to the dB meter where the results of measurements can be read. Table B shows the various sensitivity control designations, the output meter sensitivity, and the sensitivity relay operation.

TABLE B

SENSITIVITY DIAL SETTING OR KEY OPERATED	OUTPUT METER SENSITIVITY IN dBm	RELAY(S) OPERATED ON 1U PANEL
B + 20	−35 to −20	C
B + 10	−25 to −10	B
None, B, or B + 0	−15 to 0	None
A, Scale A, or A + 0	0 to +15	B & D

5.02 The 1U amplifier-rectifier is calibrated in accordance with the sections of practices covering the particular measuring system of which it is a part (for example, see Sections 103-231-500 and 103-231-510). With the calibration arrangement provided in the 1U amplifier-rectifier panel, it is possible to obtain a high degree of accuracy at two values of input power for the early version and three for the improved version. With the early version, a value of input power between −15 and 0 dBm is applied with all sensitivity relays released, or between −25 and −10 dBm with the B relay operated and the C and D relays released. The CAL potentiometer is then adjusted until the meter reads the exact value of the applied input power on the B scale of the output meter. With the improved version, an input power in the range between −25 and −10 dBm is applied with the B relay operated and the C and D relays released. The CAL 1 potentiometer is then adjusted. A value between −15 and 0 dBm is applied and, with all relays released, the CAL 2 potentiometer is adjusted. After the above adjustments have been made with either version, a value of input power between 0 and +15 dBm is applied with the B and D relays operated and the C relay released. The S resistor or CAL 3 potentiometer, as appropriate, is adjusted to provide a meter reading on the A scale of the output meter which is exactly equal to the value of input power applied. With the above procedure, it is thus possible to obtain maximum accuracy, for example, at −16 or 0 dBm on the B scale with the earlier version and at ***both*** −16 and 0 dBm on the improved version. In both versions, the same maximum accuracy can be obtained at 0 or +7 dBm, for example, on the A scale.

5.03 Descriptions of the controls and sensitivity keys or switches that operate the sensitivity relays are also contained in the sections of practices on the associated transmission measuring systems of which the 1U amplifier-rectifier is a part.

6. ACCURACY

6.01 The measuring accuracy of the 1U amplifier-rectifier and its output meter(s) is a function of the level and frequency of the signal being measured. When the amplifier-rectifier and meter are properly calibrated, the combined accuracy is shown in Table C.

7. MAINTENANCE

7.01 Maintenance of the 1U amplifier-rectifier requires periodic calibration with an accurate milliwatt supply of the proper level (see 5.02) and periodic checks for gain without feedback, scale matching, and sensitivity control requirements. It is necessary to check for these requirements whenever components are replaced or major repairs made. The test and adjustment procedures are covered in the sections on the associated transmission measuring circuits (see, for example, Sections 103-231-500 and 103-231-510).

TABLE C

FREQUENCY (Hz)	LEVEL (dBm)	COMBINED ACCURACY OF 1U PANEL AND ASSOCIATED METER (dB)
1000	Calibration (See note.)	±0.05
400 to 4000	−35 to +15	±0.15
50 to 400 and 400 to 8000	−35 to +15	±0.35
35 to 50 and 8000 to 15,000	−35 to +15	±0.65

Note: Calibration level refers to the level at which the system is calibrated (see 5.02).

A. Trouble Testing

7.02 When the requirements cannot be met, or if the system exhibits instability or difficulty in adjustment, the circuit should be investigated for trouble. Circuit details are given on the drawings listed in Part 8. It is particularly important to check the electron tubes and electrolytic capacitors whenever trouble is experienced.

