

J94002P (2P) TUBE TEST SET
DESCRIPTION

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<u>1. GENERAL</u>	

1.01 This issue replaces Issue 1 for which a copyright had not been obtained. The section describes and gives the method of operation of the 2P Tube Test Set (J94002P) which is designed primarily for checking the repeaters of the Type N Carrier Telephone System by measuring the following:

- (1) Cathode activity of the electron tubes.
- (2) Electron tube heater current.
- (3) Current through the voltage regulator tube.
- (4) D-c voltage applied to the repeater.

1.02 The above tests may be made when the repeaters are operating within the following values.

- (1) Cathode voltage: 0.75 to 3.0 volts.
- (2) Heater current: 0 to 196 milliamperes.
- (3) Regulator tube current: 0 to 40 milliamperes.
- (4) Line voltage: 0 to 280 volts.

1.03 The test set consists essentially of a meter, a selector switch, 6 variable resistors, a toggle switch and a cord which terminates in 3 plugs. The meter is a 100 microampere meter with a red scale for measuring currents and voltages and a black scale for measuring cathode activity. The selector switch is a 9 position rotary type used for changing the circuit as required for each measurement. The 6 variable resistors are used in measuring cathode activity and are each associated with a selector switch position. The toggle switch is for connecting shunting resistors into the electron tube heater circuit to reduce heater voltage. The cord and plugs are for connecting to the units under test. Connections are made to the 5 cathode circuits of the electron tubes, to the power supply and to several points in the electron tube heater circuit.

1.04 When the test set is used to measure heater current, the selector switch is set so that the meter, through a resistor network, is connected across a 135-ohm resistor in series with the electron tube heaters. The heater current is then measured as the voltage drop across this resistor. When the test set is used to measure regulator tube current, the selector switch is set so that the meter is connected directly to the terminals of a 1.87-ohm resistor in series with the regulator tube. The regulator tube current is then measured as the voltage drop across this resistor. When the test set is used to measure the d-c voltage applied to the repeaters, the selector switch is set so that the meter, through a high series

resistance, is connected across the points where plate voltage is supplied to the repeater electron tubes. In all the above measurements the red scale of the meter is used. This scale is calibrated from 0 to 200% and mid-scale, which is marked 100%, indicates normal voltage or current.

1.05 When the test set is used to measure cathode activity, the test consists of determining the per cent. change in cathode voltage after the electron tube heater voltages have been reduced by 10%. Six selector switch positions are used for measuring cathode activity. These positions are each associated with one of the 6 variable resistors. In a cathode activity measurement the selector switch is set to each of the 6 positions and at each position, the associated variable resistor is adjusted to obtain a full-scale meter indication. Then, with the selector switch on the HTR position, the toggle switch is operated from the NORMAL to the ADJ position. Setting

