ELECTRON (VACUUM) TUBE TEST SET
KS-15559 HICKOK TUBE TESTER
DESCRIPTION AND APPLICATION

CONTENTS

1. GENERAL

1.01 This section describes the Hickok KS-15559 L1 tube tester and gives the methods for operating and maintaining the set. This set is capable of testing practically all small sized amplifier and rectifier tube types of Western Electric or other manufacture. The tubes are tested 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 independent control grid bias supply as prescribed, satisfactory tests may be made both on tubes normally operating at lower plate potentials and on tubes normally operating at plate potentials up to about 300 volts.

1.02 This section is reissued to incorporate material from the addendum in its proper location. In this process marginal arrows have been omitted.

1.03 The KS-15559 L1 tester incorporates all of the test features found in the model KS-5727 L1 tester plus certain improvements and operating advantages which provide in particular superior transconductance (Gm) measuring accuracy and extension of the maximum measurable ranges of indicated transconductance. Except for minor differences in panel layout the modified KS-15559 L1 tester is electrically equivalent to the KS-15560 tester. These basic improvements over Hickok testers of older design are intended to minimize set-to-set transconductance errors hitherto encountered, as well as to make possible testing of higher Gm tube types of recent Western Electric Company manufacture under adequate testing conditions suitable for this purpose. Furthermore the superior accuracy of the KS-15559 tester will improve the relationship, particularly for amplifier types utilizing a screen grid, between indicated transconductance as measured and the nominal transconductance values usually published in Western Electric electron tube data sheets and in other tube manufacturers' handbooks.

1.04 These and other important test features and circuit innovations included in the KS-15559 L1 tester are:

(1) Greater precision of Gm measurements and reduction in difference in readings between sets. This is accomplished by:

(a) Introduction of grid signal directly into control grid circuit,

(b) Provision of an independent grid bias supply,

(c) Adjustment of grid bias on a voltage basis by addition of a d-c meter.

(2) Extension of Gm measurements to include 24,000 and 60,000 micromhos ranges.

(3) Provision of external binding posts to permit self bias testing.

(4) Shorts test circuit changed to reduce a-c test voltage to a satisfactory peak value.

(5) Jumbo 9-pin test socket added for recent Western Electric tubes such as 418A.

(6) An optional use of the micromhos meter as a microammeter to measure gas or grid leakage current directly in the grid circuit of a tube under test.

(7) Removal of grid signal voltage used in connection with grid current test under separate push switch control.

(8) Provision for the reduction of screen grid voltage as applied for tests of small battery type tubes and older Western Electric types which normally operate at lower screen voltages.

(9) A new roll chart for commercial type tubes is furnished in which the minimum or reject numerical values of indicated transconductance are listed instead of the nominal Gm values hitherto supplied on previous Hickok charts. Accordingly, the micromhos meter will not have GOOD-REPLACE sectors. Rectifier tubes and other tubes measured on a rectified current basis will be measured by observing the RECTIFIERS & DIODES OK line index on the micromhos meter scale, with an appropriate setting of the SHUNT potentiometer dial.

1.05 The KS-15559 L1 tester provides means for making the following tests:

(1) Measurement of the "indicated transconductance" in micromhos. The meter reading is directly proportional to the transconductance of the tube under test, but under the relatively fixed plate and screen grid voltage test conditions is not always a true 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 by direct grid meter measurement.

(5) Transconductance test at approximately one-half normal screen grid voltage for all tube types requiring this test condition for satisfactory Gm measurement.

(6) Rectifier tube plate current tests for thermionic and certain cold cathode types. Western Electric tubes such as cold cathode types (313C group), coded ballast lamps, and coded voltage regulator tubes such as the 423A can not be tested in this set. Tests of non-Western Electric Co. voltage regulator types such as the 0A2, 0B2, or 0D3/VR150 series are not recommended even though tests for some of these types have been listed on the roll chart. Small, hot cathode thyratrons such as the 884 and 2050 types also are listed on the roll chart. Although not entirely adequate, such tests may be made in the absence of other maintenance tests. Tests for small cold cathode rectifier types listed for tubes such as the 0Z4 are satisfactory.

1.06 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.

1.07 General purpose rejection limits for Western Electric tubes are discussed in Part 7 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.

1.08 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 approximately but not necessarily equal to true transconductance, check tests made with this set should not be used as measures of new tube quality relative to manufacturer's specifications.

1.09 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. New superseding charts may be obtained at nominal cost from the Hickok Electrical Instrument Company - 10514 Dupont Ave., Cleveland 8, Ohio. Section 100-634-501 listing complete Western Electric tube test data is printed in such form that it can be readily added to or become an integral part of the roll chart of this tester.

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 18-1/4 inches by 17 inches and 7-1/2 inches deep. The net weight is about 27 pounds. It can be shipped in a suitably reinforced 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 electron 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 never 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, grid bias voltmeter, and a group of ten electron tube test sockets. The row of selector switches, potentiometer and various selector control dials, a neon lamp for short circuit tests, an autobulb fuse, a MICROMHOS switch, four toggle switches, a pilot lamp and a bank of test pushbuttons, are all suitably designated and arranged as shown in the attached panel layout on Page 101. A roll chart (provided by the manufacturer) below the pushbutton bank, gives the test settings and adjustments for electron tubes of other than Western Electric Company manufacture.

(B) Description of Equipment on Panel of Set

2.04 The principal meter (designated herein as the micromhos meter) is a d-c microammeter calibrated in micromhos, with five basic scales corresponding to ranges of 0-3000, 0-6000, 0-15,000, 0-24,000 and 0-60,000 micromhos, to give the measurement of indicated transconductance of the tube under test. The highest ranges, 0-24,000 and 0-60,000 are designated in red on the meter scale to emphasize association with the red GMX4 switch position. In the GMX4 position the LOW SIG 6000 and 15,000 scale readings correspond to 24,000 and 60,000 micromhos, respectively. In the case of rectifier and diode types, the value of rectified plate current in terms of a minimum (reject) index line on the meter designated RECTIFIERS & DIODES OK is used as a criterion for rejection instead of micromhos. A small slide contact switch designated METER beneath the micromhos meter is provided to reverse polarity when 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 cord compartment. 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 A small d-c voltmeter, designated GRID BIAS D.C. VOLTS, is located in the upper left corner of the main panel. This voltmeter, and its associated range toggle switch designated BIAS VOLTS (having 5 and 50-volt positions) register the required grid bias voltage for a transconductance test, under control of the BIAS potentiometer.

2.07 A binding post pair, designated SELF BIAS is located immediately below the GRID BIAS voltmeter, adjacent to the BIAS VOLTS range switch. The shorting strap provided may be removed for the insertion of an appropriate self bias test resistor as required for certain tube tests. These binding posts also can be utilized to measure total space current, or plate current alone in the case of a triode, if desired, by unstrapping the two posts and connecting a suitable external d-c milliammeter + and − terminals to + and − terminals, respectively.

2.08 Ten types of push type electron tube sockets are provided, which include the standard 4-, 5-, 6-, 7-prong and two 8-prong types for the octal and lock-in type tube bases. The remaining three sockets are for miniature tubes of the 7-pin, 9-pin (Noval) and Acorn types and the 9-pin Jumbo type. Also listed below, are suitable adapters, not provided as part of the set, which must be obtained for testing certain bayonet 4-pin base Western Electric tubes.

	Standard Adapter
101-, 102-, or 104-type (W.E.Co.)	Alden No. 944 WEB
205-type (W.E.Co.)	" No. 978 WEB
215A (W.E.Co.)	" No. 972

2.09 Controls: All of the seven selector switch controls must be given their proper settings for a measurement of indicated transconductance. These selector switch controls are designated according to their functional socket pin code assignments as shown in Fig. 10, hence a test may be improvised for basing a tube for which roll chart settings are unavailable. This procedure is covered in Part 6.

2.10 Selector Switches: Seven SELECTORS, so designated, are located across the main control panel. Settings of these switches control the connections for properly basing any tube to be tested, when it is inserted into its proper socket. These settings are obtained from the roll chart or

(for Western Electric tubes) from Section 100-634-501. The first two selectors with letter designations control the filament pin assignments, while the remaining five control grid, plate, screen, cathode and suppressor elements in that order.

2.11 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 position necessary in making certain tests where the cathode return circuit is disconnected from the midpoint 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. Heater (or filament) off is provided by operating the first selector to A or the second selector to position P. These selector positions are also designated FIL. OFF.

2.12 MICROMHOS Range and GM-GMX4 Switches: The MICROMHOS switch controls the range of the transconductance test and in conjunction with the GM-GMX4 toggle switch it controls the applied voltage of the grid signal. The GM-GMX4 switch selects the meter scale multiplier. The GMX4 position designation together with the 0-24,000 and 0-60,000 scales on the meter are in red for ready distinction from the black GM position designation and black meter scales which are used with it. The first position, SHUNT, is used for tube tests in terms of the meter scale index line designated RECTIFIERS & DIODES OK. The next three positions, in order, are for the three micromho scales, 3000, 6000 and 15,000, and give indicated transconductance for the high signal grid test voltage. The second sector of the MICROMHOS switch designated LOW SIG is used in connection with the GM-GMX4 switch, to register four ranges of indicated transconductance on the micromhos meter in the following order: 60,000, 24,000, 15,000 and 6000 micromhos. The lowest ranges of this sector (15,000 and 6000) utilize a 1-volt grid signal while the higher ranges 60,000, 24,000, use 1/4-volt signal, obtained with the auxiliary toggle switch in the GMX4 position. All tubes are now tested according to a minimum or reject value of indicated transconductance as listed in the roll chart or Section 100-634-501 under the column heading MIN. TRANSCOND. The proper choice of the micromhos switch setting or the SHUNT potentiometer setting is given under the column heading MIC-SW SHUNT on the roll chart.

2.13 SHUNT Dial: The SHUNT 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 SHUNT position only. It is used for tests where the special index scale mark is specified (such as for diodes), as given on the roll chart or in Section 100-634-501.

2.14 BIAS Dial: The BIAS dial controls a potentiometer, which provides either of two continuously adjustable ranges of grid voltage from 0 to 50 volts or 0 to 5 volts on the GRID BIAS D.C. VOLTS meter, depending on the BIAS VOLTS toggle switch position. The scale divisions on the potentiometer dial no longer have any significance.

