

ELECTRON (VACUUM) TUBE TEST SET
KS-5727 HICKOK TUBE TESTER
DESCRIPTION AND APPLICATION

<u>CONTENTS</u>	<u>PAGE</u>
1. GENERAL	1
2. DESCRIPTION OF SET	2
(A) General	2
(B) Description of Equipment on Panel of Set	3
(C) Description of Circuits	5
(D) Power Supply	7
(E) Special Features	7
3. METHODS FOR TESTING TUBES	8
(A) General Procedure	8
(B) Tests of Amplifier Types of Tubes	8
(C) Rectifier and Diode Tests	10 ←
(D) Special Tests	10
4. MAINTENANCE	10
5. TEST DATA	12
<u>1. GENERAL</u>	

1.01 This section describes the set and gives the methods for operating and maintaining the Hickok KS-5727 L1 vacuum tube tester. This set is capable of testing practically all small sized amplifier and rectifier type tubes of Western Electric or other manufacture. The tubes are tested in this set at a fixed plate potential of about 150 volts less the IR drop in the circuits of the set. Similarly a fixed screen grid test potential of about 130 volts is provided. By suitable adjustment of the grid bias as prescribed, satisfactory tests

may be made both on tubes normally operating at lower plate potentials and on tubes normally operating at higher plate potentials up to about 300 volts.

1.02 Issue 2 of this section makes some clarifications in the text. Table I giving testing data for tubes of Western Electric Company manufacture has been removed from this section and designated as Section 100-630-501. ←

1.03 Certain improvements are provided in the KS-5727 L1 tube tester as compared to previous Hickok sets of the 531 (KS-13588 L1) and older models. These improvements include: ←

(1) A new arrangement of seven selector switches to connect any tube for test whatever the basing or pin arrangement. Unusual assignments of filament or heater pins can be handled, and an electrical interlocking scheme prevents the accidental application of more than one test voltage to the same pin. A PLATE pin jack colored red also is provided for the external plate cap connection on certain tube types, supplementing the usual GRID jack.

(2) A 20-volt heater tap has been added to the FILAMENT selector supply circuit, to take care of recent Western Electric tube types such as the 375A, 407A and 408A.

(3) A new low grid signal voltage (1 volt) supplements the original 5-volt (HIGH) grid signal used in older model sets. This provides a more suitable means of testing low bias, higher transconductance type tubes by avoiding positive grid drive.

(4) Anti-sing or oscillation suppressor resistors have been included in the selector switching circuits to eliminate self oscillation under test, particularly for tests of higher transconductance tubes.

(5) The test features provided in Items (1) and (4) have largely eliminated the need for special adapters, with the exception of unbased or subminiature type tubes. The repeater line of bayonet base type tubes will continue to require the Alden adapters specified for previous models of the set.

(6) In conjunction with the new 1-volt grid signal voltage, a precalibrated MICROMHOS switch circuit arrangement provides instant selection of fixed meter ranges of 3000, 6000, or 15,000 micromhos for HIGH grid signal tests and of 6000 or 15,000 micromhos for LOW grid signal tests. A separate switch position for the so-called English direct-reading colored GOOD - REPLACE range also is provided, when the ENG potentiometer is connected in place of the calibrated micromho range resistor networks.

1.04 The KS-5727 L1 tester provides means for the following tests:

(1) Measurement of the "indicated transconductance" in micromhos. The meter reading is proportional to the transconductance of the tube under test, but under test conditions is not a rigorous measurement of transconductance. For this reason it is referred to herein as "indicated transconductance."

(2) Test of the cathode (filament) activity in terms of the change in transconductance for a 10 per cent. reduction in heater (or filament) voltage.

(3) Tests for internal short circuits by means of a neon lamp continuity test circuit.

(4) Test for excessive grid current due to the presence of gas or grid insulation leakage.

(5) Rectifier tube plate current tests for thermionic and certain cold cathode types. Western Electric tubes such as cold cathode types (313C group), thyratrons such as the 338A or 393A, and coded Western Electric ballast lamps cannot be tested in this set. Although voltage regulator types (such as the OD3/VR150) and gas triodes (thyratrons such as the 2050 and similar types of other than Western Electric manufacture) are listed on the roll chart for

test, these tests are not recommended as ensuring a completely adequate test. By the limitations of the test circuits available, only rough firing point or ionization voltage control tests are afforded. Tests for small cold cathode rectifier types listed for such tubes as the OZ4 are satisfactory.

1.05 The only power supply required is commercial 60- or 50-cycle a-c power of 105 to 125 volts. Built-in rectifier circuits supply the necessary d-c potentials for the various tests.

1.06 General purpose rejection limits for Western Electric tubes are covered in Part 5 of this section. Other test limits and other methods of test may be specified in Bell System Practices covering particular applications. Where so given such limits and methods should be followed in place of those given in this section.

1.07 This tester is intended primarily for general purpose use in the maintenance of electron tubes in apparatus for which other methods of electron tube testing have not been specified in the Bell System Practices for that equipment. Since the indicated transconductance measured by this set is only approximately proportional to true transconductance, check tests made with this set should not be used as a measure of new tube quality relative to manufacturer's specifications.

1.08 Information regarding the tests for tubes of other than Western Electric manufacture is supplied in the form of a roll chart in the set. The chart, which is replaceable in the set, is revised from time to time by the manufacturer.

2. DESCRIPTION OF SET

(A) General

2.01 The set is self-contained in a carrying case for portable use. The outside dimensions of the case, including removable cover are 18-1/2 inches by 17 inches and 7-1/2 inches deep. The net weight is about 28 pounds. It can be shipped in a suitably padded container similar to that in which it is shipped from the factory.

2.02 The set is intended to be used in a horizontal position and requires 105-125-volt, 60-cycle a-c supply. The vacuum tube test data are based on 60-cycle operation, for

which this set is designed. These data, however, should be satisfactory for all practical purposes when the set is operated on commercial 50-cycle supply. It should not be operated on 25-cycle a-c supply.

2.03 The set is mounted on a metal foundation panel 14-1/2 inches deep and about 16 inches wide, containing the MICROMHOS meter, A.C. VOLTS meter, and a group of nine vacuum tube test sockets. The row of selector switches, potentiometer and various selector control dials, a neon lamp for short-circuit tests, an auto bulb fuse, a MICROMHOS switch, two toggle switches, a pilot lamp and a bank of test push buttons, are all suitably designated and arranged as shown in the attached photograph on Page 103. A roll chart is provided below the push button bank, giving the test adjustments for radio electron tubes.

(B) Description of Equipment on Panel of Set

2.04 The principal meter (designated herein as the MICROMHOS meter) is a d-c milliammeter calibrated in micromhos, with 3 basic scales corresponding to ranges of 0-3000, 0-6000 and 0-15,000 micromhos, to read the indicated transconductance of the tube under test. Also a supplementary direct reading scale designated GOOD (green) and REPLACE (red) is provided to test tubes without recourse to micromho readings. These color ranges normally are used for radio electron tubes listed on the roll chart and a few tubes in Section 100-630-501. In the case of rectifier and diode types, the value of rectified plate current in terms of the color ranges is used as a criterion for rejection instead of micromhos (the latter is an indicated transconductance measurement). A small slide switch designated METER beneath the MICROMHOS meter is provided to reverse polarity as sometimes required for tests of tubes having two sections with separate cathodes, such as the 117N7 type.

