RECTIFIERS

KS-15894 L1, L2, L3, AND L4

OPERATING METHODS

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1. GENERAL

1.01 The KS-15894 L1, L2, L3, and L4 rectifiers, employing ferroresonant transformer control regulation, are used to provide power for the following.

(a) The KS-15894 L1 and L2 rectifiers are intended to supply filamentary power for type B entrance links associated with the TJ Radio System (J68851) and for use with the 10B testboard.

(b) The KS-15894 L3 rectifier is intended for use in the J86833 (-24 volt) power supply for the 1A telephone answering system. Information for the J86833 power supply is covered in CD-81713-01 and on the associated schematic drawing.

(c) The portable KS-15894 L4 rectifier is used to supply power for the portable 3-type FM terminal system (J86383) in the TD Microwave Radio System.

1.02 This section is reissued to add information on the KS-15894 L4 rectifier. Since this reissue covers a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 The KS-15894 L1, L2, L3, and L4 rectifiers (Fig. 1, 2, and 3) are rated as follows. See Notes.

AC INPUT

L1 — 115/230 volts, 60 Hz

L2 — 115/208/230 volts, 50/60 Hz

L3 — 117 volts, 60 Hz

L4 — 117 volts, 60 Hz

DC OUTPUT

L1 and L2 — 22 or 24 volts, 6 amperes continuous

L3 — {24 volts, 6 amperes continuous / 24 volts} see Note 5

L4 — 24 volts, 4 amperes

AC OUTPUT

L3 — {10 volts, 0.300 amp continuous / 15 volts, 1.0 amp intermittent} see Note 5

Note 1: A circuit label (schematic drawing of the rectifier prepared by the manufacturer) is attached to the inside of the removable front cover of the unit. The circuit label shows the required connections for the ac input voltage and frequency and ac and dc output voltages. Connection adjustments, as

required, are made to screw-type terminals inside the unit (L1, L2, and L3 rectifiers).

Note 2: The dc output voltage of the rectifiers varies approximately 1.5 percent for each percent change in the frequency of the input voltage.

Note 3: With KS-15894 L1, L2, L3, and L4 rectifiers, the dc output voltage is unregulated for load current changes and any increase in the load current will reduce the output voltage.

Note 4: For KS-15894 L1, L2, L3, and L4 rectifiers, with a constant load on the outputs, a ±10 percent variation in input voltage will result in approximately ±1 percent change in output voltages.

Note 5: For the KS-15894 L3 rectifier, the 10-volt and 15-volt ac outputs furnish power for operation of an interrupter and card dialers, respectively, used with the telephone answering system. An additional unfiltered 24-volt dc output is provided by the rectifier to furnish voltage for rectifier failure and fuse failure alarms. See CD-81713-01 covering the J86833 power supply.

