# ELECTRON TUBE TEST SET
# KS-15750, L1 TUBE TESTER
# DESCRIPTION AND OPERATION

CONTENTS



## 1. GENERAL

**1.01** This section describes the KS-15750, L1 tube tester and gives the methods for operating and maintaining the set. This set is capable of testing practically all small-sized amplifier, rectifier, and cold cathode voltage regulator tube types of Western Electric Company or other manufacture.

**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** In this set 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 on tubes normally operating at plate potentials up to about 300 volts. This set also provides a low (65-volt) plate-screen voltage test option applicable to all micromho ranges.

**1.04** Test features which distinguish this tester from previous models are:

(a) VR Test Circuit: A supplementary voltage range has been added to the micromhos meter and a corresponding current range to the bias voltmeter. This will permit measurement of the firing and sustaining voltages with the corresponding current values of cold cathode voltage regulator or reference tubes. This VR test circuit is switched in for use by two simple switch operations.

(b) A low plate-screen transconductance test condition is provided, applicable to any micromho range, by a single switch operation.

(c) An extra low micromho range provides improved transconductance accuracy for low transconductance battery or subminiature-type tubes.

(d) Sets with serial numbers below 800 have a subpanel-mounted 9-pin noval test socket to accommodate special Vector test adapters for testing short lead subminiature tubes. A Vector test adapter for in-line based subminiature tubes also is furnished with those sets. Sets with serial number 800 and over are equipped with a permanently wired 2-socket subminiature combination replacing the previous arrangements provided on sets of earlier manufacture.

(e) The shorts test circuit has been further improved to provide a 100-volt (normal) and 50-volt (low) test voltage switch option. The SHORTS TEST switch arrangement emphasizes proper sequential testing of tube elements, beginning with heater to cathode and progressing to the outer elements.

(f) Pin jacks below the ac line voltmeter provide accessible test points to check this meter.

For Testers Beginning with Serial Number 1301:

(g) A new single deck main selector switch with 11 positions, to simplify wiring. The two extra switch positions will permit tubes of unkown future design to be based properly for test.

(h) To ensure complete oscillation suppression for tubes under test, all critical test socket wiring is equipped with ferrite beads, totaling more than 50 per tester.

(i) An additional 1200-micromho range is provided for better overlap between the low 600 and the 6000 ranges, by means of an auxiliary switch using a half-volt grid signal to obtain a 600 x 2 scale.

(j) A surge current limiter resistor to protect certain cold cathode tubes in the main gap test is provided, controlled by an existing push switch.

(k) Sets of this production come equipped with a group of three "replaceable socket-savers" for 7- and 9-pin miniature and octal sockets.

**1.05** Certain accessories are available. To facilitate self-bias testing and to eliminate the inconvenience to the plant in obtaining selected bias resistors for such testing, a precision 3-decade resistor unit is available as an accessory. This unit, totaling 1110 ohms in 1-ohm steps, can be readily mounted firmly in the right end of the cord compartment, and permanently connected to the SELF BIAS binding post pair. A test adapter for in-line short lead subminiature tubes is furnished with the set. For other types of subminiature tubes three other adapters are available as accessory equipment, as described later.

**1.06** The KS-15750, L1 tester provides means for making the following:

(a) 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 is it referred to herein as "indicated transconductance."

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

(c) Tests for internal short circuits by means of a neon lamp continuity test circuit, at normal (100-volt) and low (50-volt) test voltages.

(d) Test for excessive grid current due to the presence of gas, or grid insulation leakage by direct grid meter measurement.

(e) Transconductance test at normal plate voltage and one-half normal screen grid voltage for all tube types requiring this test condition for satisfactory transconductance measurement.

(f) Transconductance test at 65-volt plate and screen for lower transconductance tubes requiring this test condition for a satisfactory measurement.

(g) Plate current tests for thermionic (hot cathode) rectifier and gas triode types. Emission tests for half- and full-wave rectifier tubes are available for all types. Small hot cathode thyratron (gas triode) types such as the 884 and 2050 codes are also listed on roll chart for test. The thyratron tests establish

firing point by grid control and measure emission. Although not entirely adequate, such tests may be made in the absence of other maintenance tests for tubes of other than Western Electric Company manufacture only.

(h) VR Tube Test Circuit: Cold cathode 2- or 3-element gas tubes of the voltage regulator or voltage reference type can be tested. This includes Western Electric Company codes such as the 313C 3-element series as well as more recent 2- and 3-element codes such as the 423A and 427A types. Only standard based tube types can be handled directly in this set; clip lead adapters will be required for codes using short pigtail leads or fixed terminals. The set is capable of testing any cold cathode gas-filled tube where the firing voltage does not materially exceed 200 volts and the cathode current to be measured does not exceed 50 ma.

**1.07** The only power supply required is commerical 60- or 50-cycle ac power of 105 to 125 volts. Built-in rectifier circuits supply the necessary dc potentials for the various tests.

**1.08** General purpose rejection limits for Western Electric Company tubes are discussed in Part 7, Test Data, of this section. Other test limits and other test methods may be specified in practices covering particular applications. ***Where so given, such limits and methods should be followed in place of those given in this section.***

**1.09** 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 practices for that equipment. Since the indicated transconductance measured by this set is approximately equal, 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.***

**1.10** Information regarding the tests for tubes of other than Western Electric Company 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 Avenue, Cleveland 8, Ohio. With the expanded test functions of this tester, voltage regulator (cold cathode) tubes of outside manufacture will be listed on the roll chart. To conserve roll chart space for tubes of more recent manufacture, many obsolete or Manufacture Discontinued commercial tubes will be omitted from the KS-15750, L1 roll chart. However, such tubes will be separately listed for reference in the operating instructions booklet supplied by the manufacturer with each tester. Western Electric Company cold cathode 2- and 3-element gas-filled regulator tubes will be listed separately in Section 100-636-501 which contains complete Western Electric Company tube test data. The section is printed in such a form that it can readily be added to the roll chart of this tester. Supplementary test data for tubes of other than Western Electric Company manufacture and roll chart changes, when required, are listed in Sections 100-636-501 and 100-636-502. Both of these sections are referred to herein as tube data sections.

**1.11** ***Power Cord:*** The KS-15750, L1 tester is equipped with the latest National Electrical Code approved 3-conductor power cord in which the third (green) lead provides a protective ground connection to the metal panel and case of the set. The 3-prong plug attached to this cord requires a proper receptacle to ensure an external, building ground connection. In the absence of the proper 3-terminal receptacle, an adapter providing means for an external, building ground connection may be used, as discussed in 4.11. It is essential to provide this external ground to avoid possible surprise shock hazard in normal set operation.

## 2. DESCRIPTION OF SET

### A. General

**2.01** The KS-15750, L1 set is self-contained in a carrying case for portable use. The set is mounted in an aluminum case with a removable cover and is equipped with a 3-conductor power cord. The third grounding conductor provides an external ground connection to the panel and metal case through the grounding blade of a 3-prong plug. The outside dimensions

of the case including the removable cover are 18-1/4 by 18 by 7-1/4 (depth) inches. The net weight is about 27 pounds.

**2.02** The set is intended to be used in a horizontal position and requires 105- to 125-volt, 60-cycle ac supply. It is permissible to mount the set permanently in a vertical position where this is desired. Such mounting calls for a careful check, and usually a resetting, of the zero setting of the various meters of the set. 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 ac supply. It should not be operated on 25-cycle ac supply.

**2.03** The set is mounted on a metal foundation panel 14-1/2 inches deep and about 16 inches wide, containing the three meters and a group of ten electron tube test sockets. The row of selector switches, various potentiometer and selector switch control dials, a neon lamp for short-circuit tests, an auto bulb fuse, a function switch, five toggle switches, a pilot lamp, and a bank of test push buttons are all suitably designated and arranged as shown in the panel layouts on Page 36. Two lift rings are provided to facilitate removing the chassis from the metal case. A roll chart, provided by the manufacturer below the push-button 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 GM-VR METER) is a dc microammeter calibrated in micromhos with six basic scales corresponding to ranges of 0 to 600, 0 to 3000, 0 to 6000, 0 to 15,000, 0 to 30,000, and 0 to 60,000 umhos, to give the measurement of indicated transconductance of the tube under test. For the VR test circuit a separate 0- to 200-volt dc scale designated V.R. TEST VOLTS is calibrated on a separate arc sector above the basic micromhos calibration range. 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 above the designation GM-VR METER is provided to reverse polarity when required for tests of tubes having two sections with separate cathodes, such as the 117N7.

**2.05** A small ac voltmeter, designated AC VOLTS, is located near the lower 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 ac supply voltage.

**2.06** A small combination dc voltmeter and milliammeter (designated herein as the VR-bias voltmeter) is located in the upper left corner of the main panel. The voltmeter with its associated range toggle switch designated BIAS VM RANGE (having 5- and 50-volt positions) registers the required grid bias voltage for a transconductance test, under control of the adjacent BIAS VOLTS potentiometer. The milliammeter function permits the same voltmeter to register a maximum of 50 ma under control of the adjacent VR potentiometer. A toggle switch located between the VR and BIAS VOLTS potentiometer knobs provides a complete meter circuit transfer in conjunction with the proper setting of the FUNCTION switch.

**2.07** A binding post pair, designated SELF BIAS, is located immediately above the VR-bias voltmeter. The shorting strap provided may be removed for the insertion of an appropriate self-bias test resistor as required for certain tube tests. A permanent adjustable self-bias resistor can be fixed tc the SELF BIAS binding post pair through the use of a Daven Type 4416B Self-bias Decade Resistor which is available as an optional accessory. 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 dc milliammeter to the binding posts, poled as designated on the panel.

**2.08** Nine 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 bases. The remaining four sockets are for miniature tubes of the 7-pin and 9-pin noval types and the 9-pin jumbo type. In sets of earlier manufacture (up to serial number 800) an extra 9-pin miniature

test socket, subpanel-mounted, accommodates Vector subminiature test adapters for short lead types. Vector 1175 for in-line subminiature types is furnished with the set. Vector 1176 for circular 8-pin based tubes is also available as an optional accessory to use in this special socket. Testers bearing serial numbers 800 and over are equipped with a permanently wired in-line and circular 8-pin subminiature combination test socket fixture for basing short lead subminiature tubes. Accordingly, the Vector 1175 and Vector 1176 special subminiature adapters are no longer required for sets with these serial numbers. The panel layout drawing on Page 37 shows this later production model with the permanently mounted and wired dual subminiature socket arrangement.

**2.09** No Acorn tube socket is provided, but a suitable octal-based adapter, listed below, can be used for testing 950-type tubes. Roll chart settings for Acorn tubes apply as based in this adapter. Also listed below are suitable adapters, not provided as part of the set, which must be obtained for testing certain bayonet 4-pin Western Electric Company tubes. For testing long lead subminiature tubes, two additional adapters are listed, if required for in-line and circular 8-pin base tubes.

| TUBE TYPE | STANDARD ADAPTER |
|---|---|
| 101, 102, or 104 (WECo) | Alden 944 WEB |
| 205 (WECo) | Alden 978 WEB |
| 215A (WECo) | Alden 972 |
| Acorn (950 Series) | Alden 978 ATA |
| Raytheon in-line short lead | Vector 1175* |
| Sylvania octal short lead | Vector 1176* |
| Raytheon in-line long lead | Raytheon 7AX51 |
| Sylvania octal long lead | Sylvania 7400-0012 (formerly V24-198) |

* Not required for sets with serial numbers 800 and over.

**2.10** ***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. 9; hence a test may be improvised for basing a tube for which roll chart settings are unavailable. This procedure is covered in Part 6, Tube Basing Codes and Selector Setting Data.

**2.11** ***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 listed on the roll chart or in the tube data sections. The first two SELECTORS (with letter steps), designated FILAMENT, control the filament pin assignments, while the remaining five are designated GRID, PLATE, SCREEN, CATHODE, and SUPPRESSOR in that order.

**2.12** ***Filament Voltage:*** Heater (or filament) voltage is supplied from a multiple tap transformer and is controlled by the selector switch designated FILAMENT, with the following steps:

| | | | |
|---|---|---|---|
| OFF | 2.0 | 6.3 | 25 |
| BLST | 2.5 | 7.5 | 35 |
| 0.6 | 3.0 | 10 | 50 |
| 1.1 | 4.3 | 12.6 | 75 |
| 1.5 | 5.0 | 20 | 117 |

The 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 resistor normally bridged across the heater (or filament). The accuracy of the voltage for each position is within ±3 per cent when the AC VOLTS meter, is at the TEST line. Heater (or filament) off may also be obtained by operating the first selector to A or the second selector to P. These selector positions are designated FIL OFF.

**2.13** ***Grid Signal and FUNCTION Selector Switch:*** For the transconductance test the FUNCTION switch controls the high or low grid signal to be applied and the micromhos range scale as specified. Four positions are associated with the sector designated HIGH (signal) for the 5-volt grid signal. 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 micromhos scales, 3000, 6000, and 15,000, and give indicated transconductance for the high signal grid test voltage. The second sector of the FUNCTION switch designated LOW SIGNAL is used to register five ranges of indicated transconductance in the following order: 60,000, 30,000, 15,000, 6000, and 600 umhos. The lower ranges (15,000, 6000, and 600) utilize a 1-volt grid signal, while the higher ranges (60,000 and 30,000) use 1/4-volt and 1/2-volt signals, respectively. The last position (tenth) of the FUNCTION selector switch is designated VR and is to be used in making tests of voltage regulator tubes in conjunction with the other VR test circuit controls. All tubes are now tested according to a minimum or reject value of indicated transconductance as listed on the roll chart or in the tube data sections under the column heading MIN. TRANSCOND. The proper choice of the FUNCTION switch setting or the SHUNT potentiometer setting is listed on the roll chart under the column heading FUNCT. OR SHUNT.

**2.14** ***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 FUNCTION switch is in the SHUNT position only. It is used for tests where the special index scale mark is specified (such as for diodes) and listed on the roll chart or in the tube data sections.

**2.15** ***BIAS VOLTS Control:*** The BIAS VOLTS knob controls an uncalibrated potentiometer, which provides either of two continuously adjustable ranges of grid bias voltage from 0 to 50 volts or 0 to 5 volts on the VR-bias voltmeter, depending on the BIAS VM RANGE toggle switch position. The grid bias voltage control circuit is effective with the transfer toggle switch in the BIAS VOLTS position only. This toggle switch is located to the right of the combination VR-bias voltmeter.