2.05 A small a-c voltmeter, designated A.C. VOLTS, is located in the upper left corner of the main panel. This is used to indicate when the line voltage adjustment is correct, and to check the value of the external a-c supply voltage.

2.06 Nine types of push-type vacuum tube sockets are provided, which include the standard 4-, 5-, 6-, 7-prong and two 8-prong types for the octal and loktal type tube bases. The remaining three sockets are for miniature tubes

of the 7-pin and 9-pin (noval) type and the 8-contact acorn type. Suitable adapters, not provided as part of the set, must be obtained for testing the following bayonet 4-pin base Western Electric tubes:

<u>Western Electric Tube</u>	<u>Standard Adapter</u>
101-, 102-, or 104-type	Alden No. 944 WEB
205-type	" No. 978 WEB
215-A	" No. 972

An adapter also is necessary for certain un-based Western Electric tubes. This adapter is coded per Drawing ED-62777-01 group 1, and is useful for certain of the L1 carrier tube series.

Controls

2.07 The seven selector switch controls are all necessary in making a measurement of indicated transconductance.

2.08 Selector Switches - Seven SELECTORS, so designated, are located across the main control panel. Settings of these switches control the proper connections for any tube to be tested, when it is inserted into its proper socket. These settings are obtained from Section 100-630-501 for Western Electric tubes, or from the roll chart for other tubes. The first two selectors with letter designations control the filament pin assignments.

2.09 Filament Voltage - Filament (or heater) voltage is supplied from a multiple tap transformer and is controlled by the selector switch designated FILAMENT. Eighteen switch positions without an OFF setting are provided to include 17 values of voltage as follows:

1.1	3.0	7.5	25
1.5	4.3	10	35
2.0	5.0	12.6	50
2.5	6.3	20	75
			117

The remaining switch position, designated BLST is a special "off" position necessary in making certain tests where the cathode return circuit is disconnected from the mid-point of a resistance normally bridged across a filament (or heater). The accuracy of the voltage for each position is within + 3 per cent., when the LINE ADJUST control is set properly. FIL. OFF is provided by operating the first selector to A or the second selector to position P. These selector positions are so designated.

2.10 Grid Signal and MICROMHOS Range Switch -

The MICROMHOS switch controls the HIGH or LOW grid signal to be applied and the micromhos range scale as specified for a transconductance test. Four positions are associated with the HIGH or 5-volt grid signal. The first position, ENG, is used for tube tests in terms of the GOOD - REPLACE color sectors. The next three positions, in order, are for the three micromho scales, 3000, 6000 and 15,000, giving indicated transconductance for the HIGH SIGNAL grid test voltage. The remaining two positions register 15,000- and 6000-micromho ranges on the meter using the LOW SIG. (1-volt) grid test voltage sector. The majority of Western Electric tubes are tested according to nominal and minimum micromho values and the required high or low signal MICROMHOS switch settings are specified in Section 100-630-501.

2.11 ENGLISH Dial - The ENGLISH dial controls a potentiometer shunt bridged across the MICROMHOS meter to adjust its sensitivity. It is calibrated in an arbitrary scale from 0 to 100. This potentiometer is connected when the MICROMHOS switch is in the ENG position only. It is used for tests where readings on the GOOD - REPLACE scale are specified, as given on the roll chart or in Section 100-630-501.

2.12 BIAS Dial - The BIAS dial controls a potentiometer calibrated in a 0 to 100 scale, which provides a continuously adjustable range of grid voltage from 0 to about -45 volts.

2.13 Line Adjustment - This potentiometer, designated LINE ADJUST, controls the a-c voltage applied to the primaries of the various transformers in the set. When adjusted so that the A.C. VOLTS voltmeter referred to in Paragraph 2.05 deflects to the red index mark designated TEST on its scale, the voltage applied to the set is 100 volts.

2.14 SHORTS Test Switch - On a 6-position selector switch designated SHORTS, five steps are provided to make short-circuit tests

between various electrodes of the tube under test, using the neon lamp test circuit, as indicated in Fig. 1. This shorts test may be made with the tube filament (or heater) on or off, but usually is made with the filament (or heater) heated. In the sixth position labeled TUBE TEST the neon lamp short test circuit is disconnected and the tube under test is connected for indicated transconductance, cathode (filament) activity, and other tests.

2.15 Toggle Switches - Adjacent to the LINE ADJUST and SHORTS controls, two switches appear on the extreme left side of the main panel and are designated respectively:

(1) FIL ACT, a toggle switch required for cathode (filament) activity tests, is located in the lower left-hand corner. When operated to NORM, the filament (or heater) voltage is the value for which the filament voltage switch is adjusted. When in the TEST position, the voltage applied to the filament (or heater) of a tube under test is reduced 10 per cent. below its normal value. The per cent. reduction in indicated transconductance observed for this 10 per cent. filament (or heater) voltage change is used as a fundamental criterion of the condition of tubes so tested.

(2) POWER - This switch with ON and OFF positions, controls the commercial a-c power supplied to the set through the 5-foot cord and plug attached.

2.16 Push Button Switches - Eight switches are located in line in the front part of the control panel and are operated to make the various tests in conjunction with the selector and potentiometer dials described in the preceding paragraphs. Both functional and numerical designations are provided. P1 to P7 designations are used in all test setting data.

(1) Two GM (P4) push buttons (colored red) are provided for the transconductance test. These push button switches are connected in parallel and are designated to operate as indicated, NON LOCK (left-hand button) and LOCK (right-hand button). When operated, the proper d-c plate and screen grid voltages, and the grid signal which has been selected by the MICROMHOS range switch all are impressed on the tube under test, while the plate circuit is connected to the MICROMHOS meter through this same MICROMHOS switch. A locking type push button switch is provided to ensure continuously applied operating potentials to a tube during the time required for a cathode (filament) activity test.