B. Test of Gain Without Feedback

7.03 A test of the amplifier gain without feedback can be made to find troubles which might otherwise be masked by the stabilizing action of the feedback circuit. This can be done by using a 5A attenuator or its equivalent to determine the loss that must be inserted between a milliwatt source and the input of the measuring system to obtain a full-scale meter reading of 0 on the B scale. For this test, the meter shunt should be opened by disconnecting one of the leads to resistor W (59 ohms). Resistor J (41.9 ohms) should be short-circuited. With the TST-101 key operated to TST and the SEND-RCV key operated to RCV, the attenuator should be connected between the receiving jack of the system (600Ω TST, RCV, or TST MEAS) and a source of test power which provides 1 milliwatt (0 dBm) at 1000 Hz. The B + 20 sensitivity key should be held operated, or the sensitivity switch operated to B + 20 and the attenuator keys or dials adjusted until the meter reads 0 on the B scale. The total attenuation (5A attenuator plus test pads, if associated with the TST MEAS jack) should be 56 dBm ±2 dB. If this limit is not met, defective electron tubes, electrolytic capacitors, or feedback resistors should be suspected. The feedback resistors (J, K, and L) can be checked on a Wheatstone bridge against the limits shown on SD-64098-01. The electrolytic capacitors (D, E, and B) can be checked by measuring the dc voltage across the resistors (T; U; K, L, and M) shown in Table D. Use a 20,000 ohms per volt voltmeter.

C. Electron Tubes

7.04 Replacement of electron tubes in the 1U amplifier-rectifier is made in accordance with the SD drawing.

8. LIST OF DRAWINGS (Not Attached)

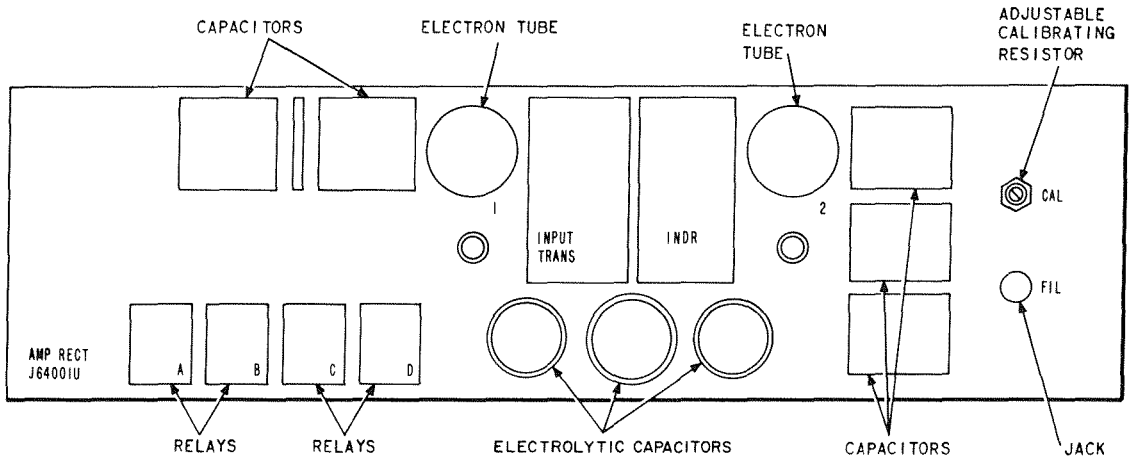
DRAWING	TITLE
SD-64098-01	1U Amplifier-Rectifier Circuit
SD-1G073-01	Transmission Measuring Circuit
SD-59432-01	Transmission Measuring Circuit
SD-95900-01	Transmission and Noise Measuring Circuit