2.15 Line Adjustment: This potentiometer, designated LINE ADJUST, controls the a-c voltage applied to the primaries of the two power

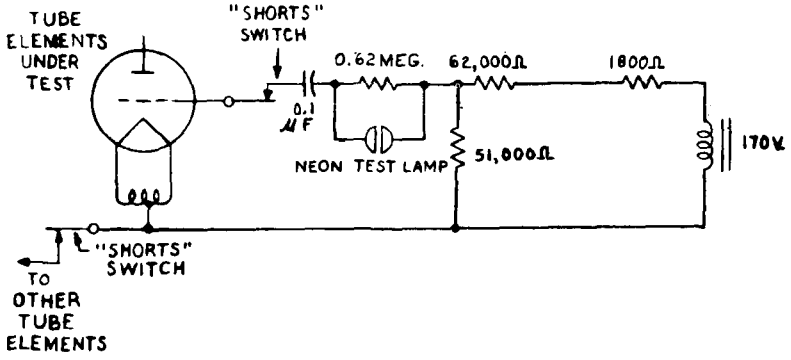

Fig. 1 - Shorts Test Circuit

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, which is normal for the test set operation.

2.16 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 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.

2.17 Toggle Switches: A FIL ACT switch and the POWER switch are located to the left of the P1-P7 push switch gang. These two switches function as follows:

(1) The FIL ACT switch is required for cathode (filament) activity tests. 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 the nominal filament selector 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. The single contact lamp bulb in the socket designated FUSE is used to protect the power circuit of the set.

(3) BIAS VOLTS: This switch, with positions 5 and 50, controls both voltmeter range and grid bias voltage registered by the GRID BIAS D.C. VOLTS meter under control of the BIAS potentiometer.

2.18 Pushbutton 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. The required P1 to P7 switches are given in all test setting data.

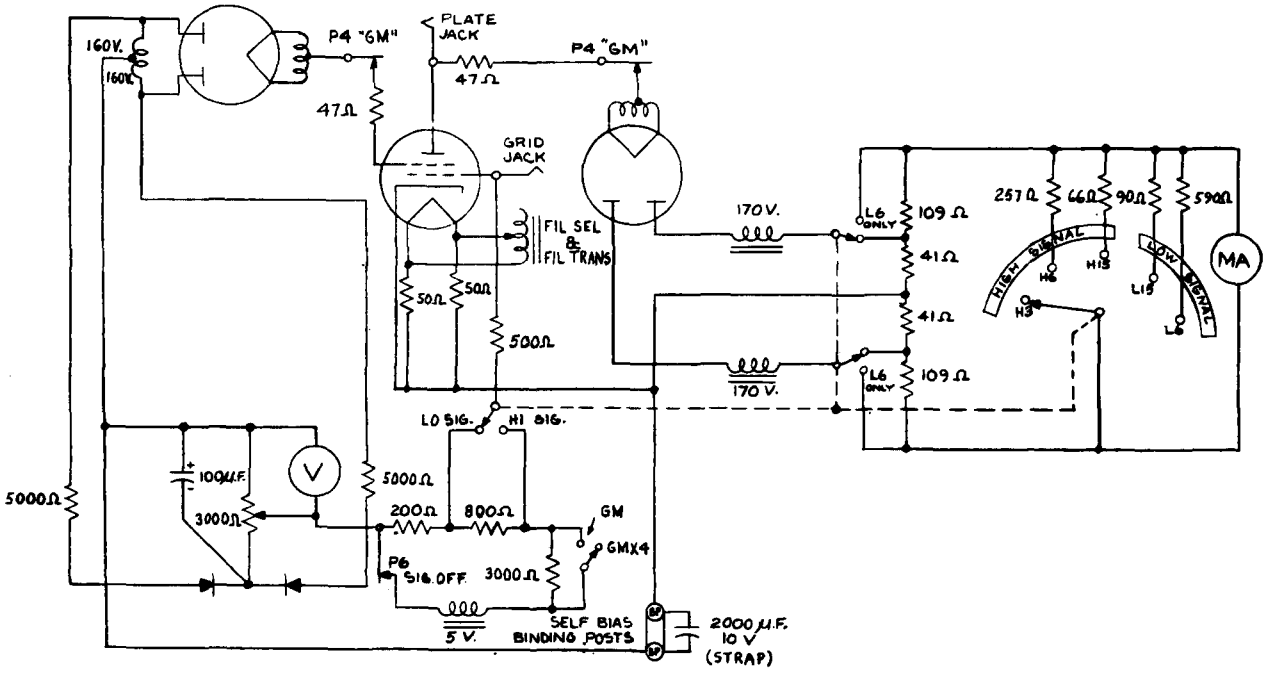

Fig. 2 - Basic Transconductance Test Circuit KS-15559, L1 (Shunt, previously designated "English," Potentiometer Test Circuit Not Shown)

(1) Two Gm (P4) pushbuttons (colored red) are provided for the transconductance test. These pushbutton switches are connected in parallel and are designated to operate as indicated by NON LOCK (left-hand button) and LOCK (right-hand button). When operated, the proper d-c plate and screen grid voltages are impressed on the tube under test, and the plate circuit is connected to the micromhos meter through the MICROMHOS switch. The locking type pushbutton switch is provided to ensure continuously applied operating potentials to a tube during the time required for a cathode (filament) activity test.

(2) Two test (non-locking) pushbuttons, designated GAS (P5) and SIG. OFF (P6), are provided. Operation of the GAS button (P5) transfers the micromhos meter directly into the grid circuit. Operation of the SIG. OFF (P6) pushbutton removes the grid signal voltage from the grid circuit of a tube under test. The combined operation of these two buttons makes possible a direct reading grid current or grid insulation leakage test using the micromhos meter as a d-c microammeter.

(3) Three pushbuttons, 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 a reading with respect to the RECTIFIERS & DIODES OK index mark gives a measure of the condition of the tube. The P2 pushbutton, designated 0Z4, 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 pushbutton, 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 pushbutton, 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

2.19 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.

2.20 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 screen grid (if any) of the tube under test. Control grid bias is developed from a full-wave selenium rectifier circuit which derives the a-c voltage supply from the screen grid high voltage transformer winding. 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.

2.21 However, the circuit actually is arranged to impress an a-c (60-cycle) potential of various values, 5 volts, 1, or 1/4 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."

2.22 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 directly proportionally to the rectified a-c current as indicated on the meter scale.

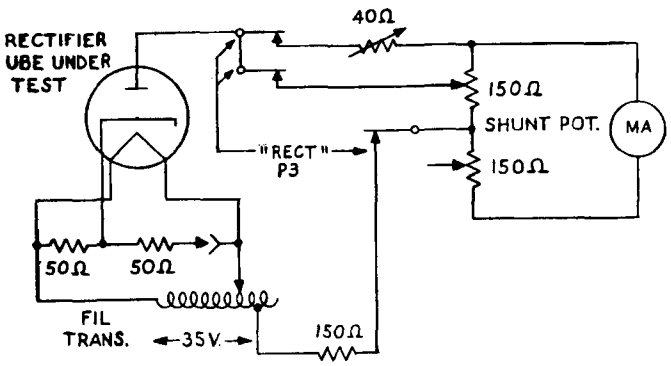

Fig. 3 - Standard Rectifier Test Circuit

2.23 When testing the diode section of a multi-purpose tube, or small hot cathode diodes, the circuit (Fig. 4) is the same as that described in Paragraph 2.22 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 diode is tested at a time. Micromhos meter readings are observed relative to the RECTIFIERS & DIODES OK index mark, readings to the right of the line indicating a satisfactory condition.

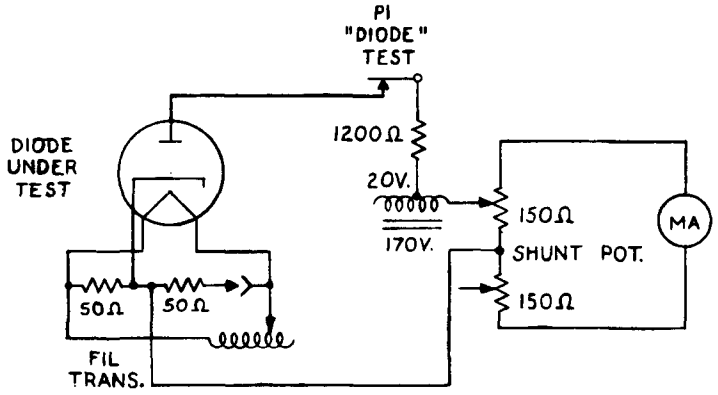

Fig. 4 - Diode Test Circuit

2.24 When testing a cold cathode tube, the circuit (Fig. 5) is similar to that described in Paragraph 2.23 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.

2.25 Gas current in a tube or grid leakage current due to poor grid to filament insulation may be detected by the switched insertion of the micromhos meter into the grid circuit of a tube under test, as shown in Fig. 6 and described in Paragraph 2.18, Item (2). In this setup the normal

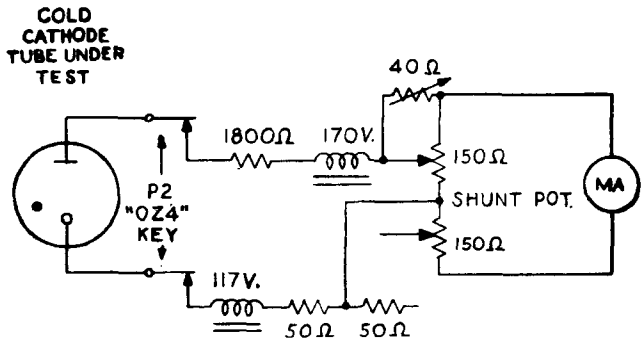

Fig. 5 - Cold Cathode Tube Test Circuit

d-c pulsating voltages are applied to the screen grid (approximately 130 volts) and to the plate (150 volts) by means of the P4 pushbutton switch. This test is made with the standard normal grid bias voltage applied under control of the BIAS dial as for a regular transconductance measurement with the P4 switch operated. Then with the P4 switch operated, the SIG. OFF (P6) push switch and then the GAS (P5) switches are operated. The P5 switch transfers the d-c micromhos meter from its normal plate circuit position directly into the control grid circuit to measure grid current, if any, directly in d-c microamperes. The SIG. OFF (P6) switch removes grid signal for the test, for in certain cases the presence of a grid signal could produce false readings. In this test the micromhos meter, used as a d-c microammeter will read 3-1/3 microamperes per small scale division.

(D) Power Supply

2.26 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-cp 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.