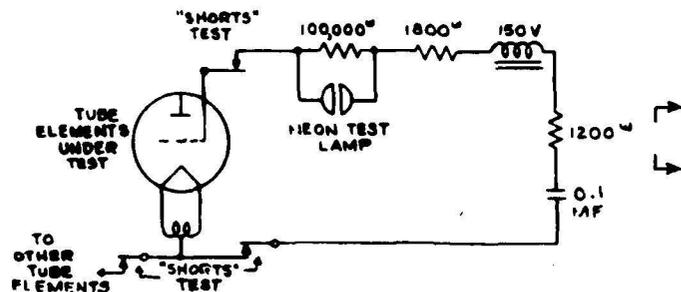


Fig. 1 - Shorts Test Circuit

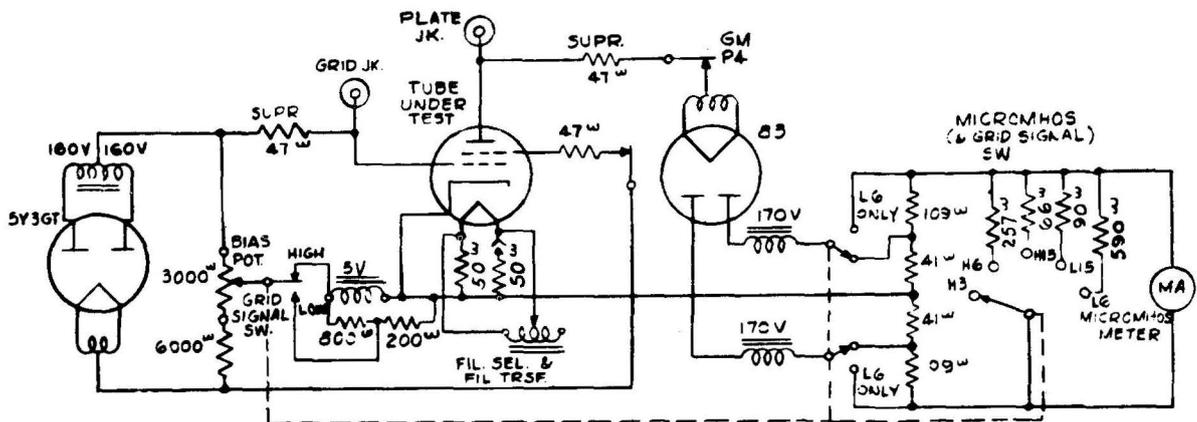


Fig. 2 - Basic Transconductance Test Circuit (English Potentiometer Test Circuit Not Shown)

(2) Two GAS test (non-locking) push buttons, designated GAS 1 (P5) and GAS 2 (P6), are provided. Operation of the GAS 1 button (P5) places plate-screen test voltage on the tube under test, and this button is held down while the GAS 2 button (P6) also is depressed. Operation of the GAS 2 (P6) test button places a $1/4$ -megohm resistor in series with the grid circuit of a tube under test.

(3) Three push buttons, designated P1, P2 and P3, are provided for rectifier-type tests. P3, identified as RECT, places an a-c potential on the plate of the rectifier tube under test. This a-c voltage is rectified and measured as direct current on the MICROMHOS meter, where the reading on the GOOD - REPLACE scale gives a measure of the condition of the tube. The P2 push button, designated OZL, provides a similar test for rectifiers of the cold cathode type. A protective series resistor is employed in this test circuit to limit the rectified current flow through the tube to a value which will not damage it. P1, the DIODE push button, controls a rectified current test for small hot cathode diode sections of multi-purpose tubes. This test is similar to the rectifier tests except that a lower a-c voltage (about 15 volts) is applied to a diode plate through a protective resistor.

(4) The remaining push button, P7, designated LINE TEST, when operated disconnects the A.C. VOLTS meter from the LINE ADJUST control circuit and connects it to check the external a-c supply voltage.

(C) Description of Circuits

2.17 A complete schematic circuit diagram of the set is given on Page 102. To aid in understanding the principles underlying the several tests, reference will be made to a few simplified schematic diagrams. The various circuit arrangements are secured by the proper operation of the controls just described.

2.18 When measuring indicated transconductance or testing cathode (filament) activity, the set is arranged to provide the circuit shown in Fig. 2. The 5Y3GT type full-wave rectifier tube supplies unfiltered (pulsating) d-c potentials to the control and screen grids (if any) of the tube under test. The unfiltered plate potential is derived from a separate rectifier employing an 83-type tube with balanced transformer secondaries supplying a-c potentials of 170 volts to each plate of the rectifier tube. The 83-type full-wave rectifier tube is of the mercury vapor type and is used to ensure a minimum internal voltage drop, with better regulation, regardless of load current. The MICROMHOS meter is connected across the potentiometer or resistances in the rectifier circuit as shown. Since the currents in the two resistances are equal, the arrangement is balanced and no potential is impressed on the meter if no a-c signal is impressed on the control grid.

2.19 However, the circuit actually is arranged to impress an a-c (60-cycle) potential of 5 volts or 1 volt on the grid by means of a divider circuit across a transformer winding inserted between the grid and the cathode. This potential appears amplified in the plate circuit of the tube under test, and is in phase

with the a-c potential impressed by the rectifier transformer on one plate of the 83-type tube, and in opposition to the potential on the other plate. Thus the rectified current in one side of the 83-type rectifier is increased and in the other is decreased, unbalancing the meter circuit and causing the meter to deflect. The amount of deflection is proportional to the transconductance of the tube under test, but under these test conditions is not a rigorous measurement of the transconductance. For this reason it is referred to herein as "indicated transconductance."

2.20 When testing a rectifier-type tube the set is arranged as shown in Fig. 3. Each anode is tested separately. The 83-type tube has no function in this circuit arrangement, the rectifier plate circuit under test being substituted for one side of it. A current limiting resistance of 150 ohms is in series with the tube under test, and the MICROMHOS meter reads proportionally to the rectified a-c current as indicated on the GOOD - REPLACE scale.

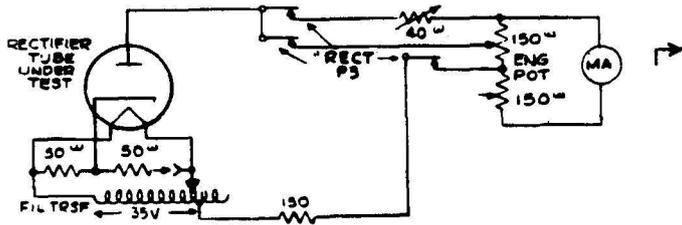


Fig. 3 - Standard Rectifier Test Circuit

2.21 When testing the diode section of a multi-purpose tube, or small hot cathode diodes, the circuit (Fig. 4) is the same as described in Paragraph 2.20 except that the a-c potential is decreased from 35 to about 15 volts, and the current limiting resistance is changed to 1200 ohms. Only one plate of the

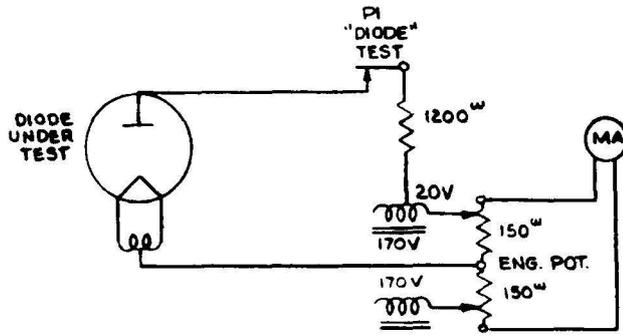


Fig. 4 - Diode Test Circuit

diode is tested at a time. MICROMHOS meter readings are observed relative to the DIODES OK index mark, readings to the right of the line indicating a satisfactory condition.

2.22 When testing a cold cathode tube, the circuit (Fig. 5) is the same as described in Paragraph 2.19 except that two windings of the power transformers are employed in series, applying an a-c potential of 290 volts in series with a current limiting resistor to the tube under test.