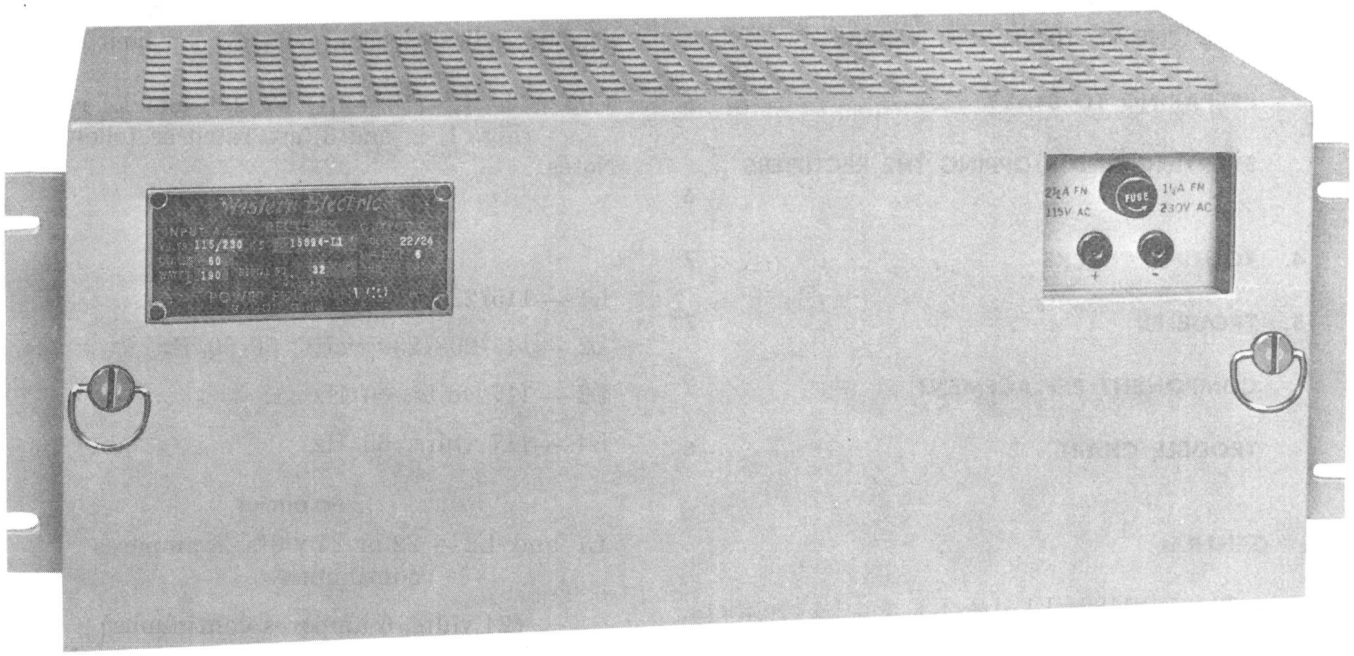

Fig. 1—KS-15894 L1 Rectifier

1.04 The L1, L2, and L3 rectifiers are equipped with ventilated removable front covers. Inside the units, screw-type terminals are provided for ac and dc connections and for making the necessary connection adjustments. See 1.03, Note 1. The ac input fuse and pin jacks for measuring the dc output voltage are accessible on the front panels without removal of the covers. The L4 rectifier (Fig. 3) is contained in a fiber-glass carrying case with a removable cover. The 6-foot, 3-wire, ac input cord is stored on a wrap-around bracket in the cover of the carrying case. When the cover is removed, the ON-OFF input switch, input and output fuses, test jacks for connecting an external voltmeter to measure the output, and receptacles for connecting the output to associated equipment are accessible.

Caution 1: The voltages inside the rectifier cases are higher than 115 volts to ground.

Fig. 2—KS-15894 L2 and L3 Rectifiers (L2 Illustrated)

Avoid all contact with terminals as high voltages may be present. Do not allow a test pick to touch two metal parts at the same time or destructive and dangerous short circuits may occur. The voltages on the ferroresonant transformer windings are dangerously high. Disconnect the alternating current supply before working on the unit, except when necessary to make tests. Where the rectifier is used in a battery reserve system, remove all CHG fuses in the system after disconnecting the alternating current supply to the equipment, except when necessary to make tests.

Caution 2: Do not operate the L4 rectifier with the cover on the carrying case.

1.05 Keeping the ventilating passages clean is especially important to avoid excessive heating.

1.06 Routine checks, other than those required by trouble conditions, should be made during a period when they will not interfere with service.