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

(E) Special Features

2.28 Neon Lamp Shorts Test Circuit: This test circuit locates shorts in any interelectrode path within a tube, as indicated previously in Paragraph 2.16. The actual method of test is given in Paragraph 3.05. Table I, or the corre-

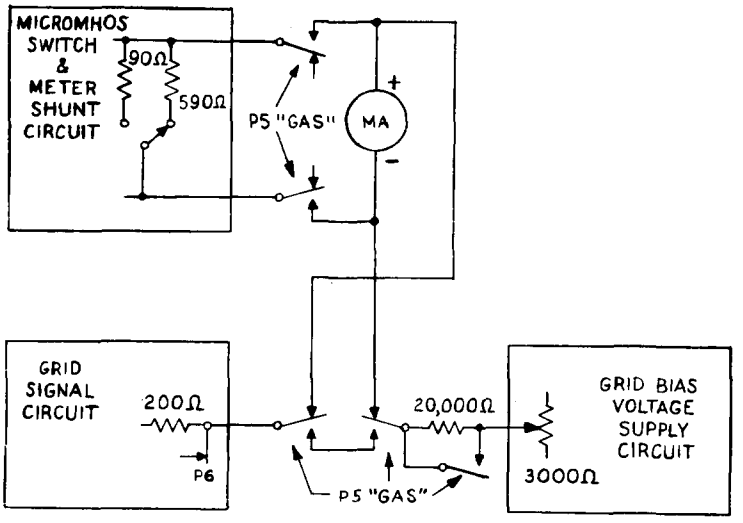

Fig. 6 - Gas Test Circuit

sponding 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.

2.29 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 tube base wiring interconnections. Such short indications should be ignored. The table shows three neon lamp indication combinations, each of which represents two separate short conditions. To a considerable extent a discrimination between these alternate path indications will be evident from a consideration of the basic type of tube under test, e.g., triode vs. tetrode, or cathode type vs. filamentary type. In certain instances a tube chart listing includes a separate "Shorts Test Only" setting as indicated under the column NOTATIONS (or OPERATING NOTES). This is necessary in cases where the regular transconductance measurement selector setting for a given tube has a duplicate electrode appearance (repetition of a selector index number) to prevent tube self oscillation on a Gm test, or in other cases to avoid false short indications in certain multi-purpose 2-section types such as pentagrid converters.

2.30 An added function is incorporated, as shown in Fig. 7, with the operation of the DIODE (P1) push switch to provide half normal screen grid voltage (about 65 volts) in conjunction only with a regular transconductance test with the GM (P4) switch operated. This test is required principally for small battery powered or older type Western Electric and non-Western tubes which normally operate with lower screen grid voltage in the 60 to 100-volt range, to obtain more precise transconductance measurements. The use of half normal screen grid voltage also minimizes the possibility of exceeding the maximum plate and screen power ratings of such tubes under test.

2.31 Adapters are required for Western Electric tubes equipped with bayonet type bases, as discussed in Paragraph 2.08.

2.32 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. It is important not to connect the cap terminal of the tube to the wrong pin jack. (See Paragraph 3.02 Item (5).)

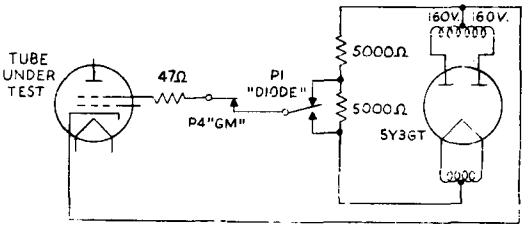

Fig. 7 - Reduced Screen Voltage Test Circuit

2.33 Noise Test Circuits: 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 required 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 pushbuttons 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.

2.34 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) Preliminary Setup Procedure

3.01 Detach the cover of the set when in use or have it properly supported in the open position. When the set is not in use, the POWER switch always should be turned off to avoid unnecessarily heating up the set.

> Caution: When setting up new selector settings or changing tubes be sure all push switches are released, particularly the P4 LOCK button, to avoid damage to the set or to the tube to be tested. To prevent accidental heater or filament burn-out the FILAMENT selector setting should be verified before a tube is placed in any socket.

3.02 Procedure:

(1) With the POWER switch at OFF, plug the attachment cord into a suitable source of 60- (or 50-) cycle, 105-120-volt a-c power.

(2) Adjust the FILAMENT selector switch, the SELECTORS switches and the MICROMHOS switch to the proper values for the type of tube to be tested. (See the roll chart and data Section 100-634-501.) Subsequent changes in the roll chart, if required, will be shown in data Section 100-634-502.

(3) If a self bias resistor is required for the tube (by roll chart or in the data section) turn the BIAS knob to the extreme counterclockwise position (0 volt) and insert a resistor of this value in place of the shorting strap across the SELF BIAS binding post pair. The tolerances of the resistors used should be no greater than indicated under "Notations" and preferably should be less.

> Note: To expedite easy insertion of the necessary self-bias resistor, when required, a simple combination consisting of a General Radio #274-MB plug with the proper external resistor may be used. The resistor can be connected to this plug without soldering, using a thin screwdriver such as the KS-6854. The nearest 145A (1%) or 145C (5%) Western Electric resistance value should be ordered. The choice between 145A and 145C depends on the precision specified under "Notations." 106A (1%) resistances also are suitable but are more costly.

(4) Insert the tube to be tested into the socket which is proper for the tube base. For certain tubes adapters are required as shown under "Notations" on the roll chart or in the data sections. (See Paragraph 2.08.)

(5) If the tube has a top terminal, plug the clip lead into the required GRID or PLATE jack (this is shown on the chart or in the data section, under "Notations"), and attach the other end to the cap of the tube. The clip on the cap should be vertical on metal shell tubes to avoid a short between the cap and the shell.

> 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.

(6) Operate the POWER switch to ON and adjust the LINE ADJUST potentiometer until the needle of the A.C. VOLTS voltmeter points to the TEST calibration mark (red). This adjustment should be checked from time to time during the tests, particularly as the plate current comes on when one of the Gm pushbuttons is operated.

Caution: The SELECTORS or filament selectors 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 certain tests involving the P1, P3, P5 or P6 pushbuttons, and checks of the line voltage by the operation of pushbutton P7, test procedures usually call for the operation of only one pushbutton at a time.

(7) Note the bias voltage required by the chart or tube data section, and adjust the BIAS potentiometer and the 5-50-volt range switch to obtain the proper grid voltage on the grid bias voltmeter. This step is not necessary if a self bias resistor is used in Item (3).

3.03 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 types 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 time interval 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 (P7) pushbutton and observing the A.C. VOLTS meter behavior.

(B) Tests of Amplifier Types of Tubes

3.04 These tests apply to all tubes having control grids whether they are used in service as amplifiers, modulators, demodulators, detectors or oscillators. The basic transconductance test provided by this set may be qualified as a Class A Gm test. In this case the tube being tested operates under normal bias voltage to approximate design center plate and screen current values within the set's limitations (such as the relatively fixed plate and screen voltage supply).

Shorts Test

3.05 Procedure:

(1) Complete the preliminary setup procedure per Paragraph 3.02.

(2) Ordinarily the shorts 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.

Note: Occasionally a longer preheating period may be desirable to disclose an interelectrode short condition with bulb temperature comparable to continuous operation. In such cases, preheat the tube under test by proceeding to the transconductance test (Paragraph 3.07) and then make the shorts test after the tube has been preheating with the P4 button locked for at least five minutes. In some cases this procedure may lead to false short indications, as discussed in Item (5).

(3) Operate the SHORTS test switch slowly through positions 1 through 5.

(4) If the neon lamp, designated SHORTS, lights continuously in any of these positions a short circuit between elements is indicated.

(5) The meaning of the short indication usually can be determined by reference to Table I.

Note: Sometimes, as discussed in Paragraph 2.29, an alternate path may exist. However, false short indications may be observed on certain non-Western types, principally converter or mixer tubes. Such short indications occur after a tube has been under plate load (Gm test) but usually disappear under shorts test conditions after a relatively short time, about 5 to 20 seconds. Specific known examples of such cases will be listed in Section 100-634-502. One typical case of false short indication usually involves neon lamp positions 1, 4 and 5, occurring only for tubes with a screen grid. It indicates a screen to cathode short and is due to the temperature condition of the screen grid.

(6) Repeat shorts test switch sequence if necessary to verify fault location.

Requirements: Continuous lighting of the neon lamp indicates an unsatisfactory tube. The nature of the short may be obtained from Table I.

3.06 In certain instances a tube chart listing may include a separate "Shorts Test Only" line in the NOTATIONS or OPERATING NOTES column on the roll chart or in the Western Electric electron tube test data chart Section 100-634-501. This is necessary in cases where the selector setting for the regular transconductance meas-

urement for a given tube employs a duplicate electrode appearance (repetition of a selector index digit) to prevent tube self oscillation on a Gm test. Table I shows three neon lamp indication combinations each of which represents two separate short conditions. Either of these indications may be the correct one. Often the identification of which short path is present may be made by a consideration of the basic type of the tube under test, i.e., triode vs. tetrode or pentode, or cathode vs. filamentary type. Tubes may be tapped lightly with a soft part of the index finger during the short tests to disclose the possibility of intermittent shorts in this test and an intermittent flash may be obtained instead of a steady illumination. However, an instantaneous flash as the switch is moved from one position to another should be disregarded as this flash is caused by the discharging of the condenser in the shorts test circuit.

Transconductance Test

3.07 Procedure:

(1) Complete the basic setup procedure (see Paragraph 3.02) and shorts test (Paragraph 3.05) for the tube to be tested.

(2) Under NOTATIONS on the roll chart or in 100-634-501 note carefully any special operating notes which may apply, such as a self bias resistor required or the combined operation of the P1 push switch with P4 button to obtain a reduced screen voltage transconductance test. The auxiliary toggle switch associated with the MICROMHOS switch normally should be in the GM position except for cases involving higher Gm tubes as called for under the MIC-SW SHUNT column.

(3) Set the FIL ACT test switch at NORM.

(4) Set the SHORTS switch at the TUBE TEST.

(5) Operate the GM button (right-hand P4).

(6) Recheck the line adjustment voltage reading on the A.C. VOLTS meter.

(7) Read the deflection of the micromhos meter corresponding to the proper micromhos scale designated by the MICROMHOS switch setting.

Requirements: See Paragraphs 3.08 and 3.09.

Note: Although this tester incorporates suppressor elements associated with the test socket circuits to prevent self oscillation or singing of a tube under transconductance test, circumstances may arise where it is desirable to identify a singing condition. Whenever a fluctuating or unstable transconductance (Gm) reading is observed an unsatisfactory test condition, possibly due to tube self oscillation, is indicated. Such a condition may be due to set or tube trouble. When this is suspected in connection with the test described in Paragraph 3.07, with the P4 button remaining locked and the bias voltage at the prescribed value, the bias voltage should be increased to obtain near cutoff or minimum micromhos meter reading. Then the bias voltage should be slowly decreased until normal bias voltage is reached, while carefully observing the micromhos reading. Any sudden change in micromhos meter or bias voltmeter indication which occurs when the bias voltage is being reduced indicates tube oscillation. Touching the external self bias binding posts in connection with this test to introduce a hand capacitance effect will aid in verifying the singing condition by causing an appreciable change in the micromhos meter reading.