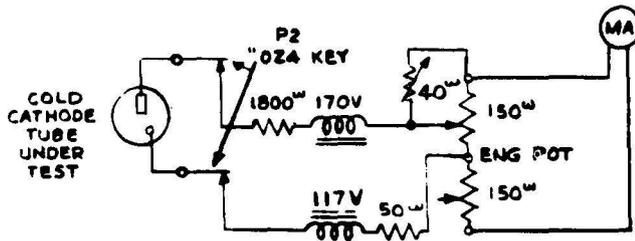


Fig. 5 - Cold Cathode Tube Test Circuit

2.23 Gas current in a tube or grid leakage current due to poor grid to filament insulation may be detected by the insertion of a high resistance into the grid circuit of a tube under test as shown in Fig. 6. In this

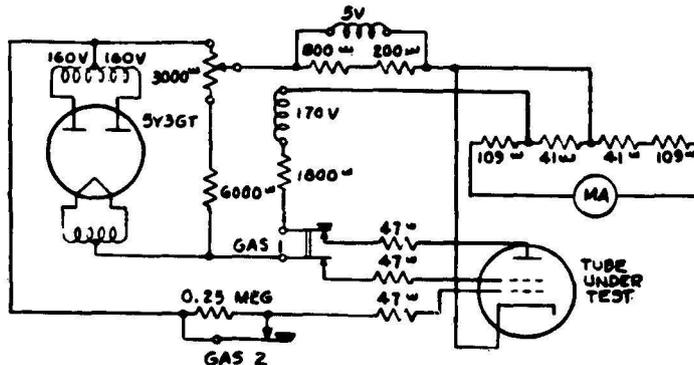


Fig. 6 - Gas Test Circuit

setup the normal d-c pulsating voltage is applied to the screen grid (approximately 130 volts) and the plate receives 170 volts from the transformer secondary winding directly through an 1800-ohm resistor by means of the GAS 1 (P5) push button switch. This test is made with the negative grid bias voltage increased by the proper adjustment of the BIAS dial to obtain a low reading on the MICROMHOS meter. When the test resistance of $1/4$ megohm is introduced into the grid circuit by operation of the GAS 2 (P6) push button switch, a change in the meter reading will occur with tubes having grid to cathode (or filament) conduction currents in excess of approximately 2 microamperes. This meter deflection corresponds to the change in grid bias resulting from the flow of grid current through the $1/4$ -megohm resistance.

(D) Power Supply

2.24 The set consumes about 60 watts of 60-cycle commercial a-c power (105-125 volts). A plug with a 5-foot cord attached to the set permits convenient connection to a local power outlet. This power supply is protected by a standard No. 81 Mazda 6-volt 3-c.p. single contact auto bulb. This is used as a fuse, and is replaceable easily from the face of the set panel. When not in use the POWER toggle switch should be operated to OFF to avoid unnecessary heating of the set.

2.25 Adjustment to compensate for power voltage and load fluctuations is provided by the LINE ADJUST dial to maintain a steady voltage as read at the red index line (100 volts) of the small A.C. VOLTS voltmeter.

(E) Special Features

2.26 Neon Lamp Shorts Test Circuit - This test circuit is for locating shorts in any interelectrode path within a tube, as indicated previously in Paragraph 2.14. The actual method of test is given in Paragraph 3.07. Table I, or the corresponding table in the manufacturer's booklet delivered with the set, provides the necessary information to determine the exact location of a short by observing which of the five positions of the SHORTS selector switch cause the neon lamp to light.

2.27 The various short locations given in Table I represent paths commonly encountered for typical tube basing arrangements. In the case of certain octal and miniature types appropriate notations on the chart show neon

lamp short positions which will flash because of base wiring interconnections. These short indications should be ignored. It may be pointed out also that other interelectrode short paths than those identified in Table I may be found, particularly in certain octal type tubes. This may result in an apparent identification of a path which does not apply to the particular type of tube base connection arrangement. Such results of tests for shorts usually indicate an unsatisfactory tube condition.

2.28 Adapters are required for Western Electric tubes equipped with bayonet type bases or certain other basing, as discussed in Paragraph 2.06.

2.29 A black pin jack designated GRID and a red pin jack designated PLATE are located above the test socket area. These are provided for the insertion of the cap clip lead furnished separately for use in testing tubes having a metal grid or plate connection on top, and it is important not to connect the cap terminal of the tube to the wrong pin jack (see Paragraph 3.03).

2.30 Noise Test Circuit - A pair of pin jacks under the selector switch, designated NOISE TEST, is included as part of the noise test to be used in conjunction with a broadcast type radio receiver equipped with a loudspeaker. These pin jacks are connected to the neon lamp test circuit through a small condenser (0.0005 mf). The right-hand jack is for a pin plug connection to the radio receiver's antenna post and the left-hand jack for the ground terminal. The noise test is made with the tube energized by the proper filament (or heater) voltage in its proper test socket and connected by means of the required selector settings. The test is made by rotating the SHORTS switch through positions 1 through 5, (no test buttons operated) while tapping the tube lightly by hand and listening to the loudspeaker. This test, described in the manufacturer's booklet, is not recommended for Western Electric tubes.

2.31 Lamp Test - The center of the 7-prong socket has a live receptacle for testing miniature screw, bayonet, or candelabra based pilot or indicator lamps for burnouts. The voltage that is applied is under the control of the FILAMENT selector and may be varied in the voltage steps of that selector, as required, for the lamp to be tested.

3. METHODS FOR TESTING TUBES(A) General Procedure

3.01 Detach the cover of the set or have it properly supported in an open position. With the POWER switch thrown to OFF, plug the attachment cord into a suitable source of a-c power.

Caution: Operate the POWER switch to OFF after each test unless the same type of tube is to be tested in sequence. In the latter case it is necessary merely to unlock the GM button (P₄) and release both P₄ buttons while changing tubes.

3.02 Adjust the SELECTORS switches, the FILAMENT selector switch, the MICROMHOS switch and the BIAS potentiometer to the proper values for the type of tube to be tested. These settings may be found in Section 100-630-501 for Western Electric tubes or on the roll chart for tubes of other than Western Electric manufacture. See that the FIL ACT key is operated to NORM and the SHORTS selector switch is turned to TUBE TEST.

Caution: The SELECTORS or FILAMENT selector should never be operated with either GM button in a locked or operated position. Also it should be emphasized that, except in the case of tests using the GAS 1 (P₅) and GAS 2 (P₆) push buttons, and checks of the line voltage by the operation of push button P₇, test procedures usually call for the operation of only one push button at a time.

3.03 Attach the clip lead (which has been plugged into the GRID jack) if the tube has a grid top terminal and insert the tube to be tested into the socket which is proper for the tube base. This clip should be attached in a vertical position on metal shell tubes to avoid a short between grid cap and shell. For Western Electric tubes with bayonet type bases and for certain other tubes with special basing arrangements, a socket adapter will be required, as discussed in Paragraph 2.06. As indicated in Section 100-630-501, certain tubes have the plate terminal at the top. In such cases the clip lead is inserted into the red PLATE jack and then attached to the top terminal of the tube.