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

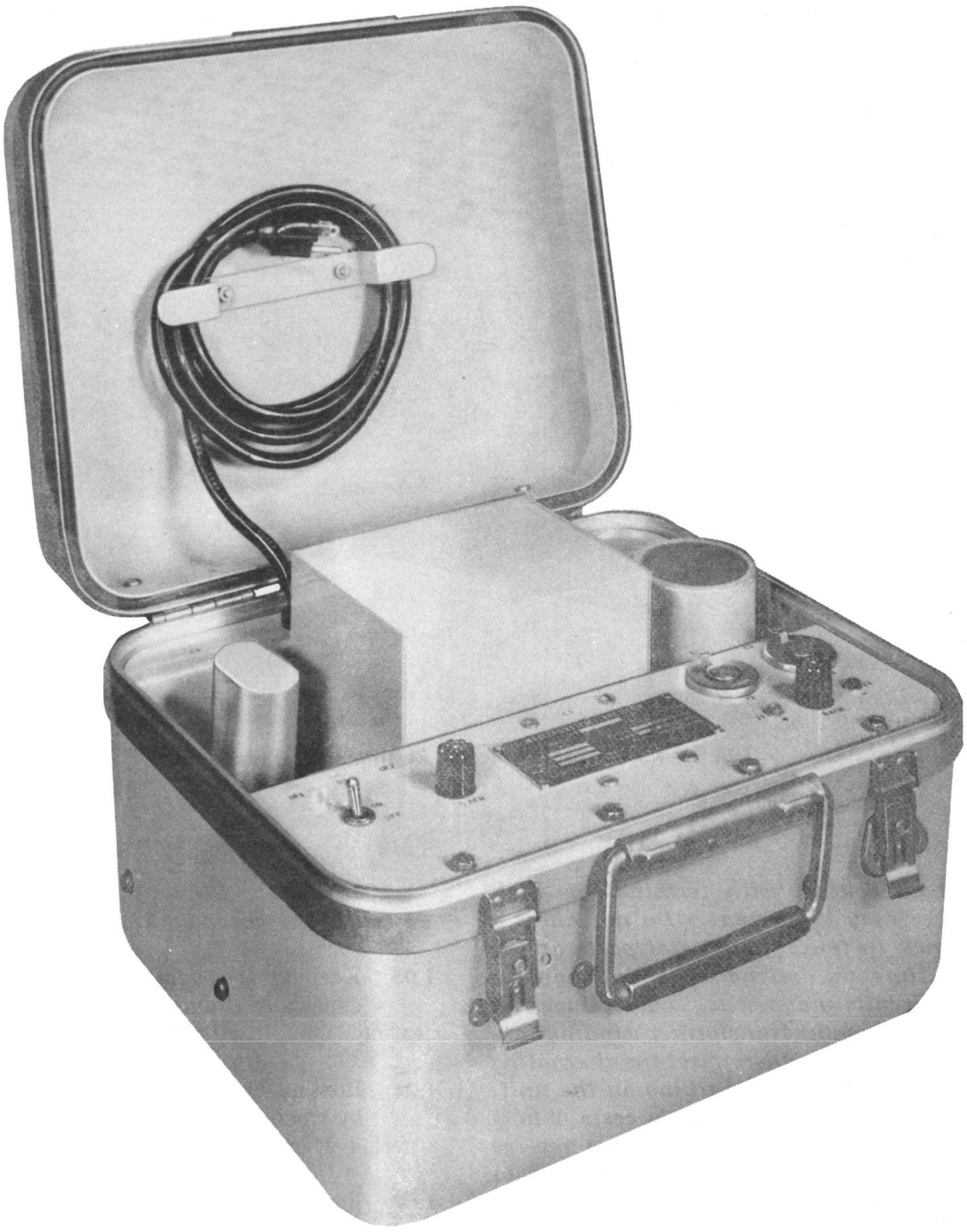

Fig. 3—KS-15894 L4 Rectifier

2. LIST OF TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	3-Inch C Screwdriver
TEST APPARATUS	
KS-14510	Volt-Ohm-Milliammeter
—	DC Ammeter, Weston, Model 281, 0/10-Ampere Range
—	Variable Resistance Load Capable of Carrying 8 Amperes at 30 Volts

3. OPERATION

HOW THE RECTIFIER UNIT WORKS

3.01 ***KS-15894 L1 Rectifier:*** The KS-15894 L1 rectifier works in a manner similar to the KS-15894 L2 rectifier (see 3.02) except as follows.