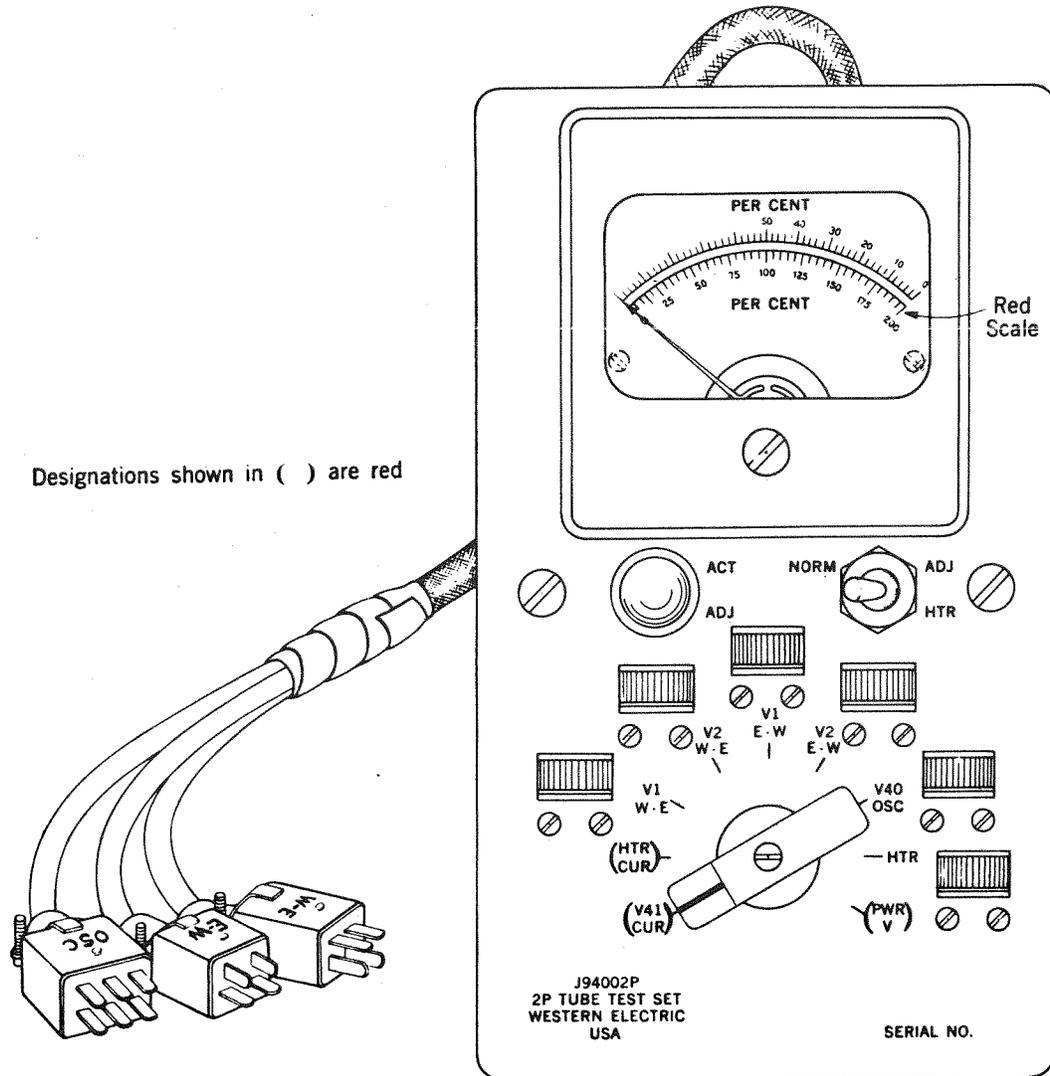
the switch to the ADJ position connects both a variable and a fixed resistor into the heater circuit so as to reduce the heater voltage of the electron tubes under test. The amount is set to 10% by adjusting the variable resistor and noting the resulting meter indication. The cathode activity of each tube is then measured by operating the selector switch to the other 5 positions and at each position reading the meter.

1.06 The over-all dimensions of the test set are 7-1/4" x 4-1/4" x 2-3/4" exclusive of the cord and the weight is 2-1/4 lbs. The cord is 4 feet long.

2. DESCRIPTION

(A) Equipment Features

2.01 A face view of the 2P Tube Test Set is shown in Fig. 1. The selector switch is in the lower middle of the panel and is surrounded by the control knobs of the 6 variable



Designations shown in () are red

Fig. 1 - Face View of 2P Tube Test Set

resistors. The designations on the switch refer to the following: V41 CUR to the current in the regulator tube; HTR CUR to heater current; V1 W-E to V40 OSC to the electron tubes in the units under test; HTR to the heater circuit and PWR V to the power supply voltage at the repeaters. The markings on the 3 plugs are W-E, E-W and OSC. These markings are for identifying each plug with the correct test jack on the units under test. The ACT ADJ knob below the meter is the control for reducing heater voltage. This control is used for adjusting to 10% when reducing heater voltage. The switch at the right designated HTR is the toggle switch used for connecting the heater circuit shunts in and out of the circuit. The two large screws are for removing the rear cover.