Caution: The clip lead necessary for external grid or plate cap tubes always should be removed from the test jack when not required, to avoid subsequent incorrect assignment or short-circuiting if left connected. A plate jack connection to the top terminal of a grid cap tube probably would damage the latter.

3.04 Operate the POWER switch to ON. Adjust the LINE ADJUST potentiometer until the needle of the A.C. VOLTS voltmeter points to the TEST calibration mark (red). Check this adjustment from time to time during the tests, particularly as the plate current load comes on when one of the GM push buttons is operated. When the set is not in use with a tube under test to provide a normal load, the POWER switch always should be turned off, to avoid possible damage to the set.

3.05 In following the subsequent detailed instructions, so as to permit the tube to become stable before making any test involving meter readings, an important precaution is to allow a minimum of 1-1/2 minutes for heater type and 1/2 minute for filamentary tubes after turning on the power or after making any change in the filament (or heater) voltage applied to the tube. Considerable variations in heating and stabilizing time for either filamentary or heater tubes may occur, depending upon the tube design. This precaution should be observed after operating the FIL ACT switch to TEST during an activity test as well as after first turning on the power. Filamentary tubes may stabilize in less time after the FIL ACT switch is operated to TEST than is required for the initial stabilizing interval. An indication of saturation in the tube is a steady MICROMHOS meter reading (allowing for temporary power voltage fluctuations). A-c power voltage fluctuations may be checked by operating the LINE TEST push button and observing the A.C. VOLTS meter behavior.

(B) Tests of Amplifier Types of Tubes

3.06 These tests apply to all tubes having control grids whether they are used in service as amplifiers, modulators, demodulators, detectors or oscillators.

Shorts Test

3.07 Operate the SHORTS test switch slowly through positions 1 through 5. If the neon lamp, designated SHORTS, lights continuously in any of these positions a short circuit between elements is indicated. The location of the short usually can be determined by reference to Table I. Under certain conditions, however, as discussed in Paragraph 2.27, the path indicated by the table may not exist. In these cases an unsatisfactory tube usually is indicated. Ordinarily this test is made with the filament (or heater) heated but it can be made with the filament (or heater) cold i.e., either of the letter designated (the two left-hand) SELECTORS in the FIL OFF A or P position.

3.08 Intermittent shorts may be detected by tapping the tube lightly with a soft part of the finger. In this test an intermittent flash may be obtained instead of a steady light.

Note: An instantaneous flash as the switch is moved from one position to another should be disregarded. This is caused by the discharging of the condenser in the shorts test circuit.

Transconductance Test

3.09 Make the basic settings as required for the tube to be tested as in Paragraph 3.02. With the FIL ACT test switch in the NORM position and SHORTS switch in the TUBE TEST position, operate the GM button (right-hand P₄) and lock it in position by turning it. Recheck the line adjustment voltage reading. Read the deflection of the MICROMHOS meter.

3.10 For Western Electric tubes, the prescribed settings of the BIAS potentiometer and MICROMHOS switch are such as to give indicated transconductance readings, under the test conditions obtained with this set, as read on the scale of the MICROMHOS meter indicated by the MICROMHOS switch. The tube should meet the minimum micromhos limit given in Section 100-630-501. The nominal value has no direct significance (see Paragraph 5.01).

3.11 For tubes of other than Western Electric manufacture, except when otherwise indicated under NOTATIONS on the roll chart a deflection to the GOOD (green) portion of the scale indicates a satisfactory transconductance, while a deflection to the REPLACE (red) portion of the scale indicates an unsatisfactory transconductance. In the latter case the tube should be discarded. The setting of the ENGLISH dial given on the chart is such as to make the set indicate directly on the colored sectors of the meter scale whether the tube is satisfactory or unsatisfactory. All tube test settings on the roll chart for P₁, P₂ or P₃ push button operation calling for an ENGLISH dial setting for meter readings to be read on the GOOD - REPLACE sectors are denoted with an asterisk (*). If it is desired to check the indicated value of the transconductance (as given under MUT COND on the roll chart), however, the only operation necessary is to set the MICROMHOS switch for the required range. The indicated transconductance value then is read from the proper scale of micromhos on the meter.

3.12 In the case of tubes listed on the roll chart calling for a low signal test, reject values (in lieu of other stated information) must be estimated. This estimated reject value is 75 per cent. of the nominal transconductance for small voltage amplifier receiving tubes such as the 6AG5, 6AU6 or 6SF5 types, and is 65 per cent. of the nominal GM for small power output types such as the 6AG7. The values in the MICROMHOS METER RDG columns of Section 100-630-501 are nominal (NOM column) and minimum reject (MIN column) indicated transconductance values with the FIL ACT key in its NORM filament voltage position. These values apply as specified for any test setting, with the MICROMHOS switch in any position except the ENG position. Whenever the ENG dial setting is called for, the GOOD - REPLACE meter readings apply, as discussed in Paragraph 2.10, and the indicated values of transconductance do not apply.

Grid Current Test

3.13 Set up the SELECTORS and FILAMENT switches as required for the tube to be tested, with the FIL ACT switch on NORM and the SHORTS switch in the TUBE TEST position. With the MICROMHOS switch in the 3000 HIGH SIGNAL position, depress the P₅ (GAS 1) push button and increase the BIAS potentiometer setting to obtain a 100 micromho meter reading (2 scale divisions).

3.14 With the P₅ push button held depressed for this MICROMHOS meter reading of 100, press the P₆ (GAS 2) push button and note any increase in the meter reading. If the increase is more than 2 scale divisions, the grid current exceeds a few microamperes and the tube should be discarded.

Cathode (or Filament) Activity Test

3.15 With operating conditions as in Paragraph 3.09 and the GM push button (P₄ LOCK) locked in its operated position the steady deflection of the MICROMHOS meter is observed on the 3000 micromho meter scale without regard to the scale indication of the MICROMHOS switch, for the NORM position of the FIL ACT switch.

3.16 Operate FIL ACT switch to the TEST position, and, after waiting at least 1-1/2 minutes for heater type tubes or 1/2 minute for filamentary type tubes (see Paragraph 3.05), note again the reading of the MICROMHOS meter.

SECTION 100-630-101

After each cathode (or filament) activity test restore the FIL ACT switch to the NORM position and release the GM-LOCK (P4) button.

Note: For convenience in estimating the percentage change, observations to determine per cent. activity should be read directly using the 3000-micromho meter scale without resetting the MICROMHO switch. In this test it is not necessary to use the actual value in micromhos as measured for tubes which normally are read on the higher MICROMHOS METER scales.

3.17 For Western Electric tubes this TEST reading (Paragraph 3.16) should not fall below the initial NORM reading (Paragraph 3.15) by a percentage greater than the limits given in Section 100-630-501 under MAX. % CATH. ACT. For this purpose Table II may be used to determine whether the required per cent. activity rejection limit has been exceeded, for the particular micromhos reading of the tube under test, i.e., for a given percentage, if the observed reading exceeds or equals the value in the proper percentage TEST column on line with its observed reading in the NORM column, the tube meets the requirements. Tubes which fall below this TEST column value should be discarded.