(a) Sixty-Hz power is connected to the primary of the T1 ferroresonant transformer.

(b) The secondary of the T1 ferroresonant transformer consists of a winding which has taps for connection to the CR1-CR2, full-wave, center tap rectifier. The C1 tuning capacitor is connected across the secondary winding.

(c) The pulsating output from the CR1-CR2 center tap rectifier is filtered by the C2, C3, and C4 shunt capacitors. The R1 bleeder resistor is connected across the filter to maintain a minimum dc output and to discharge the capacitors when the unit is disconnected from the ac input power and the load. An inductor is not provided in the filter circuit.

3.02 ***KS-15894 L2 Rectifier:***

(a) Fifty- or sixty-Hz power is connected to the primary of the T1 ferroresonant transformer which provides a substantially constant output voltage with large variations of input line voltage. The dc output voltage, however, is regulated for load current changes and, therefore, an increase in the load current reduces the output voltage. In the T1 transformer, the primary coil and a nonlinear operating coil are magnetically coupled by being wound on a common portion of the core. The primary and the nonlinear operating coil are partially separated by a shunt magnetic path of high reluctance. This arrangement serves to partially decouple the primary coil from the nonlinear operating coil and introduces a high leakage reactance. (The equivalent circuit may be represented as a linear coil connected in series with a nonlinear operating coil where the high leakage reactance is considered as having the characteristic of a linear operating coil.) The C5 tuning capacitor is connected across the nonlinear operating winding of the T1 transformer.

(b) In operation, when an ac voltage of low value is impressed upon the circuit, the parallel combination of the nonlinear inductor of the T1 transformer and the C5 tuning capacitor acts as a capacitive reactance in series with the inductive reactance. This effective capacitive reactance is smaller than the inductive reactance. As the impressed voltage is increased, the series combination of the linear inductive reactance and the nonlinear inductor in parallel with the capacitor passes through resonance due to the decreasing inductance of the nonlinear inductor. This causes a further reduction of the nonlinear inductance which carries the series-parallel combination further from resonance in a continuing process so that the nonlinear operating coil approaches saturation. After the series-parallel circuit passes through resonance, the voltage across the parallel combination rises to a much higher value than the voltage developed before resonance. Variations of the impressed voltage change the degree of saturation of the nonlinear operating coil so that the variation in the effective capacitive reactance of this portion of the circuit tends to maintain an essentially constant voltage across its terminals. The output consists of a portion of the nonlinear operating winding voltage.

(c) This type of circuit has an inherent output current limiting characteristic. As the load is increased, the effective capacitive reactance of the parallel circuit is reduced and the resultant change in voltage across the parallel combination is comparatively small until the point is reached where the capacitive reactance of the circuit falls below the value required to maintain the series-parallel combination above the resonant value. When this happens, the nonlinear operating

coil comes out of saturation and the high voltage developed across the parallel combination coming out of saturation falls to a low value.

(d) The secondary winding of the T1 ferroresonant transformer is connected to the CR1-CR2, full-wave, center tap rectifier. The pulsating output from the center tap rectifier is filtered by the L1 inductor and the C1, C2, C3, and C4 shunt capacitors. The R1 bleeder resistor is connected across the filter to maintain a minimum dc output and to discharge the filter capacitors when the unit is disconnected from the ac input power and the load.

3.03 ***KS-15894 L3 Rectifier:*** The KS-15894 L3 rectifier works in a manner similar to the KS-15894 L2 rectifier (see 3.02) except as follows.

(a) Sixty-Hz power is connected to the primary of the T1 ferroresonant transformer.