3.08 For Western Electric tubes, the prescribed settings of BIAS volts, and the MICROMHOS and auxiliary GM-GMX4 switches 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. These settings are found in Section 100-634-501, etc., under columns headed BIAS VOLTS and MIC-SW SHUNT, respectively. The tube should meet the minimum micromhos limit given in Section 100-634-501. No nominal values are given (see Paragraph 7.04). Where a transconductance test is required with half normal screen grid voltage as discussed in Paragraph 2.30, the symbol, #, will appear in the PRESS column. The complete Gm test should be made in the normal manner except that the P1 push switch should be depressed first and held depressed while the P4 (Gm) switch is operated to obtain a micromhos meter indicated Gm reading.

3.09 Tubes of other than Western Electric manufacture are set up and tested according to roll chart test data in the same manner as Western Electric tubes, as outlined in Paragraphs 3.07 and 3.08 preceding. All tubes are passed or rejected on a minimum transconductance basis except for rectifiers, diodes, special cold cathode or a few gas triodes. These exceptions, with the roll chart usually calling for operation of the P1, P2, or P3 push switches and an appropriate SHUNT dial setting as listed under the column heading MIC-SW SHUNT, are passed or rejected with reference to the RECTIFIERS & DIODES OK index mark only. All readings to be observed with respect to this rejection index are identified on the roll chart under the column heading PRESS by a star or asterisk (*).

Grid Current Test

3.10 This test to detect and measure grid leakage or gas current between control grid and cathode (or filament) usually is made, if required, in conjunction with the regular transconductance test previously described under Paragraph 3.07.

3.11 Procedure:

(1) With the tube set up for test per Paragraph 3.02 depress and lock the P4 LOCK (GM) switch in place.

(2) Operate and hold the SIG. OFF (P6) button depressed to remove the grid signal.

(3) Operate the P5 (GAS) push switch and observe the micromhos meter for any discernible deflection. In case of reverse deflection operate METER switch to REVERSE.

Requirements: If micromhos meter reading exceeds 1-1/2 small scale divisions (about five microamperes), the tube should be rejected. This general maximum grid current limit applies only in lieu of other requirements specified on the roll chart or in sections of Bell System Practices which cover the maintenance of the particular tube in the particular equipment involved.

Cathode (or Filament) Activity Test

3.12 This test is performed in conjunction with the transconductance test described in Paragraph 3.07.

3.13 Procedure:

(1) With the tube under test in operation (Gm push switch P4 LOCK operated) and FIL ACT switch NORM, when a steady deflection of the micromhos meter is obtained note the reading on the 3000-micromho range. (This may not be the proper scale to read true indicated transconductance, but this test is simplified by using the 3000-micromho scale only.) It is not necessary to observe the true indicated transconductance per the MICROMHOS switch setting.

(2) Operate the FIL ACT switch to TEST.

(3) Wait 1-1/2 minutes for heater type or 1/2 minute (minimum) for filamentary type tubes (see Paragraph 3.03) and note the micromhos meter reading again on the 3000-micromho scale.

(4) The nearest percentage cathode activity is obtained from Table II using the meter readings observed in Items (1) and (3).

Requirements: See Paragraphs 3.14 thru 3.16.

3.14 Cathode Activity Test Requirements, Western Electric Tubes: For Western Electric tubes the percentage cathode activity as determined in Paragraph 3.13, Item (4) should be not greater than the limits given in Section 100-634-501 under NOTATIONS as "@X%." The symbol "@" has been used to mean cathode activity limit, in order to save space. For this purpose Table II can 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. 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 NORMAL column, the tube meets the requirements. Tubes which fall below this TEST column value should be rejected.

3.15 Cathode Activity Test Requirements - Non-Western Electric Tubes: Tubes of other than Western Electric manufacture usually are rejected on the basis of the micromhos meter reading using the MIN. TRANSCOND. column value only. No activity test limits ordinarily 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. Table II may be used for determining whether the observed percentage exceeds 25 per cent or for determining the minimum TEST value corresponding to the observed NORMAL value.

3.16 The MIN. TRANSCOND. limits for micromhos meter reading (Paragraph 3.08) and the cathode activity limits given in Section 100-634-501 are for general use and correspond approximately to the requirements generally employed for corresponding tests made by other standard testing methods. For tubes in certain services, other limits may be specified, of course, and when so specified should be followed in place of these limits. In general, emphasis is directed toward the primary use of the Hickok tester as a maintenance tool, and in many cases its purpose is to restore to service equipmont suspected of having tube trouble. Intensive testing of tubes in equipment which is satisfactorily working unless specified by definite practices or working routines is not recommended. In such cases unnecessary replacement of tubes not actually below minimum transconductance values may serve no useful purpose and sometimes lead to unsatisfactory operation of equipment.

(C) Rectifier and Diode Tests

3.17 Procedure for Full-Wave or Half-Wave High Vacuum Rectifiers:

(1) Set up tube for test per Paragraph 3.02, with the FIL ACT switch NORM and the SHORTS selector at TUBE TEST.

(2) Set the MICROMHOS switch at SHUNT.

(3) Adjust the SHUNT potentiometer to the required value.

(4) Depress the P3 (RECT) pushbutton and observe the micromhos meter reading.

Requirements: Rectified plate current is satisfactory if the micromhos meter deflection reaches or exceeds the RECTIFIERS & DIODES OK index mark. Reject the tube for readings below this index mark.

(5) In case of twin plate rectifiers, proceed with test of the second section as listed in Section 100-634-501 or on the roll chart, by setting up new SELECTOR combinations and repeating Items (1) through (4).

3.18 Diode Tests: Diode plate current tests require a procedure similar to that of rectifiers as outlined in Paragraph 3.15. Each diode element or section of a multi-purpose tube is tested separately, and each test should preferably be of short duration to avoid possible damage to the tube.

3.19 Procedure:

(1) Set up the tube for test per Paragraph 3.02, with the FIL ACT switch at NORM and the SHORTS selector at TUBE TEST.

(2) Set the MICROMHOS switch at SHUNT.

(3) Adjust the SHUNT potentiometer to the required value shown on the roll chart or in the tube data section.

(4) Depress the P1 (DIODE) pushbutton and observe micromhos meter reading.

Requirements: The diode plate current is satisfactory if the micromhos meter deflection reaches or exceeds the RECTIFIERS & DIODES OK index mark. Reject tube for readings below this index mark.

(5) For twin diodes or diode sections of multipurpose tubes, proceed with the test of other sections as listed in Section 100-634-501 or on the roll chart, by setting up new SELECTOR combinations and repeating Items (1) through (4).

3.20 0Z4 Tests: 0Z4 gas filled rectifiers of the cold cathode and similar type are tested similarly to diodes or rectifiers.

3.21 Procedure:

(1) Set up the tube for test per Paragraph 3.02, with the FIL ACT switch NORM and the SHORTS selector at TUBE TEST.

(2) Set the MICROMHOS switch at SHUNT.

(3) Adjust the SHUNT potentiometer for the required value shown on the roll chart or in the tube data section.

(4) Depress the 0Z4 (P2) pushbutton and observe micromhos meter reading.

Requirements: The rectified plate current is satisfactory if the micromhos meter deflection reaches or exceeds the RECTIFIERS & DIODES OK index mark. Reject the tube for readings below this index mark.

3.22 In testing the rectifier section of dual purpose tubes such as the 117N7GT, 117L7GT, or similar type tubes, the METER switch is first operated to REVERSE and then the RECT (P3) pushbutton is depressed. The micromhos meter reading is observed as usual. The use of the REVERSE METER switch, whenever required, is always indicated on the roll chart under NOTATIONS.

(D) Special Tests

3.23 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.

3.24 Plate current in the case of triode type tubes, and total space current (plate plus screen current) in the case of tetrodes or pentodes, can be measured if desired, by the use of a suitable external d-c milliammeter. This meter may be connected in the cathode return circuit of a tube under test by wiring it, + to + and − to −, to the SELF BIAS binding post pair, with the normal connecting strap of the binding posts removed.

4. MAINTENANCE

4.01 Rectifier Tubes in Set: Ordinarily the set comes equipped with rectifier tubes. These tubes are 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 rectifier tube. A 5W4 or 5W4GT tube may be used as a satisfactory substitution for the 5Y3GT in this tester.

4.02 If it is necessary to install new tubes, the following applies.

Installation Procedure:

(1) Remove the screws holding the control panel. Also remove one holding bracket screw located on the bottom of the set. Then lift the panel from the cabinet.

(2) Insert a 5Y3GT tube in the 8-pin octal socket on the subpanel inside the set, and lock its base in place with the screw clamp.

(3) Insert a No. 83 tube in the 4-pin socket on the subpanel inside the set, and lock its base in place with the screw clamp.

(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 (P4) pushbutton. 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	No. 81 Mazda, 6-8 volts
Pilot Lamp	No. 47 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 Tube test sockets sometimes become defective due to contact prong spring pressure variation or misalignment. This trouble usually shows up by intermittent operation of the tube under test in a questionable socket. In such cases replacement with a new socket is desirable. To obtain proper replacements for test sockets or any other defective components, reference should be made to the complete parts list appearing at the end of the Operating Instructions booklet supplied by the manufacturer for each new tester. Both the Hickok Company's part number and the original parts maker's part number are listed.

4.06 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.

4.07 Once a year 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 in the set. They should be rejected for further use if test requirements are not met.

4.08 With the 60-cycle a-c power voltage at any value between 105 and 125 volts the set is designed to permit the 83-tube rectifier circuit to supply an adequate value of d-c operating plate potential (max. approx. 154 volts), and the 5Y3GT rectifier circuit to provide approximately 130 to 135 volts screen 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 verified first, 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. Further and more detailed test information may be found under Part 5, CALIBRATION DATA.

4.09 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

(or as indicated by the absence of an a-c voltmeter reading with the POWER switch turned to ON), the small fuse lamp should be inspected first before removing the front panel for further investigation. Except in the case of tubes having very high heater wattage consumption (e.g., 421A), burning out or extreme brilliancy of this fuse lamp, which is located in the main primary transformer circuits, usually is an indication of overload or circuit trouble. If a trouble condition exists, it should be cleared before continuing the operation of the set.

4.10 Reference may be made to the attached schematic (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, or to the manufacturer's factory or a service station. A parts list for this tester is included in the manufacturer's instruction booklet.

5. CALIBRATION DATA

5.01 General: Under normal usage of this tester, doubtful transconductance measurements involving marginal or suspect tubes can usually be checked by comparison with test results of a new or good sample of a tube type in question. However, whenever the Gm measurement accuracy of the set is suspected it may first be checked by testing certain operational standard tubes described in Paragraph 5.07, in accordance with the procedures and requirements outlined in Paragraphs 5.08 through 5.12.