3.18 Tubes of other than Western Electric manufacture usually are replaced on the basis of the MICROMHOS meter reading using the GOOD - REPLACE color scales only, and no activity test limits are specified for them. If, however, it is desired to apply a cathode (or filament) activity test, a limit of 25 per cent. maximum change in micromhos may be assumed in the absence of other specified values, and Table II may be used for determining the minimum TEST value corresponding to the observed NORM value.

3.19 The limits for minimum MICROMHOS meter reading (Paragraph 3.10) and cathode activity given in Section 100-630-501 are for general use and correspond approximately to the limits generally employed for corresponding tests made by other standard testing methods. For tubes in certain services, other limits may be specified, of course, which should be followed in those cases.

(C) Rectifier and Diode Tests

3.20 Full-wave or Half-wave High Vacuum Rectifiers, P3 Test - Set up the SELECTORS and the FILAMENT switch as required for the tube to be tested, with the FIL ACT switch on NORM and the SHORTS selector in the TUBE TEST

position. With the MICROMHOS switch in the ENG position, depress the P3 (RECT) push button and observe the MICROMHOS meter reading. If the deflection of the MICROMHOS meter falls in the GOOD (green) sector, the tube is satisfactory. If it falls in the REPLACE (red) area, the tube is unsatisfactory and should be discarded. For full-wave rectifier tubes, two tests must be made, one for each plate of the tube. Two selector settings are listed in Section 100-630-501 and on the roll chart for this purpose.

3.21 Diode Tests - For testing diode tubes or diode sections of multi-purpose tubes, depress the DIODE (P1) push button with the selectors and the BIAS and ENG potentiometer dials set as noted in Section 100-630-501 or on the roll chart. The MICROMHOS switch should be in the ENG position. If the deflection of the MICROMHOS meter is less than the special calibration line marked DIODES OK for a test of either diode plate, the tube should be discarded. Diode plate current tests preferably should be of short duration.

3.22 OZ4 Tests - OZ4 gas filled rectifiers of the cold cathode type are tested similarly to diodes or rectifiers. In this case the OZ4 (P2) push button is operated, with the ENG potentiometer set as required, and meter readings are observed on the GOOD - REPLACE scale.

3.23 In testing the rectifier section of dual purpose tubes such as the 117N7GT, 117P7GT or similar type tubes, first the METER switch is operated to REVERSE and then the RECT (P3) push button is depressed. The MICROMHOS meter reading is observed as usual. The use of the REVERSE METER switch, when required, is indicated on the chart.

(D) Special Tests

3.24 The set is arranged to provide rough tests on cold cathode tubes, electron ray (magic eye) indicator tubes, and ballast resistor tubes, all of other than Western Electric manufacture. Settings for tests of these types of tubes (except ballast tubes) are contained on the roll chart. Methods of making these tests, including continuity tests of ballast tubes resistance elements, are described in the instruction booklet furnished by the manufacturer of the test set or on the roll chart. (See Paragraph 1.04)

4. MAINTENANCE

4.01 Installation of Rectifier Tubes in Set - Before the set can be used, a No. 83 full-wave mercury-vapor rectifier tube (the high

vacuum No. 83V type rectifier tube is not suitable) and a No. 5Y3GT full-wave high vacuum type (or 5W4) rectifier tube must be installed within it.

4.02 To install the rectifier tubes, the following is the procedure:

- (1) Remove the screws holding the control panel and lift the panel from the cabinet.
- (2) Insert a 5Y3GT or 5W4 tube in the 8-pin octal socket on the sub-panel inside the set.
- (3) Insert a No. 83 tube in the 4-pin socket on the sub-panel inside the set.
- (4) Plug the power supply cord into a source of 60-cycle 105- to 125-volt a-c power, operate the POWER switch to ON and depress the GM (P₁) push button. If the MICROMHOS meter needle vibrates and the fuse lamp lights up brilliantly, an unsatisfactory 83-type tube is indicated. This condition seldom obtains with a new tube of reliable manufacture and is caused by an excess of metallic mercury within the bulb. Replace the tube with an 83-type which does not produce this effect, if it occurs.
- (5) Remount the panel and reinsert the screws. The set is ready for use.

4.03 The following data apply to the lamps used in this set:

Fuse Lamp	#81 Mazda, 6-8 volts
Pilot Lamp	#40 Mazda, 6-8 volts
Shorts Test Lamp	Neon, Type NE, 1/4-watt, 115 volts

4.04 The care ordinarily accorded any piece of calibrated testing apparatus should be given to the test set to ensure satisfactory operation. The top cover should be in place at all times when the set is not in use, to prevent dust or dirt from entering any of the moving parts, particularly the sliding potentiometer contacts. These contacts should be inspected periodically and cleaned if necessary by the standard methods for such apparatus. Key contacts and the contact prongs of the vacuum tube sockets also should be kept free from corrosion and dirt, and should be burnished as required.

4.05 The meters of this set should be stable if the set is not subjected to serious mechanical shocks or electrical abuse. Factory

meter calibrations are within 1.5 per cent. at full-scale deflection. The set is calibrated to be used in a normal horizontal position. Zero settings of the meters should be checked on installation, each time the set is carried to a new location, and from time to time as required.

4.06 The 5Y3GT (or 5W4) and 83-type rectifier tubes, used in the power supply of the tester, should be replaced by new tubes temporarily and should be tested once a year in the set. They should be rejected for further use if test requirements are not met.

4.07 With the 60-cycle a-c power voltage at any value between 105 and 125 volts the set is designed to permit the No. 83 rectifier circuit to supply an adequate value of d-c operating plate potential (max. approx. 155 volts), and the 5Y3GT rectifier circuit to provide 0 to 45 volts grid bias and sufficient screen grid and other positive grid supply. The grid signal voltage supply calibration also should be satisfactory over this 60-cycle voltage range. Should inadequate operating potentials be encountered, the a-c line voltage should be measured first and verified, using the a-c line volts check circuit. The rectifier tubes 83, and 5Y3GT or 5W4 should be checked and replaced if necessary in case of inadequate operating conditions.

4.08 In case the set fails to operate when testing a tube, i.e., no pilot lamp illumination, no d-c voltage, or no grid signal supply (as indicated by the absence of a meter reading with the POWER switch turned to ON), the small fuse lamp should be inspected first before removing the front panel for further investigation. Burning out or extreme brilliancy of this fuse lamp, which is located in the main primary transformer circuit, usually is an indication of overload or circuit trouble, which should be cleared before continuing the operation of the set.

4.09 Reference may be made to Page 102, or to the manufacturer's drawings which are part of the booklet delivered with the tester, in case it is desired to check its wiring. These drawings are schematic wiring diagrams showing essential circuit details. In the event of serious physical or electrical injury to the test set it should be returned for repair to the Western Electric Company. A parts list for this tester is included in the manufacturer's instruction booklet.