**2.16** ***VR Test Controls:*** A potentiometer for adjusting the variable dc voltage required for a VR tube test is located immediately above the VR-BIAS VOLTS transfer switch. This control is undesignated except for an index START POSITION corresponding to the minimum voltage required in making the initial voltage breakdown VR tube test. The P4 LOCK red push-button switch is also part of the VR test circuit controls.

**2.17** ***Line Adjustment:*** The rheostat designated LINE ADJUST controls the ac voltage applied to the primaries of the two power transformers in the set. When adjusted so that the AC VOLTS meter referred to in 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.

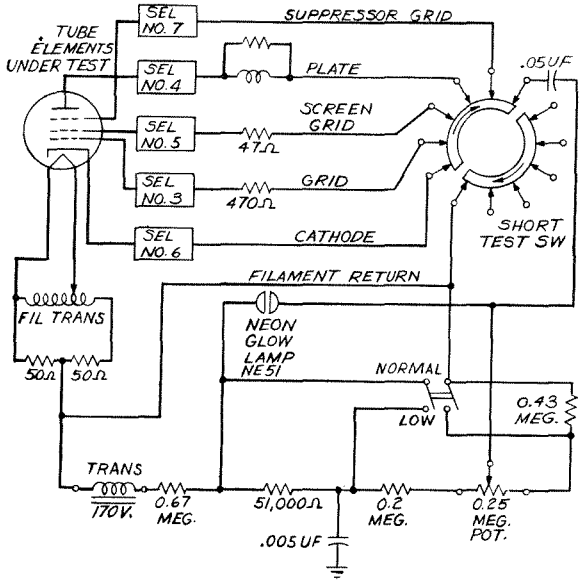



**Fig. 1 – Shorts Test Circuit**

**2.18** ***SHORTS TEST Switch:*** On a 6-position selector switch designated SHORTS TEST, five steps are provided to make short-circuit tests between various electrodes of the tube under test, using the neon lamp shorts test circuit indicated in simplified form in Fig. 1. This shorts test may be made with the tube heater (or filament) on or off, but usually is made with the heater (or filament) heated. In the sixth position, designated TUBE TEST, the neon lamp shorts test circuit is disconnected and the tube under test is connected for indicated transconductance, cathode (filament) activity, and other tests.

**2.19** ***Miscellaneous Switches:***

(a) CATH. ACT.: This switch is required for cathode (filament) activity tests. This switch is located immediately above the P1 to P7 push-button switch gang. When operated to NORMAL, the heater (or filament) voltage is the value for which the filament voltage switch is adjusted. When in the TEST position, the voltage applied to the heater (or filament) 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 heater (or filament) voltage change is used as a fundamental criterion of the condition of tubes so tested.

(b) POWER: This switch, located below the AC VOLTS meter, with ON and OFF positions, controls the commercial ac power supplied to the set. This set utilizes an 8-1/2-foot 3-conductor cord, and the plug is equipped with a separate grounding blade. The single contact lamp bulb in the socket designated FUSE is used to protect the power supply circuits of the set.

(c) VR-BIAS VOLTS: This switch, located to the right of the VR-bias voltmeter serves as a circuit transfer and meter function transfer whereby the V.R.-MA. scale of 50 ma dc and the GRID BIAS D.C. VOLTS (5- or 50-volt ranges) are associated with their respective test circuits.

(d) BIAS VM RANGE: This switch, which is found below the VR-bias voltmeter with positions 5 and 50, controls both voltmeter range and grid bias voltage range of the VR-bias voltmeter under control of the BIAS VOLTS potentiometer.

(e) SHORTS TEST LOW-NORMAL: This switch adjacent to the SHORTS TEST selector permits a NORMAL and half-normal (LOW) peak test voltage to be used with the shorts test circuit, as may be required.

(f) PLT.-SCRN. VOLTS LOW-NORMAL: This switch, which appears above the FUNCTION selector, provides a low plate-screen test voltage option to be used in conjunction with the FUNCTION switch micromho range positions. In the 600-umho LOW SIGNAL position of the FUNCTION switch, the lower plate-screen voltage is automatically obtained, regardless of the LOW-NORMAL switch setting. Unless called for in the test data the NORMAL position is assumed for the tests.

**2.20** ***Push Buttons:*** Eight push-button 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 push-button switch operations are given in all test setting data.

(a) 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 by NON LOCK (left-hand button) and LOCK (right-hand button). When operated, the proper dc plate and screen grid voltages are impressed on the tube under test, while the plate circuit is connected to the GM-VR METER through the FUNCTION switch. The P4 LOCK push button designated GM VR is required for the operation of the VR test circuit in conjunction with other controls previously described. The twist action 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 or VR tube test.

(b) Two test nonlocking push buttons, designated GAS P5 and SIG. OFF P6 are provided. Operation of the GAS P5 button transfers the GM-VR METER directly into the grid circuit. Operation of the SIG. OFF P6 push button removes the grid signal voltage from the grid circuit of a tube under test. The combined operation of the two buttons makes possible a direct-reading grid current, gas, or grid insulation leakage test using the GM-VR METER as a dc microammeter.

(c) Three push buttons, P1, P2, and P3, are provided for rectifier-type tests. P3, designated RECT., places an ac potential on the plate of the rectifier tube under test. This ac voltage is rectified and measured as direct current on the GM-VR METER, where a read-

ing with respect to the RECTIFIERS & DIODES OK index mark gives a measure of the condition of the tube. P2, designated OZ4, provides a similar test for rectifiers of the cold cathode type. A protective series resistor is employed in this test circuit to limit the amount of rectified current flow through the tube. P1, designated DIODE, controls a rectified current test for small hot cathode diode sections of multipurpose tubes. This test is similar to the rectifier tests except that a lower ac voltage (about 15 volts) is applied to a diode plate through a protective resistor. The DIODE P1 push-button switch also provides a half-normal screen voltage when held depressed, as may be specified for a Gm test.

(d) The remaining push button, P7, designated LINE TEST, when operated, disconnects the AC VOLTS meter from the LINE ADJUST control circuit and connects it to check the external ac supply voltage. For testers with serial numbers 1301 and up, push switch P7 also inserts a 47,000-ohm surge current limiter resistor, when this switch is depressed, in the VR tube anode voltage supply circuit.

### C. Description of Circuits

**2.21** ***General Schematic Circuit:*** A complete schematic circuit diagram of the set is given on Page 38. 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.

**2.22** ***Transconductance Measuring Circuit:*** When measuring indicated transconductance or testing cathode (filament) activity, the set is arranged to provide the circuit shown in Fig. 2. The 5Y3GT full-wave rectifier tube supplies unfiltered (pulsating) dc 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 ac voltage supply from the screen grid high voltage transformer winding. The unfiltered plate potential is derived from a separate rectifier employing a No. 83 tube, with balanced transformer secondaries supplying ac potentials of 170 volts to each plate of the rectifier tube. The No. 83 full-wave rectifier tube is of the mercury vapor type and is used to ensure a minimum internal voltage drop, with improved regulation, regardless of load current. The GM-VR METER is connected across the potentiometer or resistors in the rectifier circuit as shown. Since the currents in the two resistors are equal, the arrangement is balanced and no potential is impressed on the meter if no ac signal is impressed on the control grid.

**2.23** ***Grid Signal Circuit:*** However, the circuit is arranged to impress power supply frequency potential of various values, 5 volts, 1, 1/2, 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 ac potential impressed by the rectifier transformer on one plate of the No. 83 tube, and in opposition to the potential on the other plate. Thus, the rectified current in one side of the No. 83 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."

**2.24** ***Thermionic Rectifier Test Circuit:*** When testing a rectifier-type tube the set is arranged as shown in Fig. 3. Each anode is tested separately. The No. 83 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 GM-VR METER reads directly proportionally to the rectified ac current as indicated on the meter scale.

**2.25** ***Diode Test Circuit:*** When testing the diode section of a multipurpose tube, or small hot cathode diode, the circuit (Fig. 4) is the same as that described in 2.24 except that the ac potential is decreased from 35 to about 18 volts, and the current limiting resistance is changed to 1200 ohms. Only one plate of the

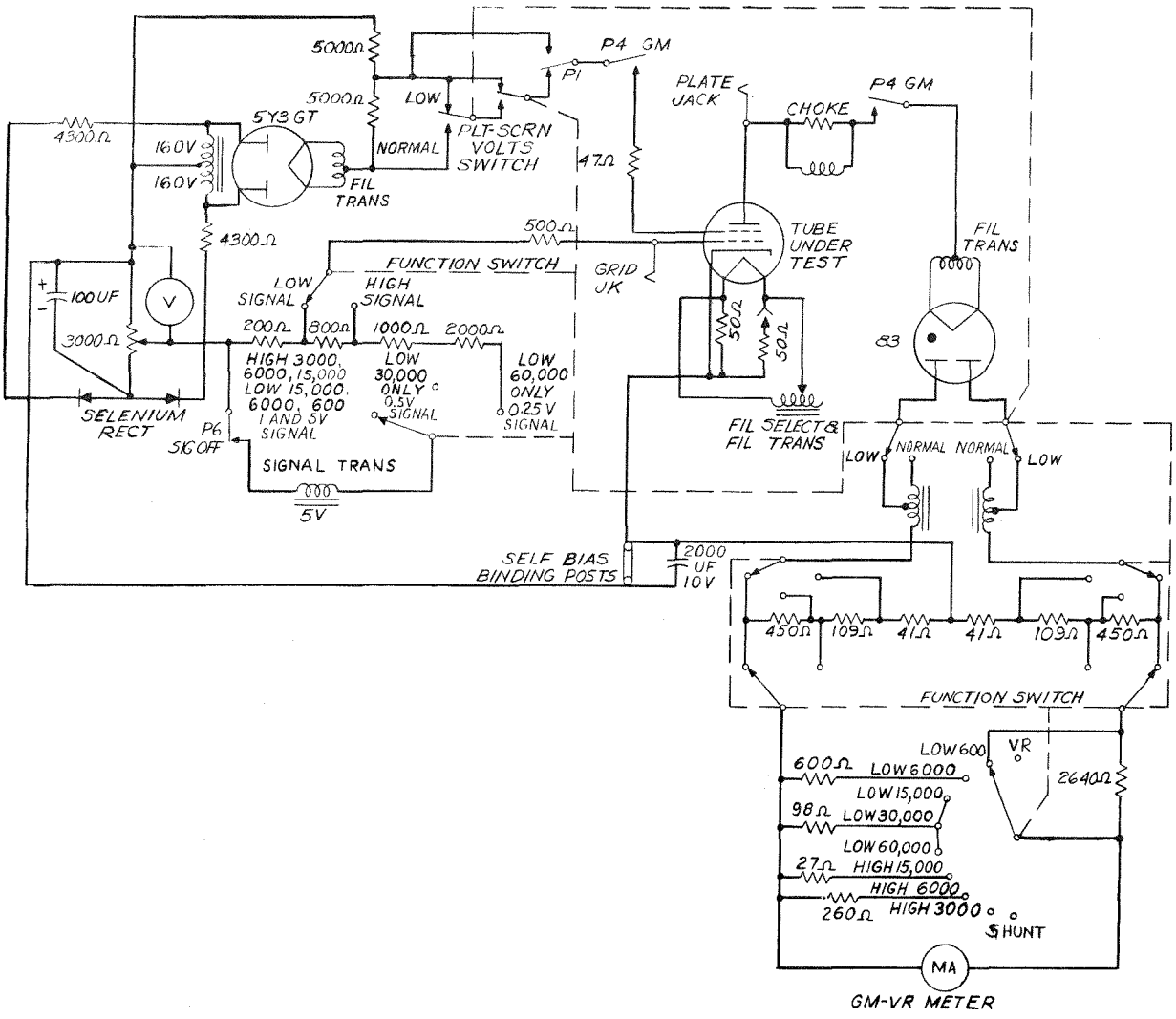



**Fig. 2 – Basic Transconductance Test Circuit (Shown in Low 600-umho Position — Shunt Potentiometer Test Circuit not Shown)**

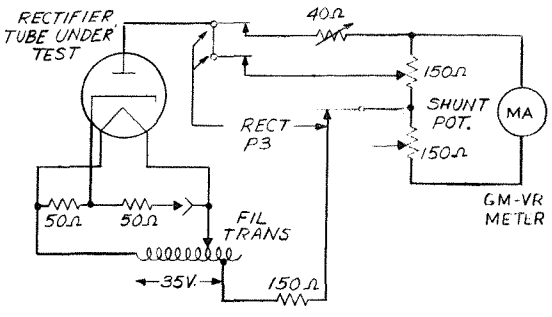



**Fig. 3 – Standard Rectifier Test Circuit**

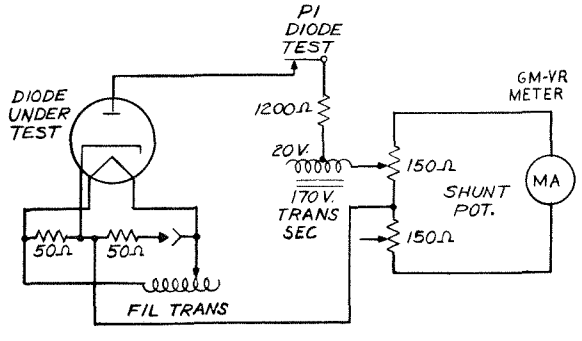



**Fig. 4 – Diode Test Circuit**

diode is tested at a time. GM-VR METER readings are observed relative to the RECTIFIERS & DIODES OK index mark, readings to the right of the line indicating a satisfactory condition.

**2.26** ***Cold Cathode Rectifier Test Circuit:*** When testing a cold cathode tube, the circuit (Fig. 5) is similar to that described in 2.25 except that the two windings of the power transformers are employed in series, applying an ac potential of 290 volts in series with a current limiting resistor to the tube under test.