5.02 The use of operational standard tubes for checking set calibration should suffice in most cases to indicate whether the set is satisfactory and further tests should be unnecessary. For those cases where difficulties persist, supplementary testing information is outlined in Paragraphs 5.13 through 5.21 for further checks on the set. These supplementary tests are principally a-c and d-c voltmeter measurements readily made if suitable meters are available. These check tests are not especially recommended as being fully indicative unless the accuracy requirements of the necessary meter equipment can be fulfilled. If a tester can not meet all of the test requirements set forth in Part 5 and if corrective measures can not be taken, it should be returned to the Western Electric Company or to the manufacturer for service.

Test Instruments and Operational Standard Tubes

5.03 For rough voltage checks, in lieu of better instruments, an analyzer type a-c/d-c volt-ohmmeter similar to the KS-14510, or the M9B-type could be used, although meters equivalent to the following are to be preferred for most satisfactory calibration results. This meter will be designated as meter (D).

5.04 Meter (A) Weston Model 433 iron vane type a-c voltmeter with full scale range of 150 volts (rms), of one per cent accuracy and with a minimum internal resistance of 5000 ohms. This meter is to be used to check the A.C. VOLTS meter per Paragraph 5.13 and can also be used to check the higher filament tap voltages (25 to 117).

5.05 Meter (B) Weston Model 1 or 45 d-c voltmeter of 1000 ohms per volt sensitivity with full scale 15 and 150-volt ranges, and full scale accuracy of at least one-half per cent. This meter is used to check the plate and screen grid voltage supplies per Paragraph 5.17, and the grid bias d-c voltage, per Paragraph 5.18.

5.06 Meter (C) an electronic a-c voltmeter similar to the Ballantine 300-type or 400C Hewlett-Packard or equivalent with ranges of 1, 10 and 30 (or 100) volts to read average values with an accuracy in the order of two per cent; with inherent power supply stability. This meter is necessary for measuring the various grid signal voltage values accurately as given in Paragraph 5.17.

5.07 Operational standard tubes of Western Electric Company manufacture, which have been preaged for stable operation and are individually identified with their true calibration Gm values, are available for set calibration tests as follows:

Tube Type	Test	Bias
KS-4732 (272A)	5-volt high signal - 3000 micromhos	Voltage
KS-4733 (2C51/396A)	1-volt low signal - 6000 or 15,000 micromhos) 1/4-volt low signal - 24,000 micromhos	Voltage
KS-4757 (404A)	1/4-volt low signal - 24,000 micromhos	Self
KS-4758 (417A)	1/4-volt low signal - 60,000 micromhos	Self

5.08 Tube Measurement Test: Calibration checks of the set can be made by the use of four types of operational standard tubes of Western Electric Company manufacture, as indicated in Paragraph 5.07. These tubes have been preaged by the manufacturer for stable operation and are individually identified with their true Gm values as originally measured in a suitable precision tube test set under standard test conditions. In order to meet the requirements given in Paragraphs 5.11 and 5.12, it will be necessary to derive a "Hickok Gm" calibration value from the true Gm value as marked on the operational standard tube. The 272A and 2C51/396A operational standard tubes do not need such correlation standard charts.

5.09 HIGH SIGNAL 3000 (5 Volts) Grid Signal Test - Voltage Bias: An operating test is made using a Western Electric Company operational standard 272A tube per KS-4732 and the micromhos meter transconductance reading is compared with the calibrated value for this tube. All tests should be made with the FIL ACT switch at NORM and the MICROMHOS switch at HIGH SIGNAL 3000.

KS-15559 Tube Tester Settings

Tube Type	Fil.	Selectors	Bias Volts	MIC-SW SHUNT	Press
272A	10	JR-3204-0	15	HI-3	P4

Requirements: The measured Gm should be within ±5 per cent of the value marked on the operational standard tube.

5.10 LOW SIGNAL 6000 (1-Volt), 15,000 (1-Volt) and 24,000 (1/4-Volt) Grid Signal Test - Voltage Bias: An operating test is made using a Western Electric Company operational standard 2C51/396A tube per KS-4733, testing both triode sections of the tube. The micromhos meter transconductance readings are compared with the calibrated values for this tube. Tests should be made with the FIL ACT switch at NORM and with the MICROMHOS switch at LOW 6000 (1.0-volt) or 15,000 (1.0-volt), and at LOW 24,000 (1/4-volt) with the GMX4 position.

5.11 LOW SIGNAL 24,000 (1/4-Volt) Grid Signal Test - Self Bias Operation: An operating test is made using a Western Electric Company operational standard 404A tube per KS-4757. The calibration chart (Fig. 8) for this tube is used to establish the Hickok Gm micromhos reading as described on this chart. This Hickok Gm value will be used as the standard value with which the measured Gm is compared. This operating test is made in accordance with the tube tester settings noted on the calibration chart (repeated here) with FIL ACT switch at NORM and the proper self bias resistor connected across the unstrapped SELF BIAS binding posts.

5.12 LOW SIGNAL 60,000 (1/4-Volt) Grid Signal Test - Self Bias Operation: An operating test is made using a Western Electric Company operational standard 417A tube per KS-4758. This is compared with the Hickok Gm standard value derived from the KS-4758 (417A) calibration chart (Fig. 9) as described thereon. As in the test preceding, this operating test is made in accord with the tube tester settings noted in Fig. 9 (repeated here), with the FIL ACT switch at NORM and the proper SELF BIAS resistor connected.

5.13 Check of A.C. VOLTS Meter: Using test clips, connect meter (A) in parallel with terminal studs of the A.C. VOLTS meter. Operate the POWER switch to ON and check the scale accuracy at the 90, TEST (100-volt), and 120-volt points.

Requirements: The TEST (100-volt) point should be accurate within ±1 volt. The 90-volt and 120-volt points should be accurate within ±2 volts at 90V and ±2.5 volts at 120V.

KS-15559 Tube Tester Settings

Tube Type	Fil.	Selectors	Bias Volts	MIC-SW SHUNT	Press
2C51/396A Sect. 1	6.3	KR-7608-2	2.0 (5-volt range)	LO-6 or LO-15, and LO-24) GMX4)	P4
Sect. 2	6.3	KR-3402-8	2.0 (5-volt range)	LO-6 or LO-15, and LO-24) GMX4)	P4

Requirements: The measured Gm reading obtained for the required micromhos scale on the KS-15559 tester should be within ±8 per cent of the calibrated Gm value of the operational standard Western Electric Company tube for each respective section.

ISSUE 1 3-14-52	DR. AAH ENG. AAH	TITLE CALIBRATION DATA 404A PER KS-4757 TUBE FOR KS-15560 OR KS-15559 TUBE TESTER	BELL TELEPHONE LABORATORIES, INC. NO. OF SHEETS PER SET / SEE SHEET 1 / SHEET ES-890230