TABLE D

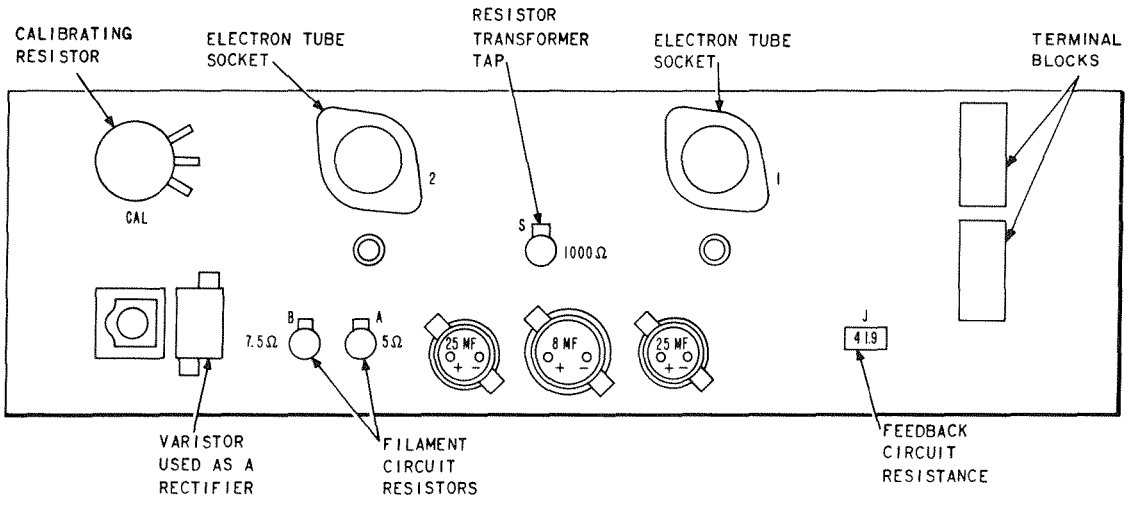
RESISTOR(S)	CAP. UNDER TEST	MEAS FROM +		MEAS TO —		DC VOLTS	
		APP	TERM.	APP	TERM.	MIN	MAX
T	D	ET 2	4	TS B	4	7.0	9.0
U	E	TS B	2	ET 2	3	45.0	75.0
K, L,* & M (See note.)	B	ET 1	5	Rel. C	1 Top	3.5	5.5

Note: When measuring voltage across resistors K, L, and M, operate the B + 20 key or switch; this operates relay C.

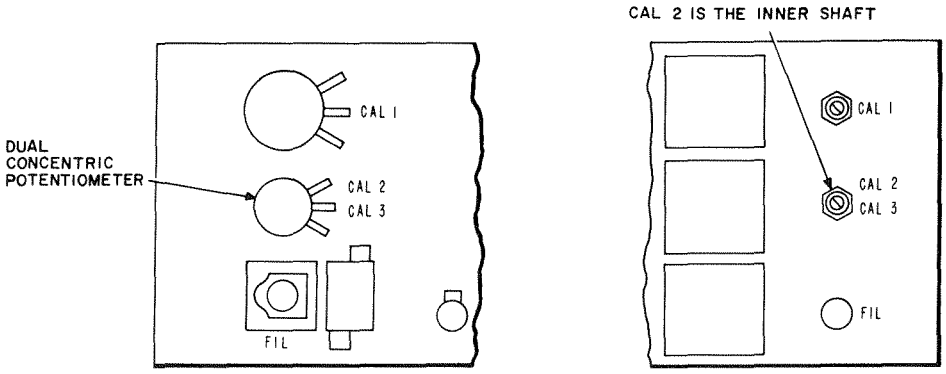
*** Resistor L is replaced by CAL 2 in the improved version.**



FRONT VIEW J64001U
(EARLY VERSION)



REAR VIEW J64001U
(EARLY VERSION)



REAR VIEW J64001U
(IMPROVED VERSION)

FRONT VIEW J64001U
(IMPROVED VERSION)