(B) Circuit Description

2.02 The functional schematic of the test set is shown in Fig. 2 and the circuit is detailed shown on SD-95139-01. The plugs W-E, E-W and OSC are used to connect the test set to the repeater. For the most part, all wires from the plugs connect to separate points on the selector switch so that each measurement is made independently. The selector switch is the 9 position switch. The detail operation of the switch is shown on SD-95139-01.

2.03 Resistors R1 to R6 are the variable resistors which are associated with 6 of the selector switch positions. Resistors R7 and R8 are for limiting the current through

meter M1. Resistor R9 is for damping the meter movement and is connected across meter M1 for all switch positions except the one for measuring heater current. Resistor R9 is removed during this measurement to minimize the effect of temperature changes. Resistors R10 and R11 are the fixed and variable resistors, respectively, which are used to reduce the heater voltage when measuring cathode activity. The toggle switch shown on Fig. 1 is for connecting resistors R10 and R11 in or out of the heater circuit. Resistors R12, R13, R14 and R16 are associated with the selector switch HTR CUR position and are of such values that when meter M1 has a 100% reading on the red scale, the heater current of the electron tubes in the units under test is 98 ma. Resistor R12 is used as a factory adjustment to obtain this condition. Resistor R15 is of such a value that at 140 volts d-c meter M1 indicates 100% on the red scale.

2.04 Within the ambient temperature range from 50°F. to 120°F., the accuracy at mid-scale of the meter is $\pm 3\%$. Outside this range the test set will be less accurate.

2.05 When the circuit is placed in operation, the 3 plugs are inserted into test jacks on the units under test. With the selector switch set to V41 CUR, meter M1 in parallel with resistor R9 is connected across terminals 5 and 6 of plug OSC. These terminals connect