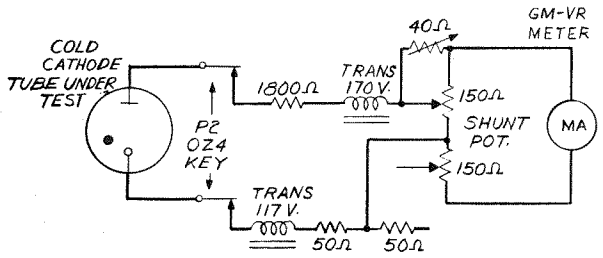



**Fig. 5 – Cold Cathode Rectifier Test Circuit**

**2.27** 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 GM-VR METER into the grid circuit of a tube under test, as shown in Fig. 6 and described in 2.20 (b). In this setup the normal dc pulsating voltage is applied to the screen grid (approximately 130 volts) and the normal plate supply (150 volts) by means of the P4 push-button switch. This test is made with the standard normal grid bias voltage applied under control of the BIAS VOLTS knob as for a regular transconductance measurement with the P4 push button operated. With the P4 push button operated, the SIG. OFF P6 push button is operated and held while the GAS P5 push-button switch is operated. The P5 push-button switch transfers the dc function of the GM-VR METER from its normal plate circuit position directly into the control grid circuit to measure grid current, if any, directly in dc microamperes. The SIG. OFF P6 push-button 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 GM-VR METER, used as a dc microammeter, will read 2 ua per small scale division. Tests for grid current are sometimes required at a bias voltage different from that required for the Gm test. When this is required it is covered under "notations" on the roll chart or in the W.E. tube data.

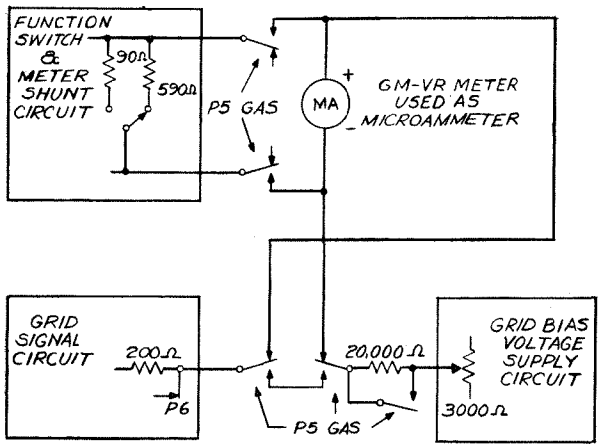



**Fig. 6 – Grid Current Gas Test Circuit**

**2.28** ***VR Tube Test Circuit:*** Provision for checking cold cathode voltage regulator or voltage reference tubes is accomplished as shown in Fig. 7. The feature using contacts

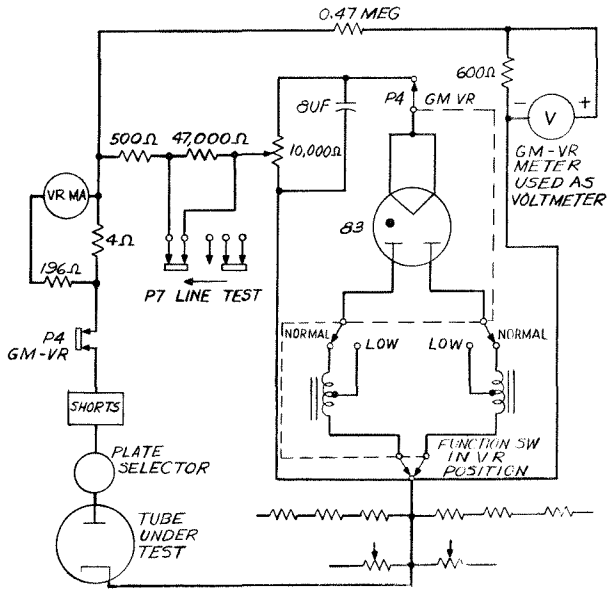



**Fig. 7 – VR Tube Test Circuit**

on the P7 push switch, to insert a 47,000-ohm surge current limiter resistor [(see 2.20 (d)] applies to only those testers with serial numbers 1301 and up. The necessary filtered dc voltage supply is obtained from the No. 83 tube rectifier circuit and balanced 170-volt secondaries. It is made to function as a full-wave rectifier connected to a variable voltage divider circuit. The VR potentiometer controls a variable dc range up to 200 volts maximum, and the GM-VR METER, with a suitable multiplier, registers the variable output on a separate 200-volt 100-division scale. This is accomplished with the FUNCTION switch in the VR position and the GM VR P4 LOCK button locked depressed. In series with the anode circuit of the voltage regulator tube under test, the 50 ma range of the combination volt-milliammeter registers current. This is accomplished with the VR-BIAS VOLTS switch in the VR position. The variable voltage control potentiometer, located above this switch, is rotated clockwise gradually from the START POSITION until the tube under test breaks down or "fires." Both firing or sustaining voltage and anode current are observed in the VR test.

### D. Power Supply

**2.29** The set consumes about 60 watts of 60-cycle commercial ac power (105 to 125 volts). 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.

**2.30** 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 AC VOLTS meter.

### E. Special Features

**2.31** ***Neon Lamp Shorts Test Circuit:*** This test circuit locates shorts in any interelectrode path within a tube, as indicated previously in 2.18. The actual method of testing is given in 3.05. Table A, on Page 16 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. An improved SHORTS TEST switching arrangement is provided to emphasize proper sequential testing of tube elements. Beginning with SHORTS TEST position 1, the heater to cathode path is checked first, with the remaining switch position progressing from the inner to the outer tube elements, to grid, screen grid, plate, and suppressor grid in that order. A further improvement in the SHORTS TEST circuit is included by providing a choice of two test voltages controlled by a NORMAL-LOW switch. The NORMAL position sets a value not exceeding 100 volts peak, while the LOW position has a 50-volt peak value. The latter value is required for certain tubes, particularly in connection with heater to cathode tests.

**2.32** ***Shorts Test Path Locations:*** The various shorts locations given in Table A on Page 16 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 glow because of tube base wiring interconnections. Such short indications should be ignored. Table A, on Page 16, shows a new code of shorts lamp switch position indications different from previous KS tube testers because of the new switching sequence described in 2.31. 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). This separate setting prevents tube self-oscillation on a Gm test or, in other cases, avoids false short indications in certain multipurpose 2-section types such as pentagrid converters.

**2.33** ***Heater to Cathode High Resistance Leakage Tests:*** While the shorts test circuit is designed to indicate steady or intermittent tube interelement shorts, up to a maximum value of about 0.4 megohm, high resistance leakage between cathode and heater may also be detected. With the SHORTS TEST switch in position 1,

a series capacitor in the circuit will be charged through the heater to cathode leakage path. If in switching to position 2 from position 1 a quick neon lamp flash is observed, it indicates that the charged capacitor has discharged through this same path. This indicates the presence of heater to cathode leakage in the order of several megohms. The minimum shorts test resistance value registered by this test is in the order of 3/4 megohm. The neon lamp flash phenomenon should not occur normally for other operating positions of the SHORTS TEST switch.

**2.34** ***Reduced Screen Voltage Test:*** An added function is incorporated, as shown in Fig. 8, with the operation of the DIODE P1 push-button switch to provide half-normal screen grid voltage (about 65 volts) in conjunction with a regular transconductance test only (GM P4 push button operated). This test is required principally for small battery powered or older type Western Electric Company tubes and tubes of other manufacture which normally operate with low 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-screen power ratings of such tubes under test.

**2.35** ***LOW PLT.-SCRN. VOLTS Test:*** Supplementing the reduced screen voltage test described in 2.34, the transconductance measuring circuit now includes a low plate and screen voltage test option applicable to any micromhos range. This test function is shown in Fig. 8 and is controlled by a 2-position LOW-NORMAL selector switch located to the right of the FILAMENT selector switch. The low 65-volt plate-screen value is useful for testing all tubes requiring lower test voltages, such as low-voltage battery types, miniature and subminiature tubes in particular.

**2.36** ***Subminiature Test Features:*** As mentioned in 1.04 (d) and described in 2.08, a special subpanel-mounted 9-pin miniature socket is available to base a suitable Vector adapter for testing short lead type subminiature tubes. For earlier production sets (up to serial number 800), either the Vector 1175 adapter for in-line tubes (Raytheon or other), or Vector 1176 for circular 8-pin based tubes (Sylvania or other) can be used. The special subpanel-mounted 9-pin miniature socket feature has been eliminated in later production sets starting with serial number 800. It is replaced by a prewired fixture incorporating 7-pin in-line and 8-pin octal subminiature test sockets permanently connected, thus eliminating the need for the special Vector 1175 and Vector 1176 adapters.

**2.37** For testing long lead subminiatures up to seven leads, the Raytheon 7AX51 adapter may be used, and for long lead circular 8-pin based tubes the Sylvania 7400-0012 adapter. Each of the latter adapters fits in the octal test socket. Some in-line subminiature tubes are furnished with long leads to be cut for subminiature socket insertion, while certain codes offer an identical tube under separate long and short lead codes. In this connection it should be noted that the same tube could call for a different selector setting for a Gm test, depending on whether the adapter used fits the noval or octal test socket (refer to 6.05).

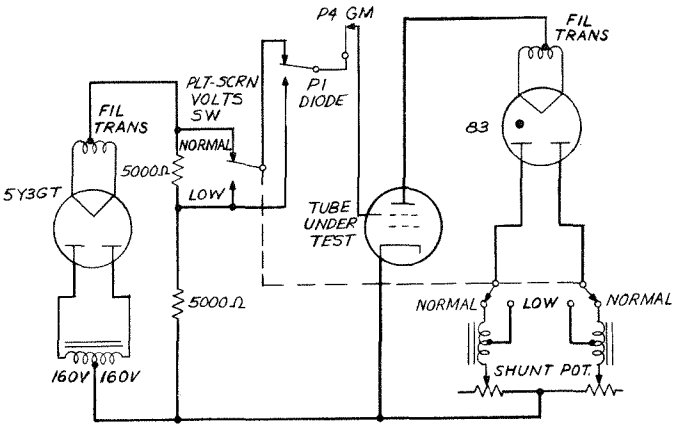



**Fig. 8 – Plate and Screen Supply Circuit**

**2.38** ***Special Test Adapters:*** Adapters are required for Western Electric Company tubes equipped with bayonet-type bases, as discussed in 2.08. In particular, attention is directed to the omission of the Acorn-type test socket in this set, and the need for a suitable

adapter, if such tubes require testing, as discussed in 2.08.

**2.39** ***Jack Appearances:*** A black pin jack designated GRID and a red pin jack designated PLATE are located below 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. A pair of neutral color pin jacks located below the AC VOLTS meter provides means for checking the accuracy of this meter externally, and particularly for verifying the red line 100-volt TEST point on which the over-all voltage calibration of the tester depends.

**2.40** ***Pin Straighteners:*** The KS-15750, L1 tester is equipped with pin straightener units for 7- and 9-pin miniature types, located above the test socket area. These should be used at all times to ensure satisfactory tube pin alignment and thereby to avoid serious test socket deformation for these types.

**2.41** ***Auxiliary Replaceable Sockets:*** As a further aid to preventing excessive wear in the most used test sockets, i.e. octal, 7- and 9-pin miniature sockets, auxiliary replaceable sockets or socket extenders are available. On sets with serial numbers 1301 and up, they are a part of the equipment supplied with the tester. The replaceable sockets also may be used for sockets which are not excessively worn as to spring contacts, in order to defer original test socket rewiring replacement.

**2.42** Extenders are all provided with long thin machine screws at socket centers to be fastened with hex nut and collar washers below the panel. Temporary removal of the chassis from the metal case is, of course, necessary to mount these extenders. Check tests should be made with a tube utilizing all its socket terminals after each socket-extender mounting to verify satisfactory operation. This is particularly the case where extenders are used with worn original test sockets.

**2.43** Three types are available and are considered satisfactory. Of these the set to be preferred is known as the "Red Line Replaceable Socket Set" and is available under the Hickok Code No. 1050-75. These sockets are equipped with ferrite beads to minimize tube oscillation. A set without the beads is available under the Hickok Code No. 1050-60. Both of these sets include the octal, the 7-pin and the 9-pin miniature sockets. In addition to these the following (without beads) also are available:

Vector 1262 socket extender, for octal socket

Vector 1263 socket extender, for 9-pin miniature socket

Vector 1264 socket extender, for 7-pin miniature socket.

**2.44** ***Decade Resistor Unit for Self-bias Gm Test:*** To facilitate self-bias Gm testing for an increased number of high transconductance tubes now listed on the roll chart, a compact 3-decade resistor unit has been made available at the customer's option. This unit is Daven Type 4416B Self-bias Decade Resistor and comprises three Series 375 variable decades having 1-, 10-, and 100-ohm steps totaling 1110 ohms, with 1 per cent accuracy. Mounted on a special metal bracket assembly, this unit is designed to fit permanently inside of the right side of the cord compartment as shown in a panel layout drawing on Page 37. It is fastened to the inner top flange of the set case by three self-tapping screws. A short rubber-covered 2-conductor cord with spade terminals provides a permanent connection to the SELF BIAS binding post pair, with shorting strap removed. When not required, the decade dials ***must be*** left set at their zero positions. This unit is offered as a more convenient, permanent, and ultimately less expensive substitution for such individually selected self-bias resistors as may be necessary. This would eliminate the need for the General Radio 274-MB twin plug resistor mounting arrangement recommended under 3.02 (4), Note.

**2.45** ***Noise Test Circuit:*** A pair of pin jacks is located under the PLATE selector switch. They are designated NOISE TEST and may be used in conjunction with a broadcast-type radio receiver equipped with a loudspeaker to make a noise test. These pin jacks are connected to the neon lamp test circuit through a small capacitor (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 heater

(or filament) voltage in its proper test socket and connected by means of the required selector settings. The test is made by rotating the SHORTS TEST switch through positions 1 through 5 (no push buttons operated), while tapping the tube lightly with a finger and listening to the loudspeaker. This test, described in the manufacturer's booklet, is not recommended for Western Electric Company tubes.

**2.46** ***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.

***WARNING: The power cord plug of the set, equipped with a third, long grounding blade, should be inserted into a proper receptacle to provide external building ground connection to the metal panel and case of the tester. This is necessary to avoid possible surprise shock hazard in normal set operation.***

***Note:*** To avoid damage to the set or to the tube to be tested, operate the POWER switch to OFF after each test unless the same type of tube is to be tested in close sequence. In the latter case it is necessary merely to unlock the GM P4 push button and release both P4 push buttons while changing tubes.