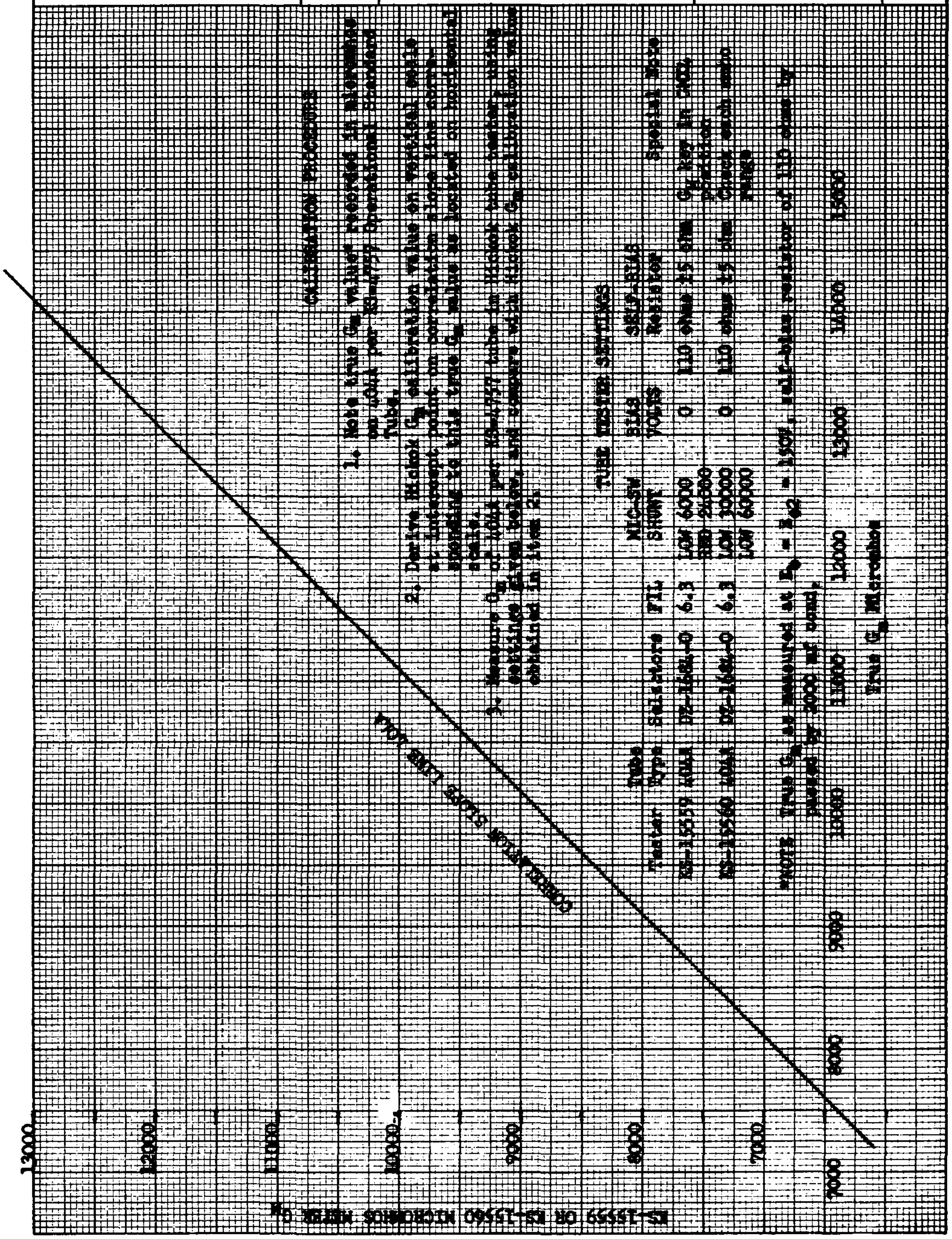

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Fig. 8

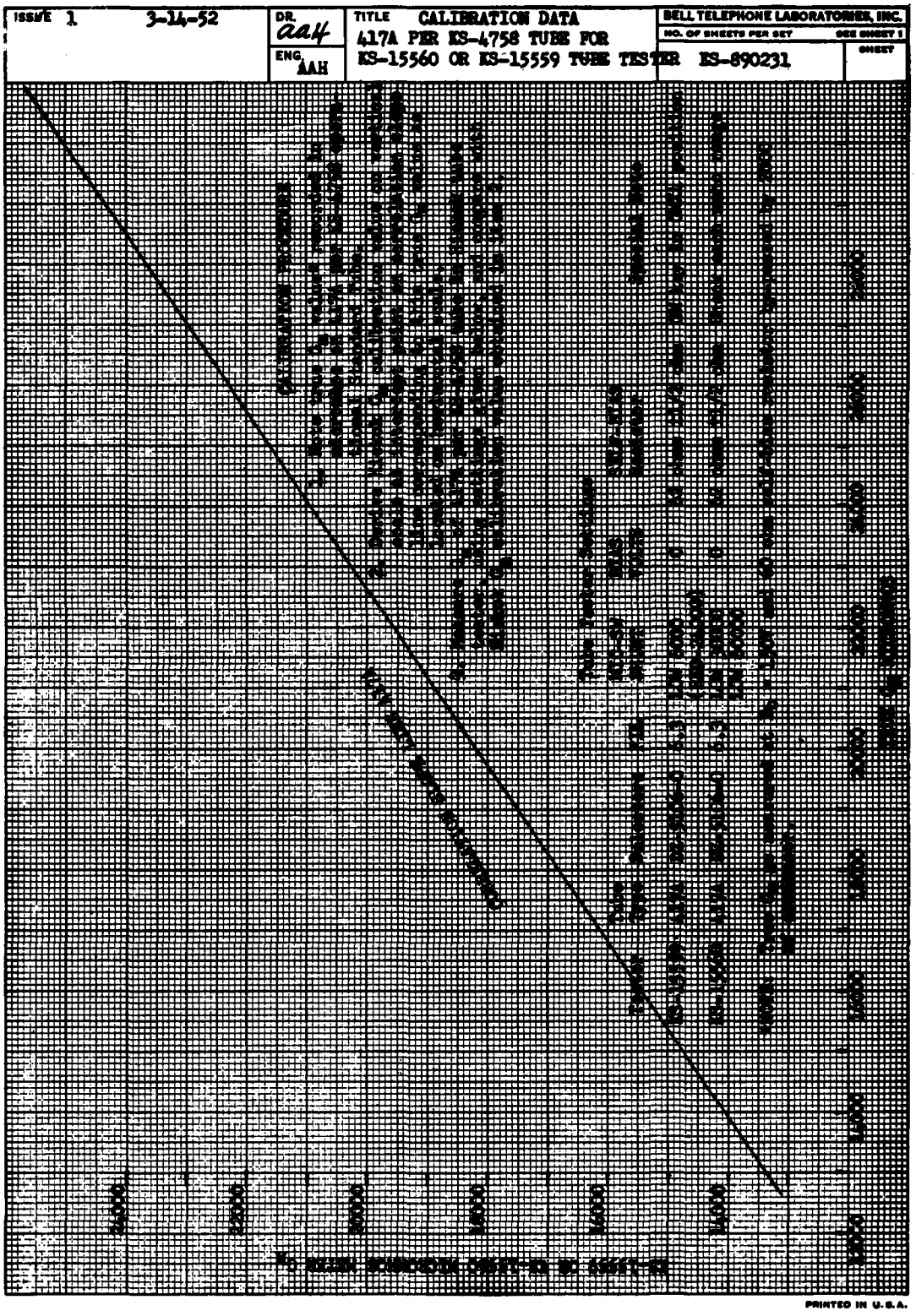
ISSUE 1 3-14-52
DR. aaf
ENG. AAH
TITLE CALIBRATION DATA
417A PER KS-4758 TUBE FOR
KS-15560 OR KS-15559 TUBE TESTER KS-890231
BELL TELEPHONE LABORATORIES, INC.
NO. OF SHEETS PER SET
SHEET
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Fig. 9

KS-15559 Tube Tester Settings

Tube Type	Fil.	Selectors	Bias Volts	MIC-SW SHUNT	Press	Self Bias Resistance
404A	6.3	DZ-1684-0	0	LO-24) GMX4)	P4	110 ohms ±5 ohms

Requirements: The measured Gm shall be within ±6 per cent of the Hickok Gm standard value derived from the calibration chart, as described in Paragraph 5.08, for any individual KS-4757 (404A) tube.

5.14 Check of Filament Supply Circuit: Filament supply taps 1.1 through 12.6 volts should be checked with meter (C). However, if a Model 433 Weston a-c voltmeter with a range near the 7.5/15-volt range is available this meter may be used. In the absence of either of these, approximate checks may be made with meter (D). The higher taps (except for the 117-volt tap) should be checked with meter (C). In the absence of this meter and for the 117-volt tap the check may be made with meter (D).

5.15 Procedure:

(1) Connect the test prods from the calibration meter to the filament terminals of any tube socket e.g. socket terminals 2 and 7 of the octal socket (see Paragraph 6.02), using the required meter as covered in Paragraph 5.14. Set filament selector switches to J and R positions.

(2) Operate the POWER switch to ON and adjust the LINE ADJUST rheostat knob until the A.C. VOLTS meter reads TEST (100 volts).

(3) Read the open circuit voltage for each FILAMENT voltage tap at each one of the following positions of the filament selector switch using the lowest suitable meter range available for each measurement. Check the TEST (100 volts) reading on the A.C. VOLTS meter for each voltage tap reading. This test should be made with FIL ACT switch at NORM.

Tap Value			Tap Value		
Nom.	Max.	Min.	Nom.	Max.	Min.
1.1	1.25	1.05	7.5	8.35	7.60
1.5	1.60	1.40	10.	11.00	10.05
2.0	2.15	2.00	12.6	13.50	12.30
2.5	2.95	2.70	20.	22.00	20.00
3.0	3.40	3.00	25.	28.20	25.50
4.3	4.90	4.30	35.	39.80	36.50
5.0	5.70	5.10	50.	57.00	52.00
6.3	6.90	6.30	75.	86.00	78.00
			117.	133.00	122.00

Note: The preceding a-c voltage tap requirements are wider than the factory requirements in order to take into account the accuracy of meters normally available in the plant. Significant departures from limits usually will indicate definite filament transformer trouble.

5.16 Check of Test Operating Voltages: For these and all other tests following, the LINE ADJUST setting always should be maintained at a point which will cause the A.C. VOLTS meter to read at the 100-volt red mark designated TEST,

KS-15559 Tube Tester Settings

Tube Type	Fil.	Selectors	Bias Volts	MIC-SW SHUNT	Press	Self Bias Resistance
417A	6.3	DZ-5106-0	0	LO-60) GMX4)	P4	62 ohms ±1/2 ohm

Requirements: The measured Gm shall be within ±6 per cent of the Hickok Gm standard value derived from the calibration chart, as described above, for any individual KS-4758 (417A) tube

unless otherwise noted. Set up the JR-0036-0 combination on the selector switches. Using the voltmeter (B) on the 150-volt range, measure the following voltages on the octal socket pin terminals indicated. Operate the POWER switch to ON, and depress the P4 LOCK button.

5.17 Procedure:

(1) Plate Voltage: Measure the plate voltage between pin 6 (cathode) of the octal socket and the PLATE jack (positive).

Requirements:

Minimum - 148 volts
Maximum - 154 volts

(2) Screen Voltage: Measure the screen grid voltage between pins 6 (cathode) and 3 (positive) of the octal socket with the BIAS knob turned to 0.

Requirements:

Minimum - 127 volts
Maximum - 132 volts

5.18 Grid Bias Voltage: Observe the d-c control grid bias voltage on the BIAS VOLTS meter directly, for maximum potentiometer settings on both 5 and 50-volt scale ranges.

Requirements:

	Minimum Volts on Range	
	5 Volts	50 Volts
At maximum BIAS potentiometer setting	5	49

5.19 Grid Bias Voltmeter Check: Using the 5-volt range switch position observe the voltmeter (B) reading on its 15-volt scale at five cardinal points 1, 2, 3, 4, and 5 volts on the grid bias voltmeter. Calibration voltmeter (B) should be connected directly across the GRID BIAS voltmeter 5-volt range terminals for this test. For the 50-volt range test, connect voltmeter (B), set on the 150-volt range, between pin 6 (cathode) of the octal socket and the GRID (negative) jack.

Requirements: At full scale 5 volts and at the 1, 2, 3, and 4-volt points on the grid bias voltmeter the value observed on the calibration voltmeter (B) shall correspond within ±0.1 volt. For the 50-volt range, the full scale reading on the grid bias voltmeter and the reading on the calibration voltmeter (B) shall correspond within ±1.0 volt.

5.20 Procedure for A-C Grid Signal:

(1) Five-volt (High) Signal: Operate the MICROMHOS range switch to the HIGH SIGNAL 3000 position, with the GM switch at GM.

(2) Turn the BIAS potentiometer to 0 and have both P4 buttons in the normal (non-operated) position.

(3) Using the 10-volt range of meter (C), measure the grid signal between pin 6 (cathode) of the octal socket and the GRID pin jack with the grounded lead of the meter on pin 6.

Requirements:

5 volts ± 0.2 volt

(4) One-volt, and 1/4-volt (Low) Signals: Operate the MICROMHOS meter switch to a LOW signal position with the GM switch at GM position. Measure the signal voltage as before with meter (C) in the 1-volt range. To measure the 1/4-volt signal set the auxiliary GM switch to GMX4 position.

(5) Measure the signal voltages with meter (C) in the 1-volt range between pin 6 (cathode) of the octal socket and the GRID (negative) pin jack.

Requirements: 1 ± .05 volt, and 0.25 ± .015 volt, respectively.

5.21 Procedure for Ratio Check of Micromhos Scale Ranges:

(1) High Signal Test Condition: Any suitable tube giving a Gm reading of less than 3000 micromhos using the high signal shall be employed for the test. It is preferable to choose a tube with a value somewhere near 3000, e.g., a 275A or a 25L6 tube so as to get a good deflection on the higher scales. In this test the bias voltage may be adjusted to obtain an exact full scale reading to simplify reading meter deflections.

Requirements: Gm readings obtained on the 6000 and 15,000 high signal Gm ranges shall be within ±5 per cent of the value read on the 3000 Gm high signal range.

(2) Low Signal Test Condition: Any suitable tube giving a Gm reading of less than 6000 micromhos using the 1-volt low signal shall be employed in this test. It is preferable to choose a tube with a value somewhere near 6000, e.g., a 2C51/396A or a 6AK5/403A so as to get a good deflection on the high scale.

Requirements: Gm readings obtained on the 15,000 low signal Gm range shall be within ±5 per cent of the value read on the 6000 Gm low signal range.