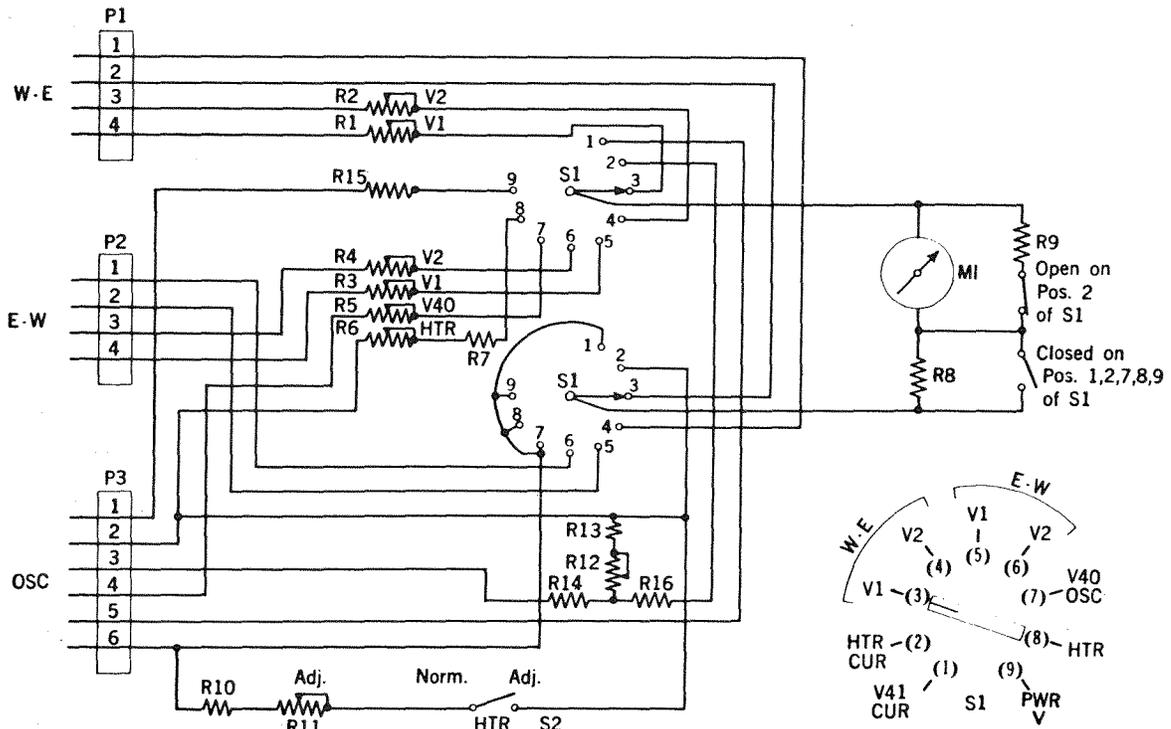


Fig. 2 - Functional Schematic of 2P Tube Test Set

to the 1.87-ohm resistor located in the units under test and in series with the regulator tube. The resistance value of meter M1 and resistor R9 in parallel is such that with 20 milliamperes flowing through the regulator tube and the 1.87-ohm resistor, meter M1 should indicate 100% on the red scale. With the selector switch set to HTR CUR, resistor R9 is removed from across meter M1 and at the same time the meter in series with resistor R16 is connected across resistors R12 and R13. Resistors R12, R13 and R14 are in series and connect to terminals 2 and 3 of plug OSC. These terminals connect to a 135-ohm resistor located in one of the units under test and in series with the heater circuit. When the selector switch is set successively to each position from V1 W-E to V40 OSC, meter M1 in parallel with resistor R9 and in series with resistor R8 is connected in accordance with the following table.

Selector Switch Position	Through Series Resistor	To Plug Terminals	On Plug
V1 W-E	R1	2-4	W-E
V2 W-E	R2	1-3	W-E
V1 E-W	R3	2-4	E-W
V2 E-W	R4	1-3	E-W
V40 OSC	R5	6-4	OSC

2.06 When the selector switch is set to HTR, meter M1 in parallel with resistor R9 and in series with resistors R6, R7 and R8 is connected across terminals 2 and 6 of plug OSC. Terminals 2 and 6 connect to the heaters of the electron tubes in the units under test.

3. OPERATING PROCEDURE

(A) Heater Current

3.01 It is important that the procedure be carefully followed in order to prevent the premature reduction of heater current, possible overloading of the meter, and the possible introduction into the carrier system of noise or level-change pulses.

3.02 Procedure:

- (1) Set HTR switch to NORM.
- (2) Set V1 W-E to V40 OSC controls to extreme left position, that is for maximum value of R1 to R6 resistances.
- (3) Insert W-E, E-W and OSC plugs in proper jacks on the front of the repeater to be tested. Be sure that W-E and E-W plugs are not interchanged.

(4) Set selector switch to HTR CUR and read the red scale of the meter. Normal reading is 100% and equals 98 milliamperes in the heater circuit.

(B) Cathode Activity

3.03 Heater current and cathode activity requirements are given in the sections of practices covering the type of equipment under test.

3.04 Procedure:

(1) Connect the test set to the repeater under test and measure the heater current as covered in Part 3(A). The test should not proceed unless the heater current meets requirements.

(2) Set the selector switch successively to V1 W-E, V2 W-E, V1 E-W, V2 E-W, V40 OSC and HTR position and at each position adjust the associated control to obtain full scale reading on the meter that is 0 on the black scale. These controls should be adjusted slowly (at least 5 seconds for each control) in order to minimize the effect on the repeater and to protect the meter.

(3) Set the ACT ADJ control to extreme counter-clockwise position.

(4) Set HTR switch to ADJ and adjust the ACT ADJ control until the meter indicates 10% on the black scale.

(5) Allow 2 minutes for the electron tubes to reach a stable condition, then set the selector switch successively to V40 OSC, V2 E-W, V1 E-W, V2 W-E and V1 W-E and at each position read the indication on the black scale of the meter. The per cent. reading is a measure of the cathode activity of the electron tube.