(b) The secondary of the T1 ferroresonant transformer consists of three isolated windings, two windings to furnish the two ac voltage outputs of the unit and a main winding for rectification purposes. The C1 tuning capacitor is connected across the main winding. A portion of the secondary is connected to the CR3-CR4, full-wave, center tap rectifier to furnish the unfiltered dc output of the unit. The same portion of the secondary is also fed into the load compensating network (L1 inductor, C2 capacitor, and T2 transformer) to produce a voltage which varies directly with the load, thereby tending to compensate for the voltage drop due to output regulation.

(c) The secondary of the T2 transformer consists of two isolated windings fed from a linear portion of the T1 ferroresonant transformer secondary. The CR1-CR2, full-wave, center tap rectifier is connected between the isolated secondary windings of the T2 transformer with a return from the center tap of the rectifier to the T1 transformer secondary.

(d) The pulsating output from the CR1-CR2 rectifier is filtered by the L2 inductor and the C3, C4, C5, and C6 shunt capacitors. The R1 bleeder resistor is connected across the filter to maintain a minimum dc output and to discharge the filter capacitors when the unit is disconnected from the ac input power and the load.

3.04 The KS-15894 L4 rectifier operates in a manner similar to the KS-15894 L2 rectifier (see 3.02), differing only in input and output voltages and in output current (see 1.03). For physical differences, refer to 1.04 and Fig. 3.

PREPARING TO START

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

(a) There is nothing in, on, above, or below the rectifier to interfere with operation or prevent free ventilation.

(b) All external connections are made in accordance with the schematic drawings covering the associated circuit of which the unit is a part.

(c) The correct size ac input fuse (L1 through L4) and dc output fuse (L4) are available.

(d) The connection adjustments are correct for the ac input voltage and frequency and the dc output voltage (L1, L2, and L3). See 1.03.

Note: Use the KS-14510 volt-ohm-milliammeter for measuring the voltages.

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.

(e) An adequate office load or an adjustable load capable of carrying at least 8 amperes at 30 volts direct current is available.

STARTING AND STOPPING THE RECTIFIERS

3.06 ***KS-15894 L1, L2, and L3 Rectifiers:*** These rectifiers have no disconnecting switches and are connected to both ac power and the load when the ac input (F1) fuse is installed. To take the rectifier out of service, remove the ac fuse.

3.07 ***KS-15894 L4 Rectifier:*** To start the L4 rectifier, install the ac input (F1) and dc output (F2) fuses and operate the ac input ON-OFF (S1) switch to the ON position. To remove the rectifier from service, operate the ac switch to the OFF position.

3.08 If it is desirable to verify the outputs of the rectifiers, follow the procedures outlined in 4.01.

4. ROUTINE CHECKS

4.01 From time to time check the output voltage and office load as follows.

(a) ***KS-15894 L1 and L2 Rectifiers:*** Connect the KS-14510 volt-ohm-milliammeter to the J1 (+) and J2 (-) test jacks and connect the test load and Weston model 281 dc ammeter in series across the output terminals of the rectifier. Insert the ac input fuse and note that the output voltage at full load is within the limits specified in Table A.

TABLE A

RECTIFIER ADJUSTED FOR	OUTPUT LIMITS
22-Volt Output	21 to 22.5 Volts
24-Volt Output	23 to 25 Volts

(b) ***KS-15894 L3 Rectifier:*** Check that the outputs of the rectifier are within the limits specified in Tables B and C. See CD-81713-01. Use the KS-14510 volt-ohm-milliammeter and the Weston model 281 dc ammeter, as required.

Note: The rectifier operates as part of the J86833 power supply which provides fusing for the outputs. Check the dc alarm output for operation of the rectifier failure and fuse failure alarms where the power supply is part of the 1A telephone answering system.

(c) ***KS-15894 L4 Rectifier:*** Connect the KS-14510 volt-ohm-milliammeter to the J1 (+) and J2 (-) test jacks and connect the test load and Weston model 281 dc ammeter, if required, in accordance with (a). Operate the ac input ON-OFF (S1) switch to the ON position and check that the rectifier output is 25.5±2 volts direct current from 0 to 4 amperes.