**3.02** ***Procedure:***

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

(2) Adjust the FILAMENT selector switch, the SELECTORS switches, and the FUNCTION switch to the proper values for the type of tube to be tested. (See the roll chart and Section 100-636-501.) Subsequent changes on the roll chart and supplementary data, if required, will be shown in Section 100-636-502.

(3) New test features provided in this tester require additional preliminary switch settings. In every case special instructions for a particular tube will be listed under NOTATIONS. The VR test circuit procedure described under Part 3, Subpart D, Voltage Regulator and Voltage Reference Tube Tests, is also furnished at the beginning of the roll chart, in abbreviated form, followed by test data on VR types of other than Western Electric Company manufacture. VR test requirements are listed under NOTATIONS using the reference symbol $\theta$. For general purpose Gm testing, the PLT.-SCRN. VOLTS selector switch shall be set in its NORMAL position unless otherwise noted, and the VR-BIAS VOLTS transfer toggle switch should be in the BIAS VOLTS position. Adapters are required for certain tubes with uncommon types of basing, as covered in 2.08. In the case of subminiature types, the use of special types of adapters is covered in greater detail in 3.37 and 3.38.

(4) If a self-bias resistor is required for the tube (by roll chart or data section), turn the BIAS VOLTS knob to the extreme counterclockwise position (0 volt) and insert the resistor 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. If the self-bias 3-decade resistor unit described in 2.44 is used, this can be connected permanently in place of the shorting strap across the SELF BIAS binding posts and the required resistance can be obtained from this unit. When not required for self-bias tests all decade units must be left set at 0.

***Note:*** If the 3-decade resistor unit is not used to expedite easy insertion of the necessary self-bias resistor, when required, a simple combination consisting of a General Radio No. 274-MB twin 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. Resistor values given in the chart are preferred values on an RMA basis. Unless the necessary selection can be made locally to obtain these values within the given tolerances, the nearest 145A (1 per cent) or 145C (5 per cent) Western Electric Company resistors should be ordered. The choice of the proper 145A and 145C depends on the precision specified under NOTATIONS.

(5) 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 2.08).

(6) If the tube has a top terminal, plug the clip lead into the required GRID or PLATE jack (this is shown under NOTATIONS on the chart or in the data section), 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.

*Note:* A plate jack connection to the top terminal of a grid cap tube probably would damage the latter. 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.

(7) Operate the POWER switch to ON and adjust the LINE ADJUST potentiometer until the needle of the AC VOLTS meter 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 push buttons is operated.

*Note:* The SELECTORS or FILAMENT selector should never be operated with either GM P4 push 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, and 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.

(8) Note the bias voltage required by the chart or tube data section, and adjust the BIAS VOLTS potentiometer and the 5-50 range switch to obtain the proper grid voltage on the VR-bias voltmeter. This step is not necessary if a self-bias resistor or decade resistor unit is used in (4).

**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 types after turning on the power or after making any change in the heater (or filament) 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 CATH. 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 CATH. ACT. switch is operated to TEST, than is required for the initial stabilizing interval. An indication of saturation in the tube is a steady GM-VR METER reading (allowing for temporary power voltage fluctuations). Power voltage fluctuations may be checked by operating the LINE TEST P7 push button and observing the AC VOLTS meter behavior.

### B. Tests of Amplifier Types of Tubes

**3.04** These general purpose 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 fixed plate and screen grid voltage supply test options).

#### Shorts Test

**3.05** ***Procedure:***

(1) Complete the preliminary setup procedure per 3.02, with the SHORTS TEST selector at position 1, ***with no push button operated,***

***and with the GM P4 LOCK button unlocked.*** Unless called for under NOTATIONS, the SHORTS TEST voltage switch should be in the NORMAL position. Certain Western Electric Company tubes such as 404A require a low shorts test voltage, as well as certain subminiature types.

(2) Ordinarily the shorts test is made with the heater (or filament) heated, but it can be made with the heater (or filament) cold, i.e., either of the two left-hand letter-designated selectors in the FIL OFF A or P position, or with the OFF position of the FILAMENT selector.

(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 A.

***Note:*** When testing heater-type tubes, cases of high leakage resistance between cathode and heater can be detected by looking for an instantaneous neon lamp flash in operating the SHORTS TEST switch from position 1 to 2. This supplementary shorts test indication, discussed in 2.33, will in most cases show high heater to cathode leakages in the order of several megohms. The new SHORTS TEST sequence switch arrangement should normally show no false instantaneous lamp flashes in operating through the five switch positions, except for the special test indication for high heater to cathode leakage just described.

(6) Repeat SHORTS TEST switch sequence as may be necessary to verify fault location.

(7) At the conclusion of the shorts test leave the SHORTS TEST selector at TUBE TEST.

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

**TABLE A**

**NEON SHORT LAMP INDICATIONS**

| KIND OF SHORT | SELECTOR SWITCH POSITION | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| HTR to CATH | X | | | | |
| HTR to GRID | X | X | | | |
| HTR to SCRN | X | X | X | | |
| HTR to PLT | X | X | X | X | |
| HTR to SUPR | X | X | X | X | X |
| CATH to GRID | | X | | | |
| CATH to SCRN | | X | X | | |
| CATH to PLT | | X | X | X | |
| CATH to SUPR | | X | X | X | X |
| GRID to SCRN | | | X | | |
| GRID to PLT | | | X | X | |
| GRID to SUPR | | | X | X | X |
| SCRN to PLT | | | | X | |
| SCRN to SUPR | | | | X | X |
| PLT to SUPR | | | | | X |

**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 tube data sections. This is necessary in cases where the selector setting for the regular transconductance measurement for a given tube employs a duplicate electrode appearance (repetition of a selector index digit). The second selector setting prevents tube self-oscillation on a Gm test. In the case of certain tubes, other special instructions concerning false short lamp indications are listed under NOTATIONS. 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. Tubes may be tapped lightly with a soft part of the index finger during the shorts test to disclose the possibility of intermittent shorts in this test, and an intermittent flash may be obtained instead of a steady illumination.

### Transconductance Test

**3.07** Any suspect case of irregular transconductance measurement, particularly one involving a grid current reading REVERSE meter direction should be carefully checked for a

possible condition of self-oscillation. Should singing or oscillation be experienced, suitable means for correcting this condition are covered in Parts 4 and 5.

*Note:* Under certain conditions a defective tube with partial loss of vacuum may register as satisfactory during the preceding shorts test. Ordinarily a complete loss of vacuum, or a "down to air" condition will result in a burned-out filament or heater in such a defective tube if it is left operating even without plate power applied. However, even a partial loss of vacuum may set up a serious trouble condition which should show up immediately when a transconductance test is attempted. The excessive plate (and screen) power developed with a filament glowing in the presence of gas (air) within a tube will be indicated by brilliant blue glow arc-over discharges between the tube electrodes. This heavy load also will cause the fuse lamp to light brilliantly. The P4 push switch should be released immediately to avoid damage to the tester when this occurs, and such tubes should be rejected for further use.

**3.08** ***Procedure:***

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

(2) Under NOTATIONS on the roll chart, or in tube data sections note carefully any special operating notes which may apply, such as a self-bias resistor required, PLT-SCRN LOW, or the combined operation of the P1 and P4 push buttons to obtain a reduced screen voltage transconductance test.

*Note:* Where a transconductance test is required with half-normal screen grid voltage as discussed in 2.34, the symbol # will appear in the PRESS column. The complete Gm test should be made in the normal manner except that ***the P1 push button should be depressed first*** and held depressed while the GM P4 push-button switch is operated to obtain a GM-VR METER indicated Gm reading.

(3) Set the CATH. ACT. test switch at NORMAL.

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

(5) Operate the GM VR P4 button.

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

(7) Read the deflection of the GM-VR METER corresponding to the proper micromhos scale designated by the FUNCTION switch setting.

***Requirements:*** See 3.09 and 310.

*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 3.08, with the P4 push button remaining locked and the bias voltage at the prescribed value, the bias voltage should be increased to obtain near cutoff or minimum GM-VR METER reading. Any sudden change in GM-VR METER reading with increase of bias voltage will be indicative of self-oscillation. When cutoff is reached the bias voltage should be slowly decreased until normal bias voltage is reached while carefully observing the micromhos reading. Any sudden change in GM-VR METER or VR-bias voltmeter indication which occurs when the bias voltage is being reduced indicates tube oscillation. Touching the external SELF BIAS binding post or tube under test 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 GM-VR METER reading. A further verification of tube oscillation can be made by a grid current reading of a suspect tube (see 3.11).

**3.09** For Western Electric Company tubes, the prescribed settings of bias volts and the FUNCTION switch are such as to give indicated

transconductance readings, under the test conditions obtained with this set, as read on the scale of the GM-VR METER indicated by the FUNCTION switch. These settings are found in the tube data section under columns headed BIAS VOLTS and FUNCT. OR SHUNT, respectively. The tube shall meet the minimum micromhos limit given in the tube data section. No nominal values are given (see 7.05).

**3.10** Tubes of other than Western Electric Company manufacture are set up and tested according to roll chart test data in the same manner as Western Electric Company tubes (outlined in 3.08 and 3.09). Supplementing the roll chart, other tube test data to cover recent tubes not included on the chart, as well as data revisions or alternative tests, may be found in the tube data section. All tubes are passed or rejected on a minimum transconductance basis except for rectifiers, diodes, special cold cathode rectifiers, or a few gas triodes. These exceptions, with the roll chart usually calling for operation of the P1, P2, or P3 push buttons and an appropriate SHUNT dial setting as listed under FUNCT. OR 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 by a star or asterisk in the column headed MIN. TRANSCOND. Voltage regulator or voltage reference tubes are tested on a voltage-current basis using the GM-VR METER as a 200-volt range dc meter and the VR-bias voltmeter as a 50 ma dc milliammeter as described in Part 3D. Other special operating procedures sometimes are included on the roll chart under NOTATIONS.

### Grid Current Test

**3.11** This test to detect and measure grid leakage or gas current between control grid and cathode (filament) usually is made, if required, in conjunction with the regular transconductance test previously described under 3.08.

**3.12** ***Procedure:***

(1) With the tube set up for test per 3.02, depress and lock the GM VR P4 LOCK push button in place.

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

(3) Operate the GAS P5 push button and observe the GM-VR METER for any discernible deflection.

***Requirements:*** If GM-VR METER reading exceeds 2 small scale divisions (about 4 ma), the tube should be rejected. This general maximum grid current limit applies only in lieu of other requirements if specified on the roll chart, the tube data section, or in sections of Bell System Practices which cover the maintenance of the particular tube in the particular equipment involved. A momentary initial deflection of the meter pointer in either direction should be ignored. It is the steady-state reading which should be observed. If a steady reverse deflection is observed, operate the GM-VR METER switch to REVERSE.

### Cathode Activity Test

**3.13** This test is performed in conjunction with the transconductance test described in 3.08.

**3.14** ***Procedure:***

(1) With the tube under test in operation (GM VR P4 LOCK push-button switch operated) and CATH. ACT. switch NORMAL, when a steady deflection of the GM-VR METER on the 3000-umho range is obtained, note the reading. (This may not be the proper scale to read true indicated transconductance, but this test is simplified by reading the 3000-umho scale only.) It is not necessary to observe the true indicated transconductance corresponding to the FUNTION switch setting.

(2) Operate the CATH. ACT. switch to TEST.

(3) Wait a minimum of 1-1/2 minutes for heater-type, or 1/2 minute for filamentary-type tubes (see 3.03) and note the GM-VR METER reading again on the 3000-umho scale.

(4) The nearest percentage cathode activity is obtained from Table B, Page 35, using the meter readings observed in (1) and (3).

***Requirements:*** See 3.15 and 3.17.

**3.15** ***Cathode Activity Test Requirements, Western Electric Company Tubes:*** For Western Electric Company tubes the percentage cathode activity as determined in 3.14 (4), should be not greater than the limits given in tube data section under NOTATIONS as @ ( )%. The symbol @ has been used to mean cathode activity limit in order to save space. For this purpose Table B, Page 35, 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 in 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.

**3.16** ***Cathode Activity Test Requirements, Non-Western Electric Company Tubes:*** Tubes of other than Western Electric Company manufacture usually are rejected on the basis of the GM-VR 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 activity test, a limit of 25 per cent maximum change in micromhos may be assumed in the absence of other specified values. Table B, Page 35, 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.

**3.17** The MIN. TRANSCOND. limits for GM-VR METER reading (3.09) and the cathode activity limits given in the tube data section 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 tube tester as a maintenance tool, and in many cases its purpose is to restore to service equipment suspected of having tube trouble. In equipment which is working satisfactorily, intensive testing of tubes is not recommended unless specified by definite practices or working routines. In such cases, unnecessary replacement of tubes not actually below minimum transconductance values may serve no useful purpose and sometimes leads to unsatisfactory operation of equipment.

### C. Rectifier and Diode Tests

**3.18** ***Procedure for Full-wave or Half-wave High Vacuum Rectifiers:***

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

(2) Set the FUNCTION switch at SHUNT.

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

(4) Depress the RECT. P3 push button and observe the GM-VR METER reading.

***Requirement:*** Rectified plate current is satisfactory if the GM-VR 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, turn off the set and prepare for the test of the second section as listed in the data sections or on the roll chart by setting up the new SELECTORS combination and repeating (1) through (4).

**3.19** ***Diode Tests:*** Diode plate current tests require a procedure similar to that of rectifiers as outlined in 3.16. Each diode element or section of a multi-purpose tube is tested separately, and each test preferably should be of short duration to avoid possible damage to the tube.

**3.20** ***Procedure:***

(1) Set up the tube for test per 3.02 with the CATH. ACT. switch NORMAL and the SHORTS TEST selector at TUBE TEST.

(2) Set the FUNCTION switch at SHUNT.

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

(4) Depress the DIODE P1 push button and observe the GM-VR METER reading.

***Requirement:*** The diode plate current is satisfactory if the GM-VR METER deflection reaches or exceeds the RECTIFIERS & DIODES OK index mark. Reject tube for readings below this index mark.

(5) For twin diode or diode sections of multipurpose tubes, turn off the set and prepare for the test of other sections as listed in the test data sections or on the roll chart by setting up the new SELECTORS combination and repeating (1) through (4).