(C) D-c Voltage Applied to Repeaters

3.05 Procedure:

- (1) If the test set is not connected to the repeater, follow the procedure of Part 3(A).
- (2) Set the selector switch to PWR V and read the red scale of the meter. A reading of 100% indicates a voltage of 140 volts. Other values are directly proportional. For example 98% reading indicates 130 volts.

(D) Regulator Tube Current

3.06 Procedure:

- (1) If the test set is not connected to the repeater, follow the procedure of Part 3(A).
- (2) Set the selector switch to V_{41} CUR and read the red scale of the meter. A reading of 100% indicates a regulator tube current of 20 milliamperes. Other values are directly proportional.

4. INVESTIGATION OF TEST SET TROUBLE

4.01 Information is given which is helpful in checking the test set if trouble develops or if it is necessary to insure that the set is in proper working condition. A routine check of the test set is not necessary. Some of the suggested procedures involve testing arrangements which may not be readily available and therefore a complete series of tests may not be practicable.

4.02 The test set may be opened for tests or replacement of parts by loosening the 2 large screws on the face of the panel and removing the rear cover.

(A) Test Equipment

4.03 The test equipment listed below or its equivalent is required. An M9B Meter may be used in place of the voltmeter, milliammeter and ohmmeter listed. If the M9B Meter is used, however, it may be less accurate than the meters specified. This possibility should be taken into account in the test results.

- 1 - D-c voltmeter to measure a voltage of 13.1 volts to an accuracy of $\pm .05$ volt.
- 1 - D-c voltmeter to measure a voltage of 0.75 volt to an accuracy of ± 0.02 volt.
- 1 - D-c voltmeter to measure a voltage of 60 and 140 volts to an accuracy of ± 1 volt.
- 1 - D-c milliammeter to measure a current of 20 milliamperes to an accuracy of $\pm .2$ milliampere.
- 1 - 106B resistor 1.87 ohms.
- 1 - 100-ohm, 1-watt variable resistor.
- 1 - Ohmmeter accurate to $\pm 5\%$.
- 1 - Wheatstone Bridge.

(B) Check of Circuit

4.04 The apparatus designations used in the procedures refer to those shown on Fig. 2 or SD-95139-01, not attached, rather than to designations appearing on the apparatus.

4.05 Procedure:

(1) With all voltage sources removed from the test set, adjust the zero setting of the meter. If the meter can not be adjusted to zero, refer to Part 4(C).

(2) Using 1.5 volt d-c and a 100-ohm variable resistor as a power source connected to a 1.87-ohm resistor, adjust the current through the 1.87-ohm resistor to 20 ± 0.2 milliamperes. This produces a voltage drop of .037 volt across the 1.87-ohm resistance for use in Item (3).

(3) With the positive side connected to terminal 5 apply .037 volt to terminals 5 and 6 of plug OSC, set the selector switch to V_{41} CUR and read the red scale of the meter. If the meter reading is not $100 \pm 3\%$ refer to Part 4(C) for meter trouble, and to Part 4(D) for check of selector switch. The resistance of R9 should be 1500 ± 20 ohms as measured with a Wheatstone Bridge. Disconnect one side of the resistor for this measurement.

(4) With the positive side connected to terminal 3, apply $13.1 \pm .05$ volts d-c to terminals 3 and 2 of plug OSC. Set selector switch to HTR CUR and adjust resistor R12 until the meter indicates 100% on the red scale. If this adjustment can not be made refer to Part 4(C) for meter trouble, to Part 4(D) for check of selector switch, to Part 4(E) for check of R12 resistor and to Part 4(F) for check of R13 and R16 resistors.

(5) With the positive side connected to terminal 1, apply 140 ± 1 volts d-c to terminals 1 and 6 of plug OSC. Set selector switch to PWR V and read the red scale of meter. If the meter reading is not $100 \pm 3\%$ refer to Part 4(D) for check of selector switch, to Part 4(F) for check of R15 resistor and to Part 4(C) for meter trouble.