Fig. 2—Principal Equipment Features

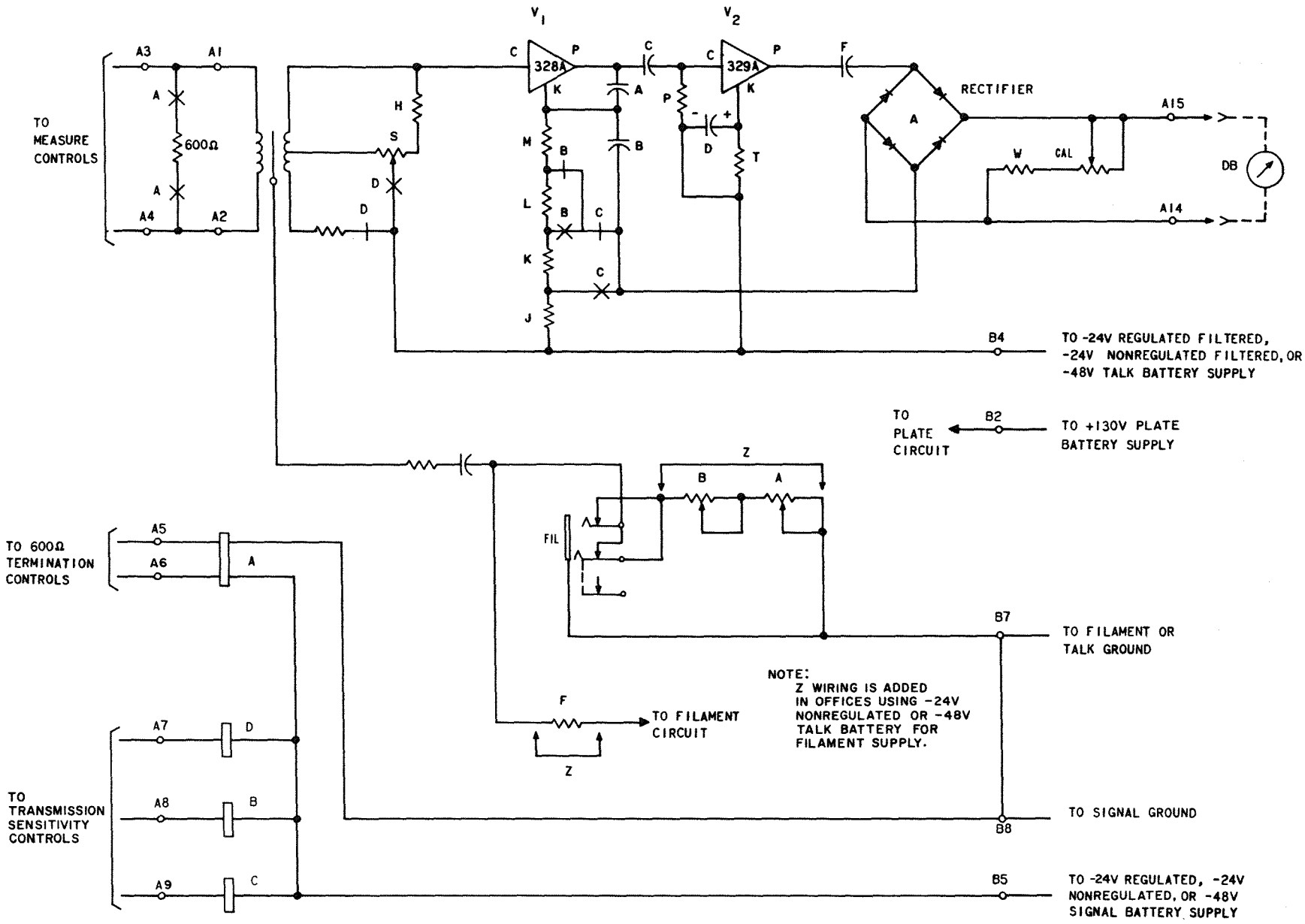


Fig. 3—J64001U Amplifier-Rectifier, Functional Schematic (Early Version)