**3.21** ***OZ4 Tests:*** OZ4 gas-filled rectifiers of the cold cathode and similar type are tested similarly to diodes or rectifiers.

**3.22** ***Procedure:***

(1) Set up the tube for test per 3.02 with the CATH. ACT. switch NORMAL and the SHORTS TEST selector switch at TUBE TEST.

(2) Set the FUNCTION switch at SHUNT.

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

(4) Depress the OZ4 P2 push button and observe the GM-VR METER reading.

***Requirement:*** The rectified plate current is satisfactory if the GM-VR METER deflection reaches or exceeds the RECTIFIERS & DIODES OK index mark. Reject the tube for readings below this index mark.

**3.23** In testing the rectifier section of dual-purpose tubes such as the 117N7GT, 117L7GT, or similar type tubes, first the GM-VR METER switch is operated to REVERSE and then the RECT P3 push button is depressed. The GM-VR METER reading is observed as usual. The use of the REVERSE-NORMAL switch, whenever required, is always indicated on the roll chart under NOTATIONS.

### D. Voltage Regulator, Voltage Reference, and Cold Cathode Tube Tests

**3.24** Both voltage regulator and voltage reference type tubes are tested for initial voltage breakdown and subsequent sustaining voltage values at specified currents. All roll chart test setting data provide test requirements under NOTATIONS. The symbols used in the test requirements designate Ez as the initial breakdown or firing voltage, Etd, as the sustaining voltages (td = tube drop) as specified for various current values, and Regul, the voltage regulation (difference) range observed between the Etd (1) and Etd (2) values noted at currents specified in the test data. The symbol $\theta$ is used opposite all tubes requiring a VR test, and for further convenience a condensed test procedure is listed with other special symbol instructions in the first column of the roll chart. A description of the VR tube test circuit is covered in 2.28.

**3.25** ***In all VR tests the short strap connection across the SELF BIAS posts should be in place, or the dials of the Daven 4416B resistor unit should be set at zero if this unit is provided.*** This is necessary to protect the 2000 mf by-pass condenser (C6) in the cathode return circuit, which is rated at only 10 volts maximum, against accidental voltage breakdown.

**3.26** Firing (breakdown) and sustaining voltage tests should always be repeated two or three times to obtain a reproducible reading, since initial breakdown values may be greater for an idle standby tube, an unused tube in a given circuit, or one from spare storage stock. Rejection limits for main gap breakdown (Ez), it should be noted, are sometimes specified for a minimum or maximum value for different tube types as listed under NOTATIONS on the chart.

**3.27** Incident light from direct or indirect sunlight also may affect breakdown voltage tests; particularly in the case of cold cathode tubes with nonopaque bulb coating, clear bulbs or those with scratched opaque surfaces. Strong nearby artificial light sources of any description in excess of 50 to 100 foot-candles value also could affect breakdown voltage or firing point tests. Such artificial light values would be more than those produced by a 100-watt incandescent lamp at less than 12 inches distance from a cold cathode tube under test. In general, cold cathode tube testing preferably should be done with a minimum of incident light falling on the bulb in the tube under test.

**3.28** ***Voltage Regulator and Voltage Reference Tubes of Other than Western Electric Company Manufacture:*** Test data for these tubes appear at the top of the roll chart.

**3.29** ***Procedure:***

(1) With the FILAMENT switch in the OFF position and the SHORTS TEST switch in the TUBE TEST position, set up SELEC-

TORS for the tube under test. Proper adapters may be required, as noted under NOTATIONS, for certain types.

(2) Verify that the short strap across the SELF BIAS binding posts is in place or that the Daven 4416B resistor unit, if provided, is at its zero setting.

(3) Set the FUNCTION switch and the VR-BIAS VOLTS switch at VR.

(4) Depress the GM VR P4 push button in the locked position and set the white dot on the control knob of the VR potentiometer at the START POSITION.

(5) Insert the VR tube to be tested in the proper test socket and turn the POWER switch on.

(6) For sets with serial numbers 1301 and up, hold the P7 push button depressed and (in all sets) rotate the VR potentiometer clockwise gradually while closely observing both the V.R. TEST VOLTS range on the GM-VR METER and the V.R.-MA. range on the VR-bias voltmeter.

*Note:* Sets with serial numbers 1301 and up are equipped with a 47,000-ohm (R57) surge current limiter resistor in the VR anode voltage supply circuit to prevent initial excessive surge currents. This resistor is inserted for anode breakdown (Ez) voltage tests by holding the P7 push switch depressed during this test. It should be released when obtaining the Etd test.

(7) Note the initial breakdown or firing voltage (Ez), evidenced by a sudden V.R.-MA. reading, and possibly a visible glow in the VR tube under test. Repeat the test to establish the Ez voltage correctly.

*Note:* Extreme care should be exercised to back off the VR potentiometer immediately after the tube fires, particularly in the case of main anode breakdown voltage (Ez) tests. This is to ensure that the initial surge of current momentarily in excess of the maximum requirement value is not permitted to persist for more than a fraction of a second.

(8) If the P7 push switch was operated, release it and (in all cases) readjust the VR potentiometer to obtain the required minimum current value on the V.R.-MA. range and read Etd (1) voltage on V.R. TEST VOLTS range of GM-VR METER.

(9) Increase the current value as read on VR-bias voltmeter to the required maximum value by adjusting VR control again and read Etd (2) on V.R. TEST VOLTS range.

*Note:* Do NOT exceed maximum current value substantially in this test (not more than 20 per cent), to protect the tube under test, particularly in the case of voltage reference types, miniature or subminiature VR types.

(10) Compute Regul as the difference between Etd (2) and Etd (1) obtained in (9) and (8) respectively.

***Requirements:*** Compare Ez, Etd (1), Etd (2) and Regul as obtained in (7), (8) and (9) in the procedure with requirements given under NOTATIONS. A tube meeting all requirements is in accord with manufacturer's test. Minor deviations, particularly as regards maximum or minimum Etd values may be satisfactory for service in known circuit applications if the Ez and Regul requirements are met.

**3.30** ***Western Electric Cold Cathode Tubes, Including Voltage Regulator and Voltage Reference Types:*** Test data for these tubes are contained in Section 100-636-501. Although Western Electric cold cathode tubes are tested essentially the same way as the tubes previously covered in 3.29, certain features found in the 313 group require changes and precautions in operating procedures. The following paragraphs describe special procedures to be observed for the 313C group, which includes the 430A tube. It also should be noted that other Western Electric Company types like the 432B have separate starter anodes which call for separate test settings in the table of data.

**3.31** Cold cathode tubes of the three electrode type in the 313C group have two symmetrical starter anodes, either of which can be designated as cathode, plus the main anode elec-

trode at the center. At the higher voltage values required for the main gap breakdown tests some transfer of the applied test voltage may occur with respect to the disconnected or unused starter anode not designated as cathode, by ionization. This will cause a lower and false main gap breakdown voltage test reading. A proper test is provided, however, as called for in the 3-asterisk note following the cold cathode test data, by bridging a high resistance value (6.8 to 10 megohms) across the two socket pins designated for the starter code terminals. This test resistor preferably should be wired in a plug adapter, such as an Amphenol type, inserted in an unused test socket, and should be removed, of course, for starter gap tests. The three electrode tubes involved here are of the 4-pin base type with starter anodes or pins 1 and 4. This can be done, for example, by connecting the resistor to test socket terminals 1 and 8 of the lock-in or noval socket, or to terminals 2 and 7 of the octal socket.

**3.32** All three electrode cold cathode tubes in the 313 group and the 430A tube have twin starter anodes as described in the preceding paragraph. Therefore, two test settings are specified for measuring firing and sustaining voltages of the starter gap in each poled direction, alternately designating pins 1 and 8 as cathode in the selector settings. Thus, on the table of data, an AP-0108-0 setting designates the starter anode on pin 1 as positive, and the twin starter anode on pin 4 (pin 8 in the testing code) as negative. The second selector setting AP-0801-0 merely reverses these polarities with respect to the twin starter anodes. If, however, the use or circuit application of a given tube in service is known, it may be tested for only the particular cathode designation path which is required.

**3.33** In cases where a breakdown voltage of over 200 volts may be needed to fire a main anode gap, a higher voltage can be obtained by first increasing the AC VOLTS meter reading to 110 volts or more. The VR potentiometer is operated as usual but to an over 200-volt V.R. TEST VOLTS meter reading until the tube fires, after which the VR potentiometer is restored quickly to the required lower current value at which the sustaining voltage drop (Etd) should be observed. To protect tubes such as the W.E.Co. 432A and B, and the 443A against excessive surge currents on voltage breakdown tests, it is recommended that for sets with serial numbers 1301 and up the P7 push switch should be held depressed in order to insert the 47,000-ohm surge current limiter resistor (see 2.20(d)).

**3.34** Should the procedure in the preceding paragraph fail to fire a main anode circuit, the main gap may be ionized through transfer by firing the starter gap in the case of tubes with a starter anode. In such cases, a voltage just over the maximum accepted sustaining main gap value (Etd) is set up and the required starter anode is connected to screen voltage supply by the appropriate screen selector setting. Operation of the P1 switch will apply sufficient voltage to fire the starter gap and by transfer will ionize the main gap to permit observing the main gap sustaining voltage drop (Etd) satisfactorily.

**3.35** ***Procedure:***

(1) With the FILAMENT switch in the OFF position and the SHORTS TEST switch in the TUBE TEST position, set up SELECTORS for the tube under test. Proper adapters may be required, as noted under NOTATIONS, for certain types.

(2) Verify that the short strap across the SELF BIAS binding posts is in place or that the Daven 4416B resistor unit, if provided, is at its zero setting.

(3) Set the FUNCTION switch and the VR-BIAS VOLTS switch at VR.

(4) Depress the GM VR P4 push button in the locked position and set the white dot on the control knob of the VR potentiometer at the START POSITION.

(5) Insert the VR tube to be tested in the proper test socket and turn the POWER switch on.

(6) Rotate the VR potentiometer clockwise gradually while closely observing both the V.R. TEST VOLTS range on the GM-VR METER and the V.R.-MA. range on the VR-bias voltmeter.

(7) Note the initial breakdown or firing voltage (Ez), evidenced by a sudden V.R.-MA. reading, and possibly a visible glow in the

VR tube under test. Repeat the test to establish the Ez voltage correctly.

*Note:* Extreme care should be exercised to back off the VR potentiometer immediately after the tube fires, particularly in the case of main anode breakdown voltage (Ez) tests. This is to ensure that the initial surge of current momentarily in excess of the maximum requirement value is not permitted to persist for more than a fraction of a second.

(8) Readjust the VR potentiometer to obtain the required current on the V.R.-MA. meter range and read the Etd sustaining voltage value on the V.R. TEST VOLTS range of the GM-VR METER.

(9) If required, readjust the current as read on the VR-bias voltmeter to the required higher value by adjusting the VR control again and reading Etd sustaining voltage on the V.R. TEST VOLTS range.

(10) If shown as a requirement, compute the Regul as the difference between the Etd readings obtained for the currents specified in Items (9) and (8), respectively.

***Requirements:*** Compare Ez, Etd and Regul as obtained in Items (7) through (10) in the procedure with the requirements given under NOTATIONS. A tube meeting all requirements is in accord with the manufacturer's test. Minor deviations, particularly as regards maximum or minimum Etd values, may be satisfactory for service in known circuit applications if the Ez and Regul requirements are met.

### E. Subminiature Tube Tests

**3.36** Subminiature tubes with in-line basing or circular 8-pin basing are tested as amplifier types based in appropriate adapters (earlier serial number sets), or permanently mounted sockets (later serial number sets), in the same manner as standard types, as covered under Part 3, Method for Testing Tubes. Data for these tubes will be given on the roll chart or in Section 100-636-502.

**3.37** ***In-line Tubes:*** In-line subminiature permanent sockets and adapters, Raytheon 7AX51 for long lead types and Vector 1175 for short lead types, previously discussed in 2.36, accommodate up to a maximum of seven subminiature tube terminals. In every case, a red dot on the tube press (or base) designates pin 1, which is on the right-hand end as a tube is viewed in a vertical plane to read the tube designation on the bulb. The red dot, pin 1 (i.e., plate lead), orients any in-line subminiature tube for insertion in the socket, or either the comb-type 7AX51 or socket-type 1175 adapter, and the red dot, pin 1, position is designated on these sockets and adapters. The 7AX51 comb adapter is used by inserting the tube leads between the teeth of the adapter comb at a point near the press, with the tooth edge of the comb up and toward the operator. The red dot (lead 1) should be at the right-hand side, corresponding to terminal 1 of the adapter. The tube should be held at about a right angle to the comb, with the tip of the tube away from the operator. The tube should be drawn up and away from the operator, simultaneously combing the leads as the tube is raised to a vertical position. This is continued until the lead ends fall into the channels above the contact openings of the adapter. The tube is then pushed down until the leads are engaged by the contact springs.

**3.38** ***Circular 8-pin Base Tubes:*** These subminiature types usually of Sylvania or RCA manufacture have eight leads in a circle with an open arc space between leads 1 and 8. Viewed from above the socket circle, lead 1 appears at about 5 o'clock and, as usual, the leads number counterclockwise to lead 8 at 7 o'clock. A short circular 8-pin base tube is readily inserted in the Vector 1176 adapter or permanent socket* using firm, but even pressure. Long lead circular 8-pin base tubes are inserted by spreading the leads to fit the 5/8-inch socket circle of the 7400-0012 adapter, with the locking pins of the adapter in the up or unlocked position. After all leads are properly inserted in the adapter top, using the small raised dot as reference for the space between leads 1 and 8, the tube leads can be pushed readily into the adapter body. Firm contact is finally made by pushing the two locking pins of the adapter down toward the plug end thus clamping all leads in place for test.

*In the later production sets, serial numbers 800 and over, the Vector 1175 and 1176 adapters for short lead subminiature tubes have been superseded by a permanent dual socket fixture to accommodate in-line or circular octal-type tubes.

*Note:* Both long lead subminiature adapters use octal-based plugs which, because of the interchange of terminals 1, 2, 7 and 8 for the octal test socket (see Fig. 9), will have different selector settings for the octal socket as compared with the 9-pin miniature socket. Therefore, in a long lead type tube, if the leads are cut short for subminiature socket use, a different selector setting as regards pins 1, 2, 7 and 8 will be required for testing such a tube. For further information, see 6.05.