(6) Set the 6 controls associated with selector switch positions V1 W-E to HTR to extreme left position. This sets resistances R1 to R6 for maximum value. With the negative side connected to terminal 2, apply 0.75 volt d-c to terminals 2 and 4 of plug W-E. With the selector switch set

to the V1 W-E position, the meter should indicate below 50% on the red scale and increase smoothly to above 200%, red scale as the associated control of R1 is slowly rotated to its extreme right position. If trouble is indicated refer to Part 4(D) for check of selector switch, to Part 4(E) for check of R1 resistor and to Part 4(F) for check of R8 resistor.

(7) For each condition listed below, apply 0.75 volt d-c to the terminals indicated, negative to the first listed terminal. Set the selector switch as indicated for each condition and slowly rotate the corresponding control of the resistors to the extreme right position. For each condition the meter should indicate below 50% on the red scale and increase smoothly to 200%, red scale as the associated control is moved to its extreme right position.

Terminals of Plug	Setting of Selector Switch	Resistor
1 + 3 of W-E	V2 W-E	R2
2 + 4 of E-W	V1 E-W	R3
1 + 3 of E-W	V2 E-W	R4
6 + 4 of OSC	V40 OSC	R5

If trouble is indicated refer to Part 4(E) for check of R2, R3, R4, R5 resistors, to Part 4(F) for check of R7 resistors and to Part 4(D) for check of selector switch.

(8) With the positive side connected to terminal 2, apply 60 + 1.0 volts to terminals 2 and 6 of plug OSC. With the selector switch set to the HTR position, the meter should indicate below 5% on the black scale and increase smoothly to above 0%, black scale, as associated control of R6 is slowly rotated to its extreme right position. If trouble is indicated refer to Part 4(E) for check of R6 resistor and to Part 4(D) for check of selector switch.

(C) Meter Trouble

4.06 If in connection with the check of the circuit, the meter is found to be sticking, can not be mechanically adjusted to zero or is damaged, it should be replaced. If an error in meter calibration is indicated, other apparatus components of the test set should be checked. The full scale calibration for the meter is 100 + 5 microamperes and the resistance is between 743 and 758 ohms.

(D) Check of Selector Switch

4.07 Set the switch to each of its positions and using the ohmmeter check the operation. At each setting the contacts of the switch should open and close in accordance with the information on SD-95139-01. If otherwise, examine the switch and make sure that none of the contacts is broken, loose or damaged. If a switch appears to be in trouble, remove the wires from the switch and recheck to insure that the trouble has been definitely located.

(E) Check of Resistors R1 to R6, R11 and R12

4.08 With plugs W-E, E-W and OSC disconnected from any external circuit, connect the ohmmeter across terminals 1 and 2 of the resistor to be checked. The numbering of the terminals of these resistors should be obtained from the schematic circuit SD-95139-01 and not from any markings on the unit itself. In the case of resistor R12, check the resistance between the terminal connected to R13 and the middle terminal. While measuring resistance as outlined above slowly and smoothly change the setting of the resistor back and forth several times over its range. The ohms indicated by the ohmmeter should increase and decrease accordingly. In addition, the resistance should change smoothly and uniformly over a range from approximately 0 to maximum value. If these requirements can not be met, the resistor should be disconnected from the circuit and the test repeated. This procedure insures that the trouble is not elsewhere in the circuit.

(F) Check of Resistors R7, R8, R10 and R13 to R16

4.09 Disconnect plugs W-E, E-W and OSC from any external circuit and using the Wheatstone Bridge measure the resistance directly across the resistance terminals and in accordance with the following table.

Resistor	Setting of Selector Switch	Measure - Ohms
R7	V41 - CUR	336,000 + 6000
R8	V41 - CUR	4270 + 200
R10	HTR - CUR	2200 + 40
R13	V41 - CUR	437 + 6
R14	V41 - CUR	12,700 + 200
R15	V41 - CUR	1,870,000 + 30,000
R16	V41 - CUR	8250 + 125

5. DRAWINGS

5.01 The following drawings are listed for reference only and are not attached to this section.

SD-95139-01 Circuit Schematic
SD-92329-01 Equipment