TABLE B

DC LOAD (AMPERES)	DC OUTPUT (VOLTS)
0 to 4.0	22 to 26.5
8.0 Max.	20.0 Min.

TABLE C

AC OUTPUTS (VOLTS)	
10 (Nominal)	9 to 11
15 (Nominal)	13 to 19

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

5. TROUBLES

COMPONENT REPLACEMENT

5.01 A diode suspected as a cause of trouble may be checked as covered in Section 032-173-301.

5.02 ***KS-15894 L1 Rectifier:*** Replacement of the T1 ferroresonant transformer and the associated C1 tuning capacitor should be made at the factory of the supplier. All other components may be replaced in the field.

Caution: Do not attempt to replace a diode in the CR1-CR2 germanium stack assembly. When replacements are required, replace the entire stack and do not combine stacks produced by different manufacturers.

5.03 ***KS-15894 L2 Rectifier:*** Replacement of the T1 ferroresonant transformer and the associated C5 tuning capacitor should be made at the factory of the supplier. All other components may be replaced in the field.

Caution: When replacements of the CR1-CR2 center tap rectifier are required, do not combine silicon diodes produced by different manufacturers.

5.04 ***KS-15894 L3 Rectifier:*** Replacement of the T1 ferroresonant transformer and the associated C1 tuning capacitor or any component in the load compensating network (C2 capacitor, L1 inductor, and T2 transformer) should be made at the factory of the supplier. All other components may be replaced in the field.

Caution: When replacements of the CR1-CR2 or CR3-CR4 center tap rectifiers are required, do not combine silicon diodes produced by different manufacturers.

5.05 ***KS-15894 L4 Rectifier:*** Replacement of the T1 ferroresonant transformer and the associated C1 tuning capacitor should be made at the factory of the supplier. All other components may be replaced in the field.

Caution: When replacements of the CR1-CR2 center tap rectifier are required, do not combine diodes produced by different manufacturers.

TROUBLE CHART

5.06 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 aging or drift in the constants of some faulty component.

Caution: The ac voltage across the terminals of the tuning capacitor connected to the terminals on the ferroresonant transformer may exceed 500 volts. When making tests inside the rectifier, take care to avoid any contact with this capacitor, its leads, and its terminal connections.

Note: In the KS-15894 L3 rectifier, two ac outputs and one unfiltered dc output in addition to the filtered dc power output are furnished by the unit.

TROUBLE	POSSIBLE CAUSE
(a) No output voltages (See Note)	AC input fuse not installed.
	DC output fuse not installed in L4.
	Failure or disconnection of the ac input power.
	Blown ac input fuse.
	Blown dc output fuse in L4.
	Defective ferroresonant transformer.
	Defective inductor, capacitor, or transformer (L3 rectifier load compensating network).
	Shorted filter capacitors, bleeder resistor, or tuning capacitor.
(b) Low output voltages	Low input power voltage.
	Incorrect ferroresonant transformer taps (L1, L2, L3).
	Defective ferroresonant transformer and/or tuning capacitor
	Excessive load on rectifier output.
	Breakdown of any or all filter capacitors.
	Defective filter inductor (L2, L3, L4).
	Defective inductor, capacitor, or transformer (L3 rectifier load compensating network).
(c) High output voltages	High input voltage.
	Incorrect ferroresonant transformer taps (L1, L2, L3).
	Defective ferroresonant transformer and tuning capacitor.

TROUBLE	POSSIBLE CAUSE
(c) High output voltages (Cont)	Open bleeder resistor.
	Defective inductor, capacitor, or transformer (L3 rectifier load compensating network).
(d) High ripple voltage (dc power output)	Filter capacitor or capacitors open.
	Defective rectifying element.
(e) Erratic output voltages	Fluctuating input voltage.
	Intermittent open or short in any component.
	Defective connections.