6. TUBE BASING CODES AND SELECTOR SETTING DATA

6.01 For non-Western Electric electron tubes it may sometimes be desirable either to verify the SELECTORS setting code or in certain cases to base a new type for which no roll chart setting is available, if the new type is an equivalent electronically to a listed tube. The test sockets in this tester are number coded for basing purposes as shown in Fig. 10. From the socket numbering arrangement and Table A of this figure, the correct filament or heater pin basing may be determined. The numbers appearing on each type socket, i.e., 4 pin, 5 pin, etc., represent the selector code setting number to be used in basing the various elements of any particular tube as related to their function, such as filament, grid, plate, etc. The latter functions all appear as separate SELECTOR dials, but are not so designated on the main panel of the tester. From left to right the first 2 selectors are filament, and the remaining 5 are grid, plate, screen, cathode and suppressor, in that order.

6.02 In particular, attention is directed to the code numbers 1 and 8 appearing on every socket. These represent the most common filament (or heater) terminal assignments for most tube types. This arrangement has been used to minimize the over-all variation required in the two filament selector settings, and is evident from the frequency of appearance of the code JR on the roll chart, as derived from Table A of Fig. 10. The majority of variations in filament selector settings appear more often in 7- and 9-pin miniatures (Noval and Jumbo), and occasionally in the octal socket, as for example, where the heater pins 7 and 8 of certain tube types result in a JX filament selector code setting. Another example is found in 7-pin miniature tubes where pins 1 and 7 of this tube are sometimes assigned as filament. These are selector codes numbered 3 and 7 and result in a filament setting code of DX from Table A of Fig. 10. In any case the opposite code could also be used for filament pin basing, for example, HT instead of DX in the example just given.

6.03 The remaining basing for the grid, plate, screen, cathode and suppressor switches is accomplished by viewing the desired coded number socket to be used in Fig. 10 and associating the grid, heater, screen, cathode positions or whatever elements are found on the new tube to be based, and using the code numbers found on the required Fig. 10 socket, as selector settings for each function (grid, plate, etc.). For example in the 6AK5 or Western Electric 403B, using tube base data for element pins as found in any handbook, this type is based for SELECTOR settings as follows:

Actual Pin Basing		Function	Code Fig. 10	Sel. Switch Sequence Setting
1		Grid	3	FIL. J
2		Cathode & Suppr. Grid)	2	FIL. R
3	From	(Heater	1	GRID 3
4	Table A	(Heater	8	PLATE 5
5		Plate	5	SCREEN 6
6		Screen Grid	6	CATHODE 2
7		Cathode & Suppr. Grid)	7	SUPPRES-) 0 SOR)

6.04 In this example, tube pins 2 and 7 are the same, so it is only necessary to connect cathode and internally connected suppressor grid once at code pin 2. If this tube example were the 415A (6AS6) type the final SELECTOR switch setting

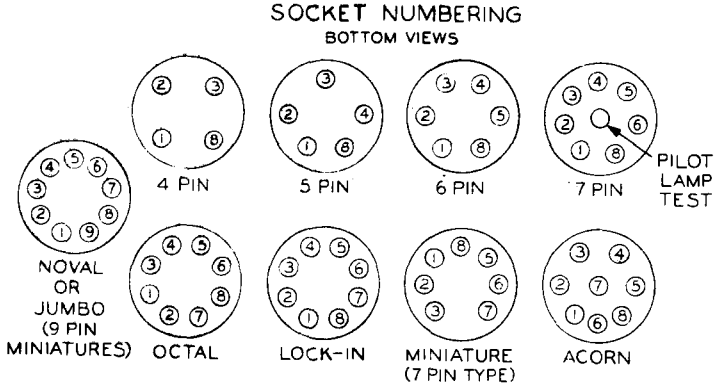


TABLE A
SOCKET CODING
FOR FILAMENT SELECTORS

0 (FIL OFF)	A	P
1	B	R
2	C	S
3	D	T
4	E	U
5	F	V
6	G	W
7	H	X
8	J	Y
9	K	Z

Fig. 10

would be JR-3562-7 in order to ground the separate G3 suppressor grid element also. When an external cap grid or plate is used, the grid or plate selector is set at 0. In the case of diode or rectifier plate element pins, the diode or rectifier plate elements are always associated with the PLATE selector switch. (In this case a separate setting is required to test each diode or rectifier plate section.) The two 9-pin types (Noval and Jumbo) and the lock-in pin codes are straightforward (see Fig. 10) and require no code interpretation except for FILAMENT pin assignments.

7. TEST DATA

7.01 Roll Chart Details: As indicated in Paragraphs 3.08 and 3.09, most Western Electric Company tubes and non-Western types are set up for test and evaluated for acceptance or rejection on a basis of a minimum indicated transconductance reading. In the case of diodes, rectifiers, and a few other types, the test is in terms of the RECTIFIER & DIODES OK rejection index mark on the micromhos meter scale. The Western Electric Company tube test data as set up in Section 100-634-501 for each tube type conforms to the non-Western tube roll chart headings and columnar spacing engraved on the designation panel of the set. This has been done so that the test data may be inserted at the end of the roll chart, if desired. If this is done, it should be fastened securely to the roll chart strip with scotch tape or other suitable means. The principal settings necessary for an indicated transconductance measurement are given in the following order: FIL. for the FILAMENT voltage selector, complete SELECTORS letter and number code in proper sequence (for basing a tube correctly for test) and the BIAS VOLTS for the required grid bias voltmeter reading. Also the MIC-SW SHUNT column heading provides the proper MICROMHOS switch range choice in combination with the GMX4 switch operation multiplier when required for any indicated transconductance measurement, or if a number is given it denotes a SHUNT setting of the MICROMHOS switch and the number given is the required SHUNT potentiometer setting.

7.02 Two special symbols are sometimes found under the BIAS VOLTS column. Where the symbol, ϕ, is found next to a 0, self bias is indicated, and a resistor value, as given under NOTATIONS for the tube type being tested, is required. This resistor must be strapped in place of the short-circuit link across the SELF BIAS binding post pair for a self biased Gm test (see Paragraph 3.02). The symbol, ↕, indicates that the BIAS VOLTS is to be reduced gradually, using the BIAS potentiometer control, until the tube strikes. This is manifested by a sudden micromhos meter reading. This test, principally for small non-Western gas triodes or thyratrons, considers a tube to be satisfactory if the meter reading passes the RECTIFIERS & DIODES OK index at a BIAS VOLTS striking point value as specified under NOTATIONS.

7.03 The final operation is listed under the column heading PRESS, designating the particular pushbutton switch to be depressed by number code (P4, etc.). The principal exception appearing in the PRESS column is the symbol, #. This means that a regular Gm test is made except that the P1 push switch should be depressed first, and held depressed while the P4 (Gm) switch is operated. This is done to make this test at reduced screen voltage.

7.04 The column heading MIN. TRANSCOND. lists the minimum value of indicated transconductance for each tube type. A tube should be rejected only for micromhos meter readings less than such listed reject or minimum values, as previously discussed in Paragraphs 3.08 and 3.09. A star or asterisk, *, symbol appearing in the MIN. TRANSCOND. column denotes a micromhos meter reading to be observed with respect to the RECTIFIERS & DIODES OK index mark, with the MICROMHOS switch set at SHUNT and the SHUNT potentiometer at the required setting as given in the MIC-SW SHUNT column.

7.05 The BIAS VOLTS meter settings have been selected to approximate normal plate and screen grid current operation as well as to obtain micromhos meter readings as near as possible to nominal values for both Western Electric and non-Western electron tubes, within the limitations imposed by the set. Nominal values of indicated transconductance have been purposely omitted from 100-634-501 and the roll chart for both Western Electric Company and non-Western electron tubes to avoid confusion in rating or classifying new and unused tubes by comparison with the nominal transconductance values given for other tube testers. Furthermore, the use of nominal values for comparison or rating purposes is misleading without a specialized knowledge of the new tube "maximum spread" of Gm permissible under the manufacturing specification. This is different in every tube type. Although in many cases tubes might be so rated in this new tester, the variables as to the permissible Gm range in a new tube product for many tube types are sufficiently great that such use of the set is impracticable except in a laboratory where correlative check testing facilities are available.

7.06 The column heading labeled NOTATIONS shows test operations as required for certain tubes by reference to the particular pushbutton. Multi-purpose tubes and the separate anode circuits of diodes and full-wave rectifier types require more than one series of test settings. The column headed NOTATIONS includes all special test information as may be required for each tube type. In the Western Electric Company list of 100-634-501 the principal item first listed for each tube is the maximum allowable per cent cathode (or filament) activity which appears as @X%. The symbol, @, is used here to designate "cathode activity" and is used to conserve space. This percentage is the limit to be observed in conjunction with the procedure indicated in Paragraphs 3.12 through 3.16. For commercial tubes of other than Western Electric Company manufacture a broad minimum limit for cathode activity of 25 per cent may be assumed, as discussed in Paragraph 3.15.

7.07 Other test information supplied in the NOTATIONS column includes GRID or PLATE cap connection if required, identification of sections of multi-purpose tubes, SHORTS switch neon lamp glow positions to be ignored, self bias resistor values, adapter codes when necessary, and in a few cases special references or unusual operating test instructions.

Attached:

Tables I and II

Pages 101 and 102

7.08 In the interest of economy in keeping roll chart information up-to-date, the same roll chart is being used for the KS-15559 tester as for the KS-15560 tester. There are a few tubes which require change either in procedures due to differences in the available micromho ranges of the two sets, or in socket and adapter arrangements. A tube which requires the use of the GMX4 switch position when tested in the KS-15559 tester will be listed on the roll chart as a second entry and that entry will be printed in a different type to call attention to this difference. For example: a tube listed as using the Lo-30 micromho switch position on the KS-15560 tester will have a second listing immediately below it for use with the KS-15559 tester. If the range is sufficient on the 24,000 micromho meter scale, it will be indicated as Lo-24 in the MIC-SW SHUNT column and an entry will be made under NOTATIONS calling for the GMX4 switch position. This will require a MICROMHO switch setting of LOW SIG 6000.

7.09 The socket and adapter difference arises because the KS-15559 tester contains an Acorn socket, while the KS-15560 tester has none and therefore requires the use of a #978 ATA adapter. For tests with the KS-15559 tester, when the roll chart entry calls for the use of the #978 ATA adapter, this should be ignored and the tube should be tested in the Acorn socket.