SECTION 100-630-101

5. TEST DATA

5.01 Other data, referred to throughout this practice, are required for the setting up and testing of Western Electric tubes. Section 100-630-501 for Western Electric tubes lists for each tube type the principal settings necessary for an indicated transconductance and a cathode (or filament) activity test, i.e., selector switches, filament (or heater) voltage (FILAMENT switch setting), the ENG and BIAS potentiometer settings and the MICROMHOS switch position. In addition, rejection limits are given under two column headings, i.e., (a) the maximum limit of the filament activity percentage difference and (b) the minimum MICROMHOS meter value required at normal filament voltage. Another column in Section 100-630-501 lists the nominal value of transconductance, GM, as measured by the set for a tube in good condition. Individual tubes will vary from this nominal value, depending on particular tube types, and failure to meet the values given in this column should not be the basis for discarding a new or old tube.

5.02 The BIAS dial settings have been selected to approximate normal plate current operation as well as to obtain MICROMHOS meter readings as near as possible to nominal values for Western Electric tubes, within the limitations imposed by the set.

5.03 A column heading labeled "Operating Notes" shows test operations as required for certain tubes by reference to the particular test button. Multi-purpose tubes and the separate anode circuits of diodes and full-wave rectifier types require more than one series of test settings.

5.04 It should be noted that the nominal values of indicated transconductance listed in Section 100-630-501 for Western Electric tubes are for the test conditions obtained with this set and as affected by the fixed plate and other operating voltages. Of necessity, therefore, these nominal values of transconductance will not always correspond exactly to values given in Western Electric vacuum tube data sheets for the particular tube type. (See Paragraph 5.01)

Attached:

Pages 101, 102 and 103.

TABLE I
SHORTS TEST LOCATION
BY NEON LAMP LIGHTING UNDER X
Hickok KS-5727 L1 Tube Tester

Kind of Short	Selector Switch Position				
	1	2	3	4	5
FIL -- CATHODE			X		
FIL -- GRID	X	X			X
FIL -- PLATE	X	X		X	X
FIL -- SCREEN	X		X	X	X
FIL -- SUP		X			
GRID -- CATHODE	X	X	X		X
GRID -- PLATE				X	
GRID -- SCREEN		X	X	X	
GRID -- SUP	X				X
PLATE -- SCREEN		X	X		
PLATE -- SUP	X			X	X
SCREEN -- SUP	X	X	X	X	X

TABLE II (Cont'd)

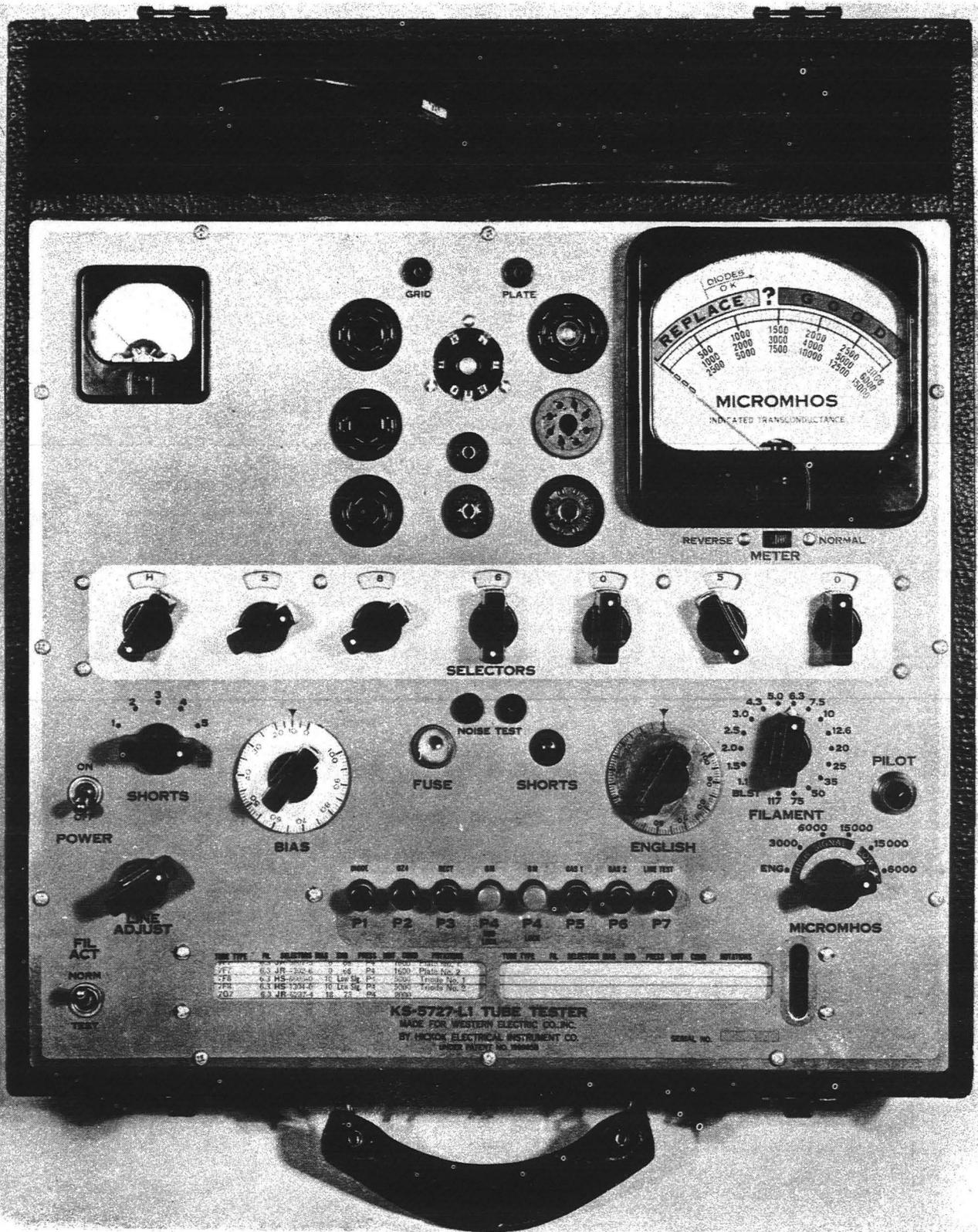
MICROMHOS Meter Rdg. FIL-ACT NORM	Corresponding TEST Position Meter Reading for Activity Limits of:			
	15%	20%	25%	30%
1000	850	800	750	700
1040	885	830	780	730
1080	920	865	810	755
1120	950	900	840	785
1160	985	930	870	810
1200	1020	960	900	840
1240	1050	990	930	870
1280	1090	1020	960	900
1320	1120	1060	990	925
1360	1160	1090	1020	950
1400	1190	1120	1050	980
1440	1220	1150	1080	1010
1480	1260	1180	1110	1040
1520	1290	1220	1140	1060
1560	1325	1250	1170	1090
1600	1360	1280	1200	1120
1640	1390	1310	1230	1150
1680	1430	1345	1260	1180
1720	1460	1380	1290	1200
1760	1500	1410	1320	1230
1800	1530	1440	1350	1260
1840	1565	1470	1380	1290
1880	1600	1500	1410	1320
1920	1630	1540	1440	1345
1960	1670	1570	1470	1370
2000	1700	1600	1500	1400
2040	1735	1630	1530	1430
2080	1770	1665	1560	1460
2120	1800	1700	1590	1485
2160	1840	1730	1620	1510
2200	1870	1760	1650	1540
2240	1900	1790	1680	1570
2280	1940	1825	1710	1600
2320	1970	1860	1740	1625
2360	2000	1890	1770	1650
2400	2040	1920	1800	1680
2440	2080	1950	1830	1710
2480	2110	1985	1860	1740
2520	2140	2020	1890	1765
2560	2180	2050	1920	1790
2600	2210	2080	1950	1820
2640	2245	2115	1980	1850
2680	2280	2140	2010	1880
2720	2315	2180	2040	1900
2760	2350	2210	2070	1930
2800	2380	2240	2100	1960
2840	2420	2275	2130	1990
2880	2450	2300	2160	2020
2920	2480	2340	2190	2040
2960	2520	2370	2220	2070
3000	2550	2400	2250	2100