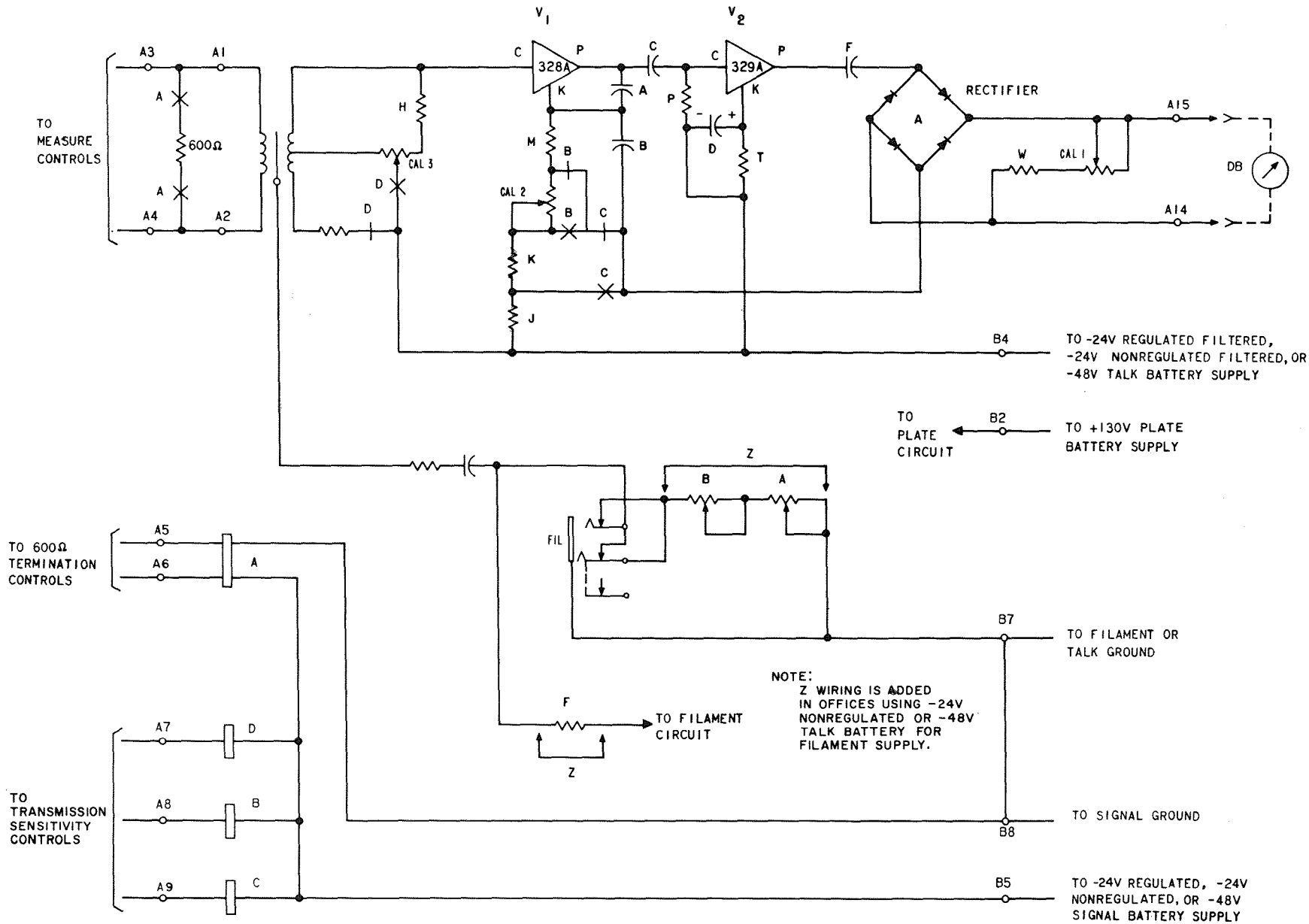


Fig. 4—J64001U Amplifier-Rectifier, Functional Schematic (Improved Version)