### F. Special Tests

**3.39** The set is arranged to provide rough tests on electron ray (magic eye) indicator tubes and ballast resistor tubes, all of other than Western Electric Company manufacture. Settings for tests of these types of tubes (except ballast tubes) are given on the roll chart. Methods of making any of the special tests not covered in this section are described in the instruction booklet furnished by the manufacturer of the test set or briefly on the roll chart. Tests for ballast tubes check only the continuity of the resistance elements.

**3.40** 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 dc milliammeter. This meter may be connected into the cathode return circuit of a tube under test by wiring it, properly poled, to the SELF BIAS binding post pair, with the normal connecting strap of the binding posts and any self-bias resistance leads removed.

**3.41** ***Plate Current Test for 421A Tubes:*** For the 421A tube a new supplementary plate current test per section at zero bias has been listed with the PLT-SCRN VOLTS switch in the LOW (65-volt) position. The purpose of this test is to evaluate the 421A tube on a plate current basis at a zero bias on a comparable basis with the original manufacturing requirements, to ensure adequate service in series circuit use in regulated power rectifiers. Plate current differences between sections of one tube and comparisons with other tubes used together in the same series circuit of a regulated rectifier are important to ensure satisfactory load division between all tubes in a given unit. The settings for this special test are similar to the standard Gm test except that an auxiliary dc milliammeter with a range of at least 150 ma properly connected between the SELF BIAS binding posts is necessary. The connecting strap and self-bias resistance leads must be removed from these binding posts for this test. With zero bias and the P4 (GM VR) switch operated, plate current for each section is observed, ignoring the transconductance reading obtained during this test. ***Tests for shorts should be made only in conjunction with the standard Gm test at 18 volts bias.***

## 4. MAINTENANCE

*Note:* It is important in doing any repair or exploratory work inside of the set to make sure that the wiring to the various test sockets is not moved around. It has been found that self-oscillation conditions are set up or prevented by changes in placement of this wiring. This is especially true in the case of sets having the subpanel-mounted noval socket (serial numbers below 800).

**4.01** ***Rectifier Tubes in Set:*** Ordinarily the set comes equipped with two rectifier tubes, the No. 83 full-wave mercury-vapor rectifier tube (the high vacuum 83V rectifier tube is ***not*** suitable), and the 5Y3GT full-wave high vacuum type rectifier tube. A 5W4 or 5W4GT tube may be used as a satisfactory substitution for 5Y3GT in this tester.

**4.02** If it is necessary to install new tubes, the following procedure applies:

**Installation Procedure:**

(1) Remove the screws holding the control panel; also remove one holding screw located on the bottom of the set. Then, using the lift rings, lift the panel from the cabinet.

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

(4) Plug the power supply cord into a source of 60-cycle, 105- to 125-volt ac power, operate the POWER switch to ON, and depress the GM P4 push button. If the GM-VR METER needle vibrates and the fuse lamp lights up brilliantly, an unsatisfactory No. 83 tube is indicated. This condition seldom is obtained with a new tube of reliable manufacture and is caused by an excess of metallic mercury within the bulb. Replace with a tube 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. 40 Mazda | 6-8 volts |
| Shorts Test) Lamp ) | (Neon, NE51 (115 volts | 1/25 watt |

**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 electron 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 spring contact pressure variation, misalignment, or excessive wear. This trouble usually shows up by intermittent or erratic operation of the tube under test in a questionable socket. In such cases replacement with a new socket is desirable. For the most used sockets of the tester, e.g. 7- and 9-pin miniature and octal types, replacement of worn or defective sockets may be avoided or deferred by the use of replaceable sockets or socket extenders described in 2.41. 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. If it is used in a vertical position (see 2.02) it usually will be necessary to change the zero adjusters of the various meters. 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 No. 83 rectifier tubes, used in the power supply of the tester, should be temporarily replaced by new tubes and should be tested in the set. They should be rejected for further use if test requirements are not met.

**4.08** In case the set fails to operate when testing a tube, i.e., there is no pilot lamp illumination, no dc voltage, or no grid signal supply indicated (or an ac voltmeter reading is absent when the power switch is 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 tube), burning out or extreme brilliancy of the small 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.

**4.09** Reference may be made to the schematic (Page 38, 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. A parts list for this tester is included in the manufacturer's instruction booklet.

**4.10** Although the shorts test circuit is adjusted at the factory to respond to a short resistance value of 0.1 megohm and to

show no neon lamp indication for 0.47 megohm, cases may occur where false lamp indications are observed with no tube in any test socket. This test circuit has been designed to limit peak test voltages to 100 volts in the NORMAL test position and to 50 volts in the LOW test position and a sensitive neon lamp, NE51 of 1/25-watt rating, is used. Accordingly, when replacement is necessary, substitutions of the NE51 lamp should be tried to obtain an optimum lamp firing voltage which avoids false short indications. In addition, a 0.25-megohm potentiometer (R54 in schematic drawing, Page 38) is provided as a variable voltage divider in the shorts test circuit. The potentiometer is located beneath the panel near the SHORTS TEST controls and is initially screwdriver adjusted at the factory. Readjustment of the R54 potentiometer may sometimes be necessary to meet test requirements previously given for both NORMAL and LOW test voltage conditions.

**4.11** The 3-conductor ac power cord of this tester (KS-14532, L1) is equipped with a 3-prong plug utilizing conventional parallel, polarized blades for the input circuit and a third, longer grounding prong of U-shaped cross section terminating the protective green lead which is connected to the chassis of the set. This plug requires the new standard National Electrical Code receptacle, but a suitable adapter such as Hubbell 5273L or equivalent may be used to connect this ac power cord. Such adapters are equipped with a short green clip lead to connect building ground to the third lead where the plug is fitted to a conventional parallel blade 2-wire ac receptacle. The use of a proper external ground connection to the metal set chassis is important to avoid accidental surprise shock hazard in normal set operation.

**4.12** ***Correction of Self-oscillation Trouble Conditions:*** Where such troubles are discovered in a tester this condition may be remedied locally or the set may be returned for repair through channels or directly to the Hickok Electrical Instrument Company, 10514 Dupont Avenue, Cleveland 8, Ohio. If handled locally it will involve the replacement of the subpanel-mounted 9-pin miniature test socket originally provided for short lead subminiature test adapters and the simple insertion of fixed anti-oscillation replaceable sockets (similar to "socket savers") for the 7- and 9-pin miniature and octal test sockets. Should serious oscillation be encountered for other test socket positions it will probably be necessary to return the set for repair.

**4.13** This material may be ordered as kit parts directly from the Hickok Co., (address above).

(1) Prewired Subminiature Dual Socket Assembly per code No. 19351-16.

(2) 8 Ferrite Ceramic Beads per code No. 2250-1.

(3) One set of 3 Anti-oscillation Replaceable Sockets for octal, 9- and 7-pin miniature sockets per code No. 1050-75.

It should be noted that these items utilize ferrite ceramic body beads to suppress possible parasitic oscillation in a tube under test in the most used test socket positions of the set.

**4.14** Installation of the dual subminiature socket plate is accomplished by complete removal of the subpanel-mounted 9-pin socket. The eight leads of this socket should be identified and then unsoldered or cut at the sockets to which they were connected. The dual subminiature plate will fit the same mounting holes. The in-line 7-pin subminiature socket should be to the rear of the 8-pin subminiature circular socket as the main panel is viewed normally (see Page 37). The 8 lead wires of the dual socket plate are color coded 1 through 8 by the use of the standard RMA resistor color identification system, i.e. 1 = brown, 2 = red. These are connected to pins 1, 2 and so on of the lock-in socket. A ceramic bead should be threaded onto each new color lead before connecting it permanently, each bead being secured with a drop of General Electric Co. Glyptol cement close to its tie point at the subminiature socket terminals. The three special replaceable sockets are mounted by normal insertion in each corresponding test socket and fastened in place with the nut and washer provided for the long thin machine screw in each case. It should be noted that these anti-oscillation replaceable sockets (code 1050-75) are each marked with red trade marks and a red dot of enamel on

the top surface of each unit for identification. This is to distinguish them from the standard replaceable socket set or other "socket savers."

## 5. SET OPERATION CHECKING PROCEDURES

**5.01** ***General:*** Under normal usage of this tester, doubtful transconductance measurements involving marginal or suspect tubes can usually be checked by comparing with test results of a new or good sample of a tube in question using a comparable tester known to be in satisfactory operating condition.

**5.02** ***General Over-all Check*** — In the absence of some specifically indicated trouble in the tester the first test which should be made is a check with the KS-15840, L1 micromhos meter calibrator, when this set is available. This provides a check, at certain important points on the ranges of the FUNCTION switch, that the general operation of the tube tester is satisfactory. It is accomplished through a simulation of tubes under test. The check is, of course, only a broad indication that the micromhos meter and the associated circuits of the tester are accurate.

**5.03** ***Procedure:***

(1) Place the KS-15840, L1 calibrator in a horizontal position adjacent to the KS tube tester to be checked. With the tube tester power switch off, insert the plug of the calibrator into the 5-pin test socket of the tube tester.

(2) On the calibrator, set the RANGE switch at HI 3000 and turn the METER ADJUST knob to full counterclockwise position.

(3) On the KS tester, set the main selectors at JR-0300-0.

(4) On the KS tester, set the FUNCTION switch at HIGH 3000.

(5) On the KS tester, set the FILAMENT switch at the 35-volt position.

(6) On the KS tester, check the zero setting of the Gm meter.

(7) On the KS tester, switch ac power on, and adjust the line voltage to the red line on the AC VOLTS meter.

(8) On the KS tester, depress and lock the GM VR P4 push button.

(9) Check and adjust the ac voltmeters, if necessary, on both the calibrator and KS tester.

(10) Observe the micromhos reading on the KS tester.

***Requirement:*** The reading should be 1000 micromhos within 1.5 scale divisions.

(11) Unlock the P4 push button.

(12) On the calibrator, set the RANGE switch at LO 6000.

(13) On the KS tester, set the FUNCTION switch at LOW SIGNAL 6000.

(14) Repeat items (8) through (10).

***Requirement:*** The reading should be 5000 micromhos within 1.5 scale divisions.

(15) Unlock the P4 push button.

(16) On the calibrator, set the RANGE switch at LO 600.

(17) On the KS tester, set the FUNCTION switch at LOW SIGNAL 600.

(18) Repeat items (8) through (10).

***Requirement:*** The reading should be 500 micromhos within 2.5 scale divisions.

### Test Instruments

**5.04** For rough voltage checks, in lieu of better instruments, an analyzer-type ac/dc volt-ohmmeter similar to KS-14510 or M9B can be used. Meters equivalent to the following are to be preferred for most satisfactory calibration results where they are already available in the plant. Access to meter test points will require temporary lifting of the main panel chassis as described in 4.02 (1).

**5.05** ***Meter A:*** Weston Model 433 or 904 iron vane ac voltmeter with full-scale range of 150 volts (rms) of 1 per cent accuracy and with a minimum internal resistance of 5000 ohms. This meter is to be used to check the AC VOLTS meter per 5.09 and can also be used to check the higher filament tap voltages (25 to 117).

**5.06** ***Meter B:*** Weston Model 901, 931 or Model 1 dc voltmeter of 1000-ohms-per-volt sensitivity with full-scale 15-, 150-, and 300-volt ranges, and full-scale accuracy of at least 1/2 per cent. This meter is used to check the plate and screen grid voltage supplies per 5.12 and the grid bias dc voltage, per 5.13 and 5.14.

**5.07** ***Meter C:*** An electronic dc voltmeter such as the Hewlett-Packard 400D or the Ballantine 300, or equivalent, with ranges of 1, 10, and 100 volts to read rms values with an accuracy in the order of 2 per cent, with inherent power supply stability. This meter is necessary for measuring the various grid signal voltage values accurately as required in 5.18, as well as lower filament tap voltages.

**5.08** ***Meter D:*** A dc milliammeter providing a 50 ma range with 1/2 per cent full-scale accuracy for checking the V.R.-MA. dc range on the VR-bias voltmeter.

**5.09** ***Check of AC VOLTS Meter:*** Connect meter A to the test pin jacks below the AC 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- and 120-volt points should be accurate within ±2 volts at 90 volts and ±2.5 volts at 120 volts.

**5.10** ***Check of Filament Supply Circuit:*** In lieu of a low-range Model 433 or 904 Weston iron vane ac voltmeter or equivalent, filament voltage supply taps between 0.6 and 12.6 volts, inclusive, may be checked with the low ranges of the electronic voltmeter C. A suitable analyzer-type ac rectifier voltmeter such as KS-14510, M9B, or Weston Model 772 or equivalent could be used as a less accurate substitute.

**5.11** ***Procedure:***

(1) Connect the test prods from meter A or C, as required, to the filament terminals of any tube socket. Set the FILAMENT selector switches to the J and R positions.

(2) Operate the POWER switch to ON and adjust the LINE ADJUST rheostat knob until the AC VOLTS meter reads TEST (100 volts). Filament taps up through 12.6 should be tested with meter C. The remaining taps should be tested with meter A.

(3) Read the open-circuit voltage for each voltage tap at each one of the following positions of the FILAMENT selector switch using the lowest suitable meter range required for each measurement. Check the TEST (100-volt) reading on the AC VOLTS meter for each voltage tap reading. This test should be made with the CATH. ACT. switch at NORMAL.

***Requirements:***

| NOMINAL TAP VALUE | MAX | MIN | NOMINAL TAP VALUE | MAX | MIN |
|---|---|---|---|---|---|
| 0.6 | 0.65 | 0.55 | 7.5 | 8.35 | 7.6 |
| 1.1 | 1.25 | 1.05 | 10. | 11.0 | 10.0 |
| 1.5 | 1.6 | 1.4 | 12.6 | 13.5 | 12.3 |
| 2.0 | 2.15 | 2.0 | *20. | 22.0 | 20.0 |
| 2.5 | 2.95 | 2.7 | *25. | 28.2 | 25.5 |
| 3.0 | 3.4 | 3.0 | *35. | 39.8 | 36.5 |
| 4.3 | 4.9 | 4.3 | *50. | 57.0 | 52.0 |
| 5.0 | 5.7 | 5.1 | *75. | 86.0 | 78.0 |
| 6.3 | 6.9 | 6.3 | *117. | 133.0 | 122.0 |

*Use meter A for these taps.