TABLE II

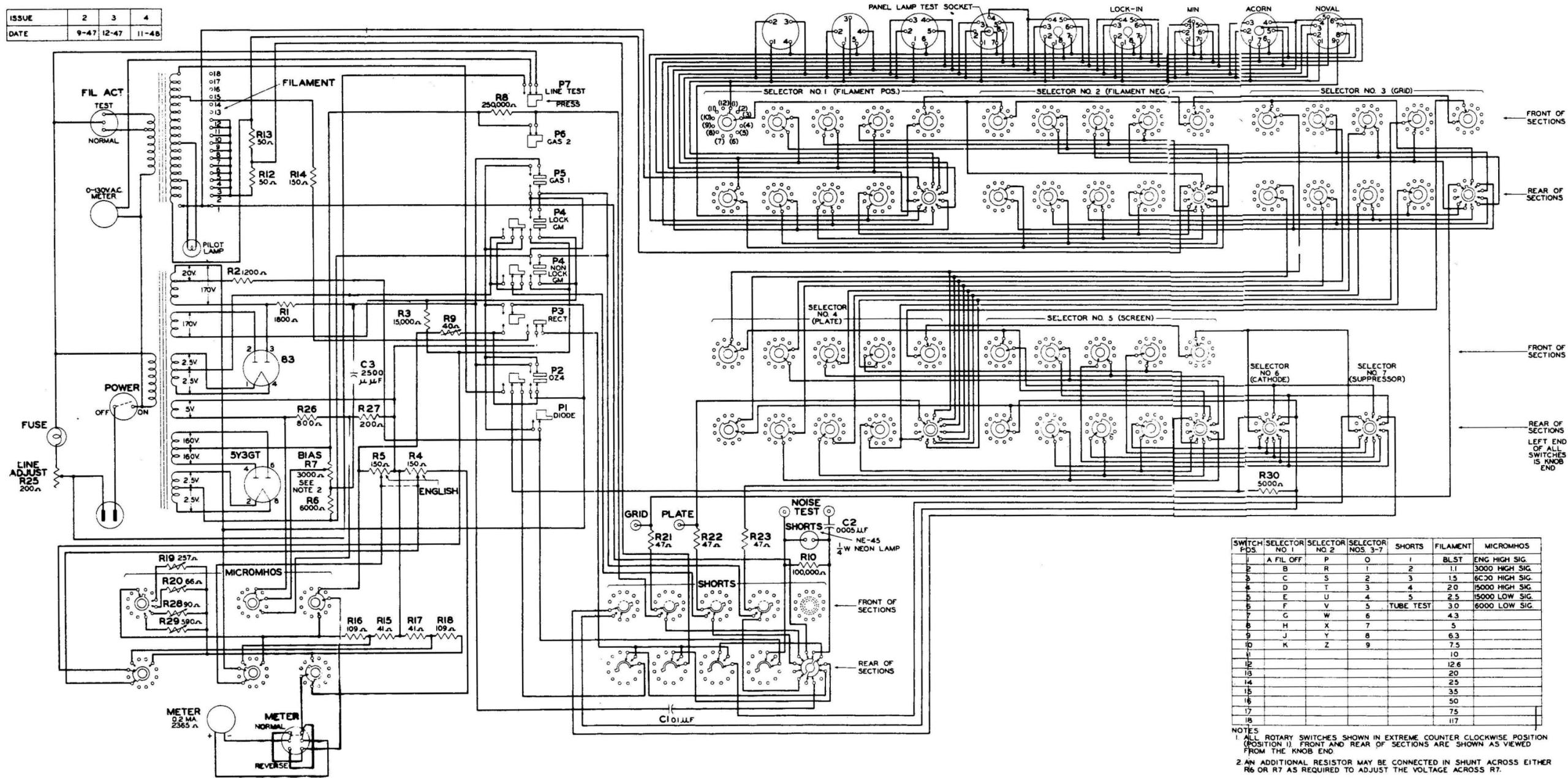
(Read on the 0-3000 Micromho Scale only, irrespective of the Scale Range indicated by the MICROMHOS Switch.)

MICROMHOS Meter Rdg. FIL-ACT NORM	Corresponding TEST Position Meter Reading for Activity Limits of:			
	15%	20%	25%	30%
200	170	160	150	140
240	205	190	180	170
280	240	225	210	195
320	270	255	240	225
360	305	290	270	250
400	340	320	300	280
440	375	350	330	310
480	410	385	360	335
520	440	415	390	365
560	475	450	420	390
600	510	480	450	420
640	540	510	480	450
680	580	540	510	475
720	610	575	540	505
760	645	610	570	530
800	680	640	600	560
840	715	670	630	590
880	750	705	660	615
920	780	735	690	645
960	815	770	720	670

Per cent. activity limits in this table computed to + 5 micromhos (approximately).



ISSUE	2	3	4
DATE	9-47	12-47	11-48



SWITCH POS.	SELECTOR NO. 1	SELECTOR NO. 2	SELECTOR NOS. 3-7	SHORTS	FILAMENT	MICROMHOS
1	A	FIL OFF	P	0	1	
2	B	R	1	2	BLST	ENG HIGH SIG.
3	C	S	2	3	1.5	3000 HIGH SIG.
4	D	T	3	4	2.0	6000 HIGH SIG.
5	E	U	4	5	2.5	15000 LOW SIG.
6	F	V	5	TUBE TEST	3.0	6000 LOW SIG.
7	G	W	6		4.3	
8	H	X	7		5	
9	J	Y	8		6.3	
10	K	Z	9		7.5	
11					10	
12					12.6	
13					20	
14					25	
15					35	
16					50	
17					75	
18					117	

NOTES
 1. ALL ROTARY SWITCHES SHOWN IN EXTREME COUNTER CLOCKWISE POSITION (POSITION 1). FRONT AND REAR OF SECTIONS ARE SHOWN AS VIEWED FROM THE KNOB END.
 2. AN ADDITIONAL RESISTOR MAY BE CONNECTED IN SHUNT ACROSS EITHER R6 OR R7 AS REQUIRED TO ADJUST THE VOLTAGE ACROSS R7.

TUBE TESTER SCHEMATIC

CS-857221
 TOLL SYSTEMS TUBE TESTER SCHEMATIC
 KS-5727 FIG. 3
 BELL TELEPHONE LABORATORIES, INC.
 ES-857221
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