TABLE I

SHORTS TEST LOCATION

BY NEON LAMP LIGHTING UNDER X

Hickok KS-15559 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) CATHODE -- SUP)		X	X		
PLATE -- SUP) CATHODE -- SCREEN)	X			X	X
SCREEN -- SUP) CATHODE -- PLATE)	X	X	X	X	X

TABLE II

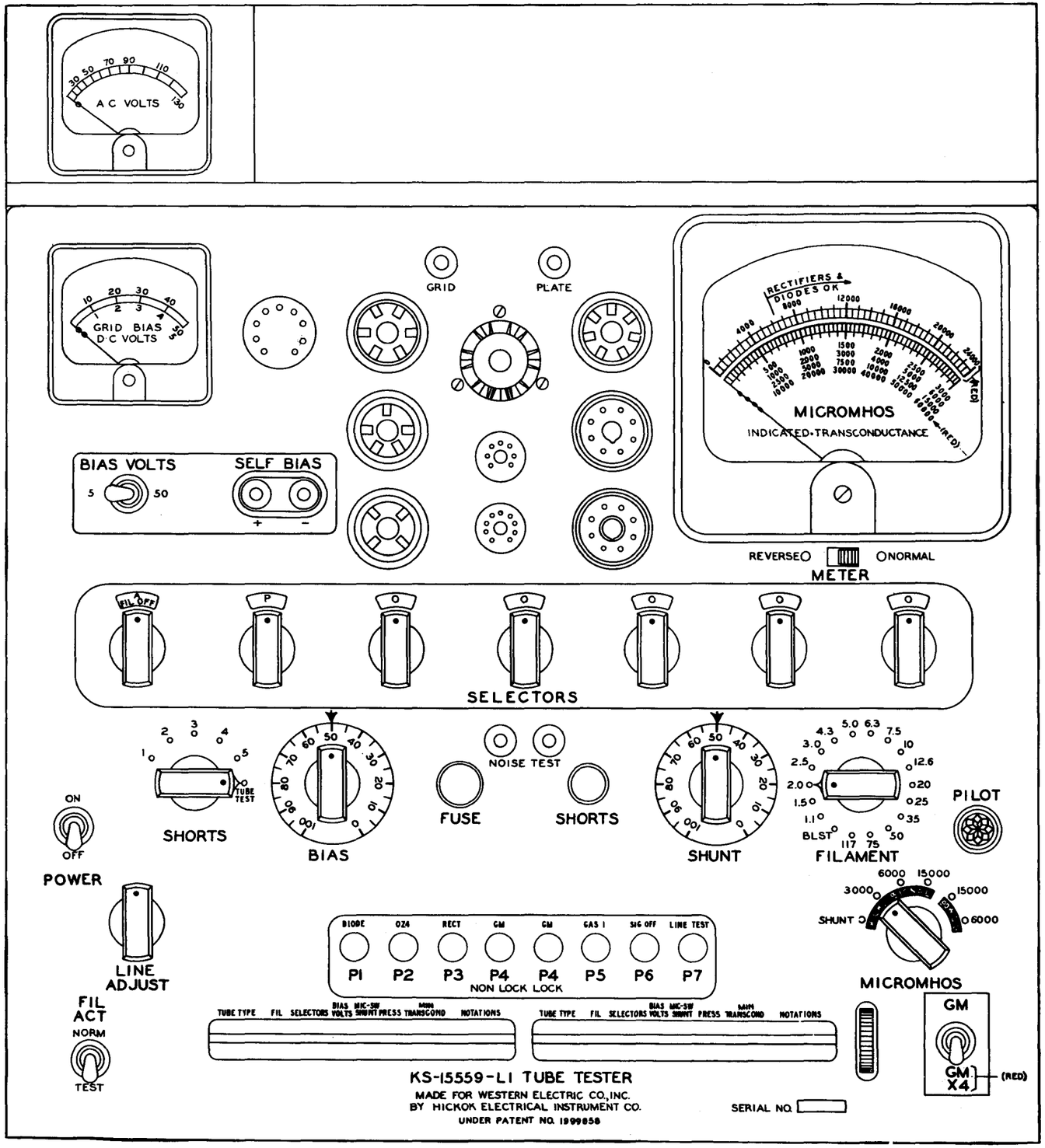
CATHODE ACTIVITY TEST GUIDE

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

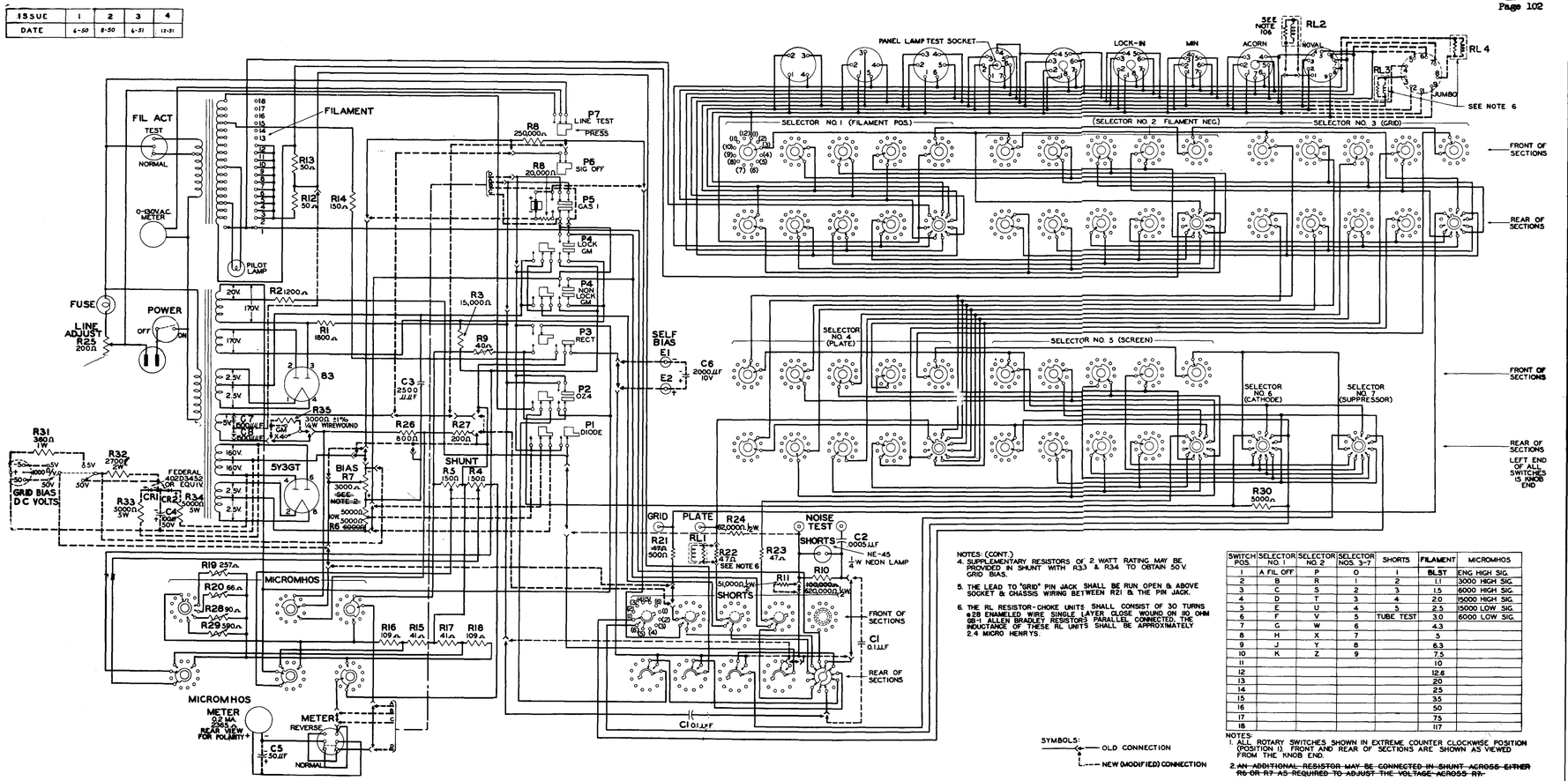
Micromhos Meter Rdg. FIL ACT NORM	Corresponding TEST Position Meter Reading for Activity Limits of: 15%	20%	25%	30%
200	170	160	150	140
240	205	190	180	170
280	240	225	210	195
320	270	255	240	225
360	305	290	270	250
400	340	320	300	280
440	375	350	330	310
480	410	385	360	335
520	440	415	390	365
560	475	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
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

Micromhos Meter Rdg. FIL ACT NORM	Corresponding TEST Position Meter Reading for Activity Limits of: 15%	20%	25%	30%
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

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


A C VOLTS
GRID BIAS D C VOLTS
GRID
PLATE
RECTIFIERS & DIODES OK
MICROMHOS
INDICATED TRANSCONDUCTANCE
REVERSE
NORMAL
METER
BIAS VOLTS
SELF BIAS
FIL OFF
SELECTORS
NOISE TEST
SHORTS
FUSE
SHORTS
BIAS
SHUNT
FILAMENT
PILOT
ON
OFF
POWER
LINE ADJUST
FIL ACT
NORM
TEST
DIODE
OZ4
RECT
GM
GM
GAS I
SIG OFF
LINE TEST
P1
P2
P3
P4
P4
P5
P6
P7
NON LOCK
LOCK
TUBE TYPE
FIL
SELECTORS
BIAS VOLTS
MIC-SW SHUNT
PRESS
MMM TRANSCOND
NOTATIONS
MICROMHOS
GM
GM X4
(RED)
KS-15559-L1 TUBE TESTER
MADE FOR WESTERN ELECTRIC CO., INC.
BY HICKOK ELECTRICAL INSTRUMENT CO.
UNDER PATENT NO. 1999858
SERIAL NO.

ISSUE	1	2	3	4
DATE	6-50	8-50	6-51	12-51



NOTES: (CONT.)

4. SUPPLEMENTARY RESISTORS OF 2 WATT RATING MAY BE PROVIDED IN SHUNT WITH R33 & R34 TO OBTAIN 50 V. GRID BIAS.
5. THE LEAD TO "GRID" PIN JACK SHALL BE RUN OPEN & ABOVE SOCKET & CHASSIS WIRING BETWEEN R21 & THE PIN JACK.
6. THE RL RESISTOR-CHOKE UNITS SHALL CONSIST OF 30 TURNS #28 ENAMELED WIRE SINGLE LAYER CLOSE WOUND ON 80 OHM GB-1 ALLEN BRADLEY RESISTORS PARALLEL CONNECTED. THE INDUCTANCE OF THESE RL UNITS SHALL BE APPROXIMATELY 2.4 MICRO HENRYS.

SWITCH POS.	SELECTOR NO. 1	SELECTOR NO. 2	SELECTOR NOS. 3-7	SHORTS	FILAMENT	MICROMHOS
1	A FIL OFF	P	O	1	BLST	ENG HIGH SIG.
2	B	R	1	2	1.1	3000 HIGH SIG.
3	C	S	2	3	1.5	6000 HIGH SIG.
4	D	T	3	4	2.0	15000 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	

SYMBOLS:
- OLD CONNECTION
- NEW (MODIFIED) CONNECTION

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.~~
3. HEAVY DASH LINES INDICATE MODIFICATION CHANGES CONVERTING KS-5727-L1 TO KS-15559-L1.