***Note:*** The preceding ac voltage tap requirements are wider than the factory requirements in order to take into account the accuracy of meters A and C. Significant departures from limits usually will indicate filament transformer trouble.

**5.12** ***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 AC VOLTS meter to read at the 100-volt red mark designated TEST, unless otherwise noted. Set up the JR-0036-0 combination on the SELECTOR switches. Operate the POWER switch to ON and depress and lock the GM VR P4 LOCK push button. Using voltmeter B on the appropriate range, measure the following voltages on the octal socket terminals indicated.

**5.13** ***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 — 156 volts

(2) Reduced Plate Voltage: Operate the PLT.-SCRN. VOLTS switch to LOW and repeat (1).

***Requirements:*** Minimum — 64 volts
Maximum — 68 volts

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

***Requirements:*** Minimum — 127 volts
Maximum — 132 volts

(4) Reduced Screen Voltage: Repeat (2) with the P1 push-button switch operated.

***Requirements:*** Minimum — 63.5 volts
Maximum — 66 volts

**5.14** ***Grid Bias Voltage:*** Observe the dc control grid bias voltage on the VR-bias meter directly for maximum potentiometer settings on both 5- and 50-volt scale ranges.

***Requirements:***

| | RANGE 5 VOLTS | 50 VOLTS |
|---|---|---|
| Minimum volts at maximum BIAS VOLTS control setting | 5 | 50 |

**5.15** ***VR-bias Voltmeter Check:*** Using the 5-volt range position, observe the voltmeter B reading on the 15-volt scale at five cardinal points 1, 2, 3, 4, and 5 volts. Calibration voltmeter B should be connected directly across the VR-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-volt and at the 1-, 2-, 3-, and 4-volt points the observed value should vary not more than ±0.1 volt from the calibration voltmeter B value. For the 50-volt range, the full-scale reading should vary not more than ±0.1 volt from the calibration voltmeter B value.

**5.16** ***V.R. TEST VOLTS Range Check:*** Connect the calibration voltmeter B using 300-volt range between the PLATE pin jack (+) and the SELF BIAS jack pair short strap. Set the FUNCTION switch at the VR position, lock the GM VR P4 LOCK push-button switch and compare the following voltages at cardinal points 200, 160, 120, and 80 as read on the V.R. TEST VOLTS scale of GM-VR METER.

***Requirements:*** At 200, 160, and 80 the meter in the set should vary not more than ±2 per cent of the full-scale value from calibration voltmeter C. At the 120-volt point the deviation should not exceed ±1 volt.

**5.17** ***V.R.-MA. DC Milliammeter Range Check:*** Set up an OD3/VR150 tube for VR test using the JP-0501-0 selector setting with the FUNCTION and the BIAS VOLTS switches in the VR position. Remove the shorting strap and any self-bias resistor leads from the SELF BIAS jack pair. Connect the calibration milliammeter D properly poled to the SELF BIAS jacks. Make a VR tube test by carefully operating the VR test potentiometer, and observe, after the tube fires, the following cardinal point 50, 40, 30, 20, 10, and 5 ma values as compared with meter D readings.

***Requirements:*** At 40, 30, 20, and 10 ma, the meter in the set should vary not more than ±2 per cent of the full-scale value from milliammeter D. At the 5 ma point the deviation should not exceed more than ±3/4 ma.

**5.18** ***Procedure for AC Grid Signal:***

(1) Five-volt (High) Signal: Operate the FUNCTION switch to HIGH 3000.

(2) Turn the BIAS VOLTS potentiometer to 0 and have both P4 push buttons in the NORMAL (nonoperated) 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.

***Requirement:*** 5 ±0.2 volts.

(4) One-volt, 1/2-volt, and 1/4-volt (Low) Signals: Operate the FUNCTION switch successively through the various LOW SIG-

NAL positions, beginning with the 15,000 (1-volt), continuing with the 30,000 (0.5-volt), and 60,000 (0.25-volt) switch positions.

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

***Requirements:*** 1 ±0.05 volt, 0.5 ±0.015 volt, and 0.25 ±0.015 volt, respectively.

**5.19** ***Procedure for Ratio Check of Micromhos Scale Ranges:***

(1) High Signal Test Condition: Any suitable tube giving a Gm reading of about 3000 umhos should be employed for the high signal 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-umho high signal ranges should be within ±5 per cent of the value read on the 3000-umho high signal range.

(2) Low Signal Test Condition: Any suitable tube giving a Gm reading of about 6000 umhos should 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 tube so as to get a good deflection on the high scale.

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

**5.20** ***Operation Test for Singing or Oscillation under Transconductance Measurement:*** This check test should be made if there is reason to suspect singing or self-oscillation trouble conditions in a tester. Such conditions may exist in some of the testers with serial numbers up to 800. However, they may occur in isolated cases for a particular tube type or a particular tube in any tube test set. The purpose of this test is to observe operation of the test when measuring high Gm tubes or tubes known to be critical with respect to oscillation under test. This test should be performed using one each of the following tube types and preferably in the order named: 6J6, 396A, 403B (6AK5), 6BG6G or 6CU6 (choice of either), 6AU5, 6AC7 (or 6AH6), and 418A. A transconductance measurement should be made in each case, using standard roll chart settings.

**5.21** The GM VR P4 LOCK button should be depressed. After a steady-state maximum value GM-VR METER reading is obtained, the bias voltage should be increased to the plate current cutoff point as indicated by a minimum GM-VR METER reading approaching zero. Then the GM-VR METER reading should be carefully observed while the bias voltage is slowly decreased at a constant rate until the normal bias voltage for the tube being tested is reached. Any sudden change of the GM-VR or VR-bias voltmeter reading as the bias control is being decreased at a constant rate should be noted. Each case of tube oscillation should be verified further by obtaining a grid current reading of a suspected oscillating tube. Operation of the P6 and P5 push switches with the GM VR P4 switch in its locked position provides the standard grid current test. In certain cases it may be necessary to operate the P5 (GAS) switch only thus inserting the micromhos meter as a dc microammeter in the grid circuit, but permitting the grid signal circuit controlled by P6 switch to be left connected. This has been found desirable to detect difficult marginal cases of tube oscillation, where the interruption on the grid signal circuit continuity will eliminate singing detection by grid current observation.

***Requirements:*** Singing or oscillation is indicated if a sudden increase or change in GM-VR METER reading or a sudden change in the VR-bias voltmeter indication occurs at any time when the bias voltage is being reduced to its normal value. Hand capacitance effect on touching the external SELF BIAS binding posts will sometimes aid in verifying tube oscillation by again observing either of the meter reading effects as previously described. All cases of singing or oscillation should also be verified by a grid current test carefully made as previously described.

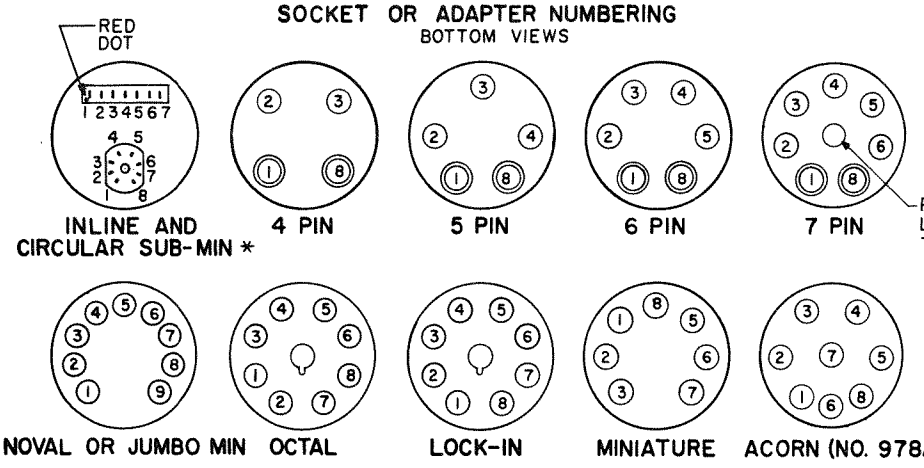
**5.22** Singing or oscillation in a tube under test, particularly for the higher Gm tubes in certain cases may be manifested by an abnormally high or low Gm reading. This may be a steady value relatively unaffected by hand capacitance or other external capacitance effects. This self-oscillation condition usually can be substantiated by a grid current reading or by a comparative reading using the same tube in another tester which has been found to be normal with respect to testing this type of tube.

**5.23** Oscillation of certain tubes on the Gm test occasionally has been encountered in these testers of earlier manufacture (up to serial number 800). This is due in part to interaction of common test socket wiring originating in the special subpanel-mounted noval socket for the Vector subminiature adapters. The vertical plane wiring exposure below the panel of this special panel-mounted 9-pin socket has been found to be a source of possible singing trouble. Replacement of the special subpanel-mounted noval socket by the combination dual subminiature socket fixture as used in the later production sets usually eliminates this source of self-oscillation. Means for correcting self-oscillation conditions are given in Paragraphs 4.12 through 4.14.

## 6. TUBE BASING CODES AND SELECTOR SETTING DATA

**6.01** For commercial 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 when the new type is equivalent electronically to a listed tube. The test sockets in this tester are number-coded for basing purposes as shown in Fig. 9. From the socket numbering arrangement and the table in this figure, the correct heater (or filament) 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, and are so designated on the main panel of the tester.

**6.02** In particular, attention is directed to code numbers 1 and 8 appearing on every socket in Fig. 9. These represent the most common heater (or filament) terminal assignments for most tubes. Code pin 1 corresponds to the actual pin 1 assignment in all sockets except the octal and the 7-pin miniature. This arrangement has been used to minimize the over-all variation re-




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 |

*Subminiature sockets permanently mounted, for short lead types as provided in the later production sets (serial numbers 800 and over). These are obtained by use of Vector adapters in earlier sets.

**Fig. 9 – Tube Basing Selector Code Arrangements**

quired 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 the table in Fig. 9. This usually necessitates the recording of other pin assignments. 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 actual heater pins 7 and 8 of certain tubes result in 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 the table in Fig. 9. 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 selector switches is accomplished by viewing the desired coded number socket to be used in Fig. 9 and by associating the grid, heater, screen, and cathode positions, or whatever elements are found on the new tube to be based, and by using the code numbers found on the required Fig. 9 socket, as selector settings for each function (grid, plate, etc). For example, in 6AK5 or Western Electric Company 403B, using tube base data for element pins as found in any handbook, and referring to the miniature 7-pin socket in Fig. 9, this type is based for SELECTOR settings as follows:

| ACTUAL PIN BASING | FUNCTION | CODE Fig. 9 | SELECTORS SEQUENCE SETTING | |
|---|---|---|---|---|
| 1 | Grid | 3 | FILAMENT | J |
| 2 | Cathode & Supr Grid | 2 | FILAMENT | R |
| 3 | *Heater | 1 | GRID | 3 |
| 4 | *Heater | 8 | PLATE | 5 |
| 5 | Plate | 5 | SCREEN | 6 |
| 6 | Screen Grid | 6 | CATHODE | 2 |
| 7 | Cathode & Supr Grid | 7 | SUPPRESSOR | 0 |

*From Table in Fig. 9.

**6.04** In this example, for the 403B type 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, and pin 7 is assigned 0 (no external connection). Thus the selector settings would be JR-3562-0. If this tube example were the 415A (6AS6) type, the final SELECTOR switch setting would be JR-3562-7 in order to tie the separate G3 suppressor grid element to the cathode pin 2 externally to the tube. When an external cap grid or plate is used, the GRID or PLATE SELECTOR, respectively, 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 9-pin types (noval and jumbo) and the lock-in pin codes are straightforward (see Fig. 9) and require no code interpretation except for FILAMENT pin assignments.

**6.05** ***Subminiature Tube Basing:*** Subminiature tubes, when properly based for a Gm test in the appropriate adapter, offer no special basing problem except in certain cases involving both long lead types (in-line and octal). These types utilize adapters with standard octal plugs to fit the otcal test socket. The selector settings for any subminiature type listed in Section 100-636-502 are given for a tube as specified in the manufacturer's tube data for the original lead length. However, cases may occur where either long lead type has been cut to the proper short lengths for subminiature socket service. In such cases, the selector code setting will be affected when the tube is mounted for test as a short lead type in either the Vector 1175 or 1176 adapters in earlier production sets or in permanent subminiature sockets of later sets.

**6.06** The selector code change will be affected for only those leads which were previously connected to terminals 1, 2, 7, and 8 of either long lead adapter. Applying the basing codes of Fig. 9, terminals appearing on leads 1 and 2, and 7 and 8 are interchanged. Taking the 1AD4 type in-line example, plate (P, red dot) = 1, screen (G2) = 2, − Fil (and G3) = 3, Grid (G1) = 4, and + Fil =5, and an original long lead type based in the 7AX51 adapter has a DV-4210-0 SELECTOR setting. This same tube with leads cut short for socket use would be tested in the 1175 noval base adapter or permanent socket,

using the direct basing code given in Fig. 9 for a noval socket. The SELECTOR setting in this case would be DV-4120-0. Similarly, the circular 8-pin based 5899 would have a DW-2584-0 SELECTOR setting as a long lead tube in the 7400-0012 octal base adapter, and DW-1574-0 in the 1176 adapter. Here lead terminals 1, 2, 7, and 8 only are affected. As a short lead tube, control grid, G1, is terminal 1; suppressor grid, G3, and cathode (internally connected) are 4; and screen grid, G2, is 7. The remaining terminals in this tube are heater leads 3 and 6; cathode and suppressor grid, G3, also on 2 and 8; and plate on 5.

## 7. TEST DATA

**7.01** Test data for Western Electric Company tubes are given in Section 100-636-501 and supplemental or corrective data for tubes of other than Western Electric Company manufacture are given in Section 100-636-502.

**7.02** ***Roll Chart Details:*** As indicated in 3.09 and 3.10, most Western Electric Company tubes and tubes of other manufacture are set up for test and evaluated for acceptance or rejection on the basis of minimum indicated transconductance readings. 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 GM-VR METER scale. The test data as set up in the tube data section for each tube conform to the commercial 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), the BIAS VOLTS for the required VR-bias voltmeter reading, and the FUNCT. or SHUNT requirements. This last column heading provides the proper FUNCTION switch range choice for any indicated transconductance measurement, or if a number up to 100 is given it denotes a SHUNT setting of the FUNCTION switch and the number given is the required SHUNT potentiometer setting. The new low 600-umho range appears simply designated as 600 in the FUNCT. or SHUNT column.

**7.03** ***BIAS VOLTS Column:*** Special symbols are sometimes found under the BIAS VOLTS column. Where the symbol $\phi$ is found next to a 0, self bias is indicated, and a resistor value, as given under NOTATIONS for the tube 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. As described in 2.44, a Daven Type 4416B Self-bias Decade Resistor unit is optionally available for permanent installation in the cord compartment of a set (see Page 37) to eliminate individual self-bias test resistor units. The symbol ‡ indicates that the bias volts is to be reduced gradually, using the BIAS VOLTS control, until the tube strikes. This is manifested by a sudden GM-VR METER reading. This test, principally for small commercial 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.

**7.04** ***PRESS Column:*** The final operation is listed in the PRESS column, designating the particular push-button 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 button should be depressed first and held depressed before the GM P4 push button is operated. This is done to make this test at reduced screen voltage.

**7.05** ***MIN. TRANSCOND. Column:*** The minimum value of indicated transconductance for each tube is listed under the column heading MIN. TRANSCOND. A tube should be rejected for GM-VR METER readings only if ***less than*** such listed reject or minimum values as previously discussed in 3.09 and 3.10. A star or asterisk, *, symbol appearing in the MIN. TRANSCOND. column denotes a GM-VR METER reading to be observed with respect to the RECTIFIERS & DIODES OK index mark when

the FUNCTION switch is set at SHUNT and the SHUNT potentiometer is set at the required value given in the FUNCT. or SHUNT column. Certain rectifiers, e.g., 1B3, 1V2, do not have the star or asterisk designation but are tested with the FUNCTION switch set at 3000 or 6000 and a criterion based on the RECTIFIERS & DIODES OK index mark. Such tube tests are all covered in the NOTATIONS column.

**7.06** The BIAS VOLTS meter settings have been selected to approximate normal plate and screen grid current operation as well as to obtain GM-VR METER readings as near as possible to nominal values for both Western Electric Company and tubes of other manufacture, within the limitations imposed by the set. Nominal values of indicated transconductance have been purposely omitted from tube data sections, and the roll chart for both Western Electric Company and tubes of other manufacture to avoid confusion in rating or classifying new and unused tubes by comparison with the nominal transconductance values given for other tube testers. Although in many cases tubes might be so rated in this tester, the variables as to the permissible Gm range in a new tube product for many tubes are sufficiently great that such use of the set is impracticable except in a laboratory where correlative check testing facilities are available.

**7.07** ***NOTATIONS Column:*** Special test operations required for certain tubes by reference to the particular controls involved are shown under the NOTATIONS column. Multipurpose tubes and the separate anode circuits of diodes and full-wave rectifier types require more than one series of test settings. The NOTATIONS column includes all special test information required for each tube. In the Western Electric Company tube data section the principal item first listed for each tube is the maximum allowable per cent cathode activity, which appears as @ ( )%. 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 3.13 through 3.17. 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 3.16.

**7.08** Other test information supplied in the NOTATIONS column includes mention of GRID or PLATE cap connection if required, identification of sections of multipurpose tubes, PLT.-SCRN. VOLTS — LOW test option, special test conditions of SHORTS switch neon lamp glow SHORTS TEST — LOW voltage test option, self-bias resistor values, adapter codes when necessary, and, in a few cases, special references or unusual operating test instructions. All similar pertinent test information is also contained in this column in the tube data sections.

**7.09** ***VR Test Data:*** Test data for voltage regulator or reference voltage tubes of other than Western Electric Company manufacture are located at the beginning of the roll chart, including condensed operating procedure, as previously discussed in 3.24. Comparable data for Western Electric Company VR tubes are contained in tube data section. The symbol $\theta$ is used as a reference for the VR test and the VR test and the VR designation in the BIAS VOLTS and FUNCT. or SHUNT columns refers to the settings of the VR-BIAS VOLTS transfer switch and FUNCTION SELECTOR switches. GM-VR in the PRESS column refers to the GM VR P4 LOCK push-button switch to operate the VR test circuit. Test requirement data appear under the NOTATIONS column and the electrical symbols used here are explained in 3.24.

**7.10** The set has a blank space on the panel below the left-hand roll chart window. This area is designated LAST TUBE. The last tube code appearing in the first column of the particular chart issue in the tester should be entered in pencil in this space to serve as convenient subsequent reference information.

**7.11** ***Supplementary Roll Chart Data:*** To conserve chart space and editing effort, several hundred obsolete and Manufacture Discontinued items have been omitted from the roll chart. However, all entries omitted from the roll chart have been listed for reference as Addendum No. 3, which is a supplement to the manufacturer's instruction booklet originally delivered with a new set.

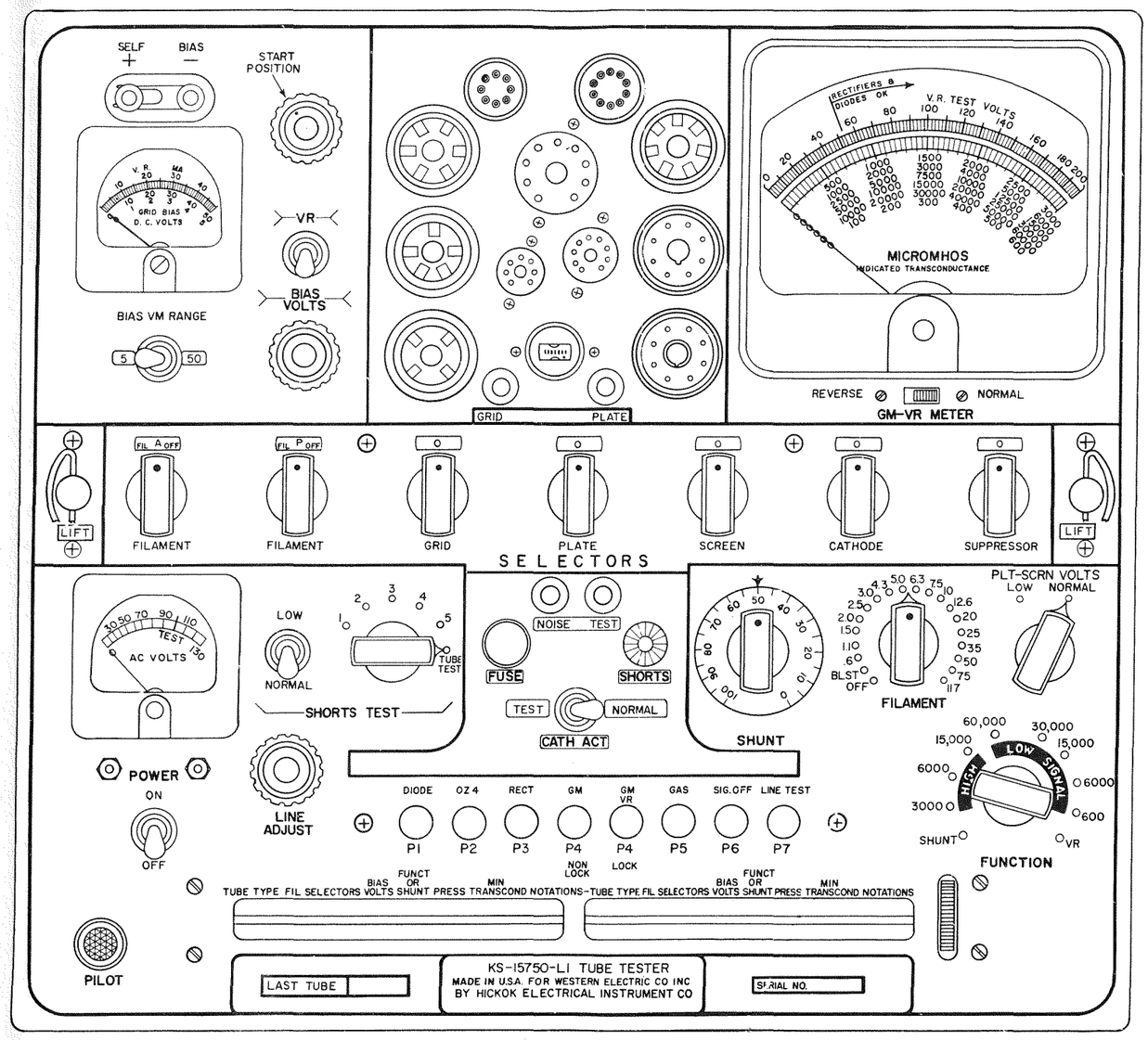
## TABLE B

## CATHODE ACTIVITY TEST GUIDE

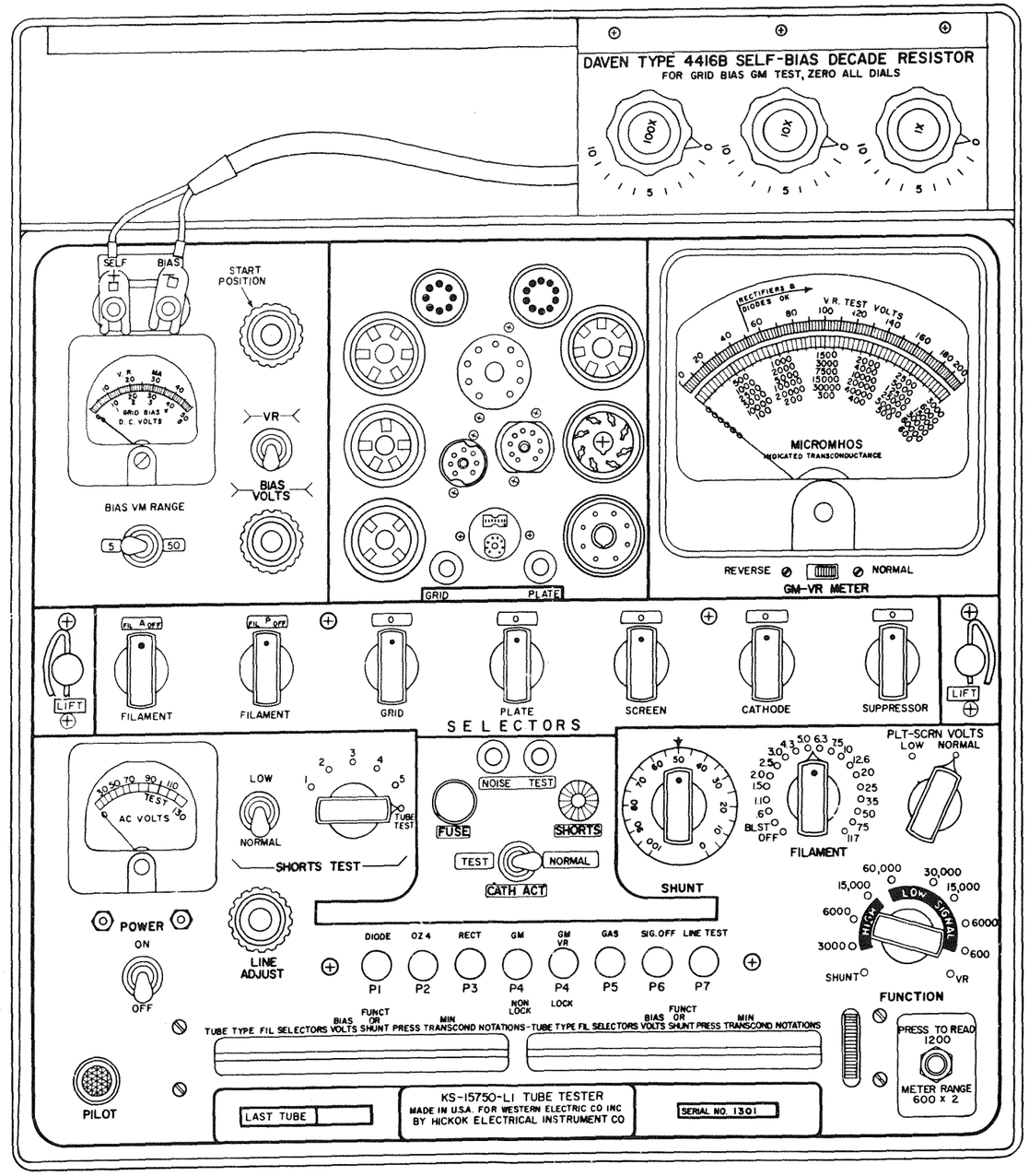
**(Read on the 0- to 3000-micromho scale *only*, irrespective of the scale range indicated by the FUNCTION switch.)**

| GM-VR METER RDG, CATH. ACT. NORMAL | CORRESPONDING TEST POSITION METER READING FOR ACTIVITY LIMITS OF: PER CENT | | | | GM-VR METER RDG, CATH. ACT. NORMAL | CORRESPONDING TEST POSITION METER READING FOR ACTIVITY LIMITS OF: PER CENT | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 15 | 20 | 25 | 30 | | 15 | 20 | 25 | 30 |
| 200 | 170 | 160 | 150 | 140 | 1600 | 1360 | 1280 | 1200 | 1120 |
| 240 | 205 | 190 | 180 | 170 | 1640 | 1390 | 1310 | 1230 | 1150 |
| 280 | 240 | 225 | 210 | 195 | 1680 | 1430 | 1345 | 1260 | 1180 |
| 320 | 270 | 255 | 240 | 225 | 1720 | 1460 | 1380 | 1290 | 1200 |
| 360 | 305 | 290 | 270 | 250 | 1760 | 1500 | 1410 | 1320 | 1230 |
| 400 | 340 | 320 | 300 | 280 | 1800 | 1530 | 1440 | 1350 | 1260 |
| 440 | 375 | 350 | 330 | 310 | 1840 | 1565 | 1470 | 1380 | 1290 |
| 480 | 410 | 385 | 360 | 335 | 1880 | 1600 | 1500 | 1410 | 1320 |
| 520 | 440 | 415 | 390 | 365 | 1920 | 1630 | 1540 | 1440 | 1345 |
| 560 | 475 | 450 | 420 | 390 | 1960 | 1670 | 1570 | 1470 | 1370 |
| 600 | 510 | 480 | 450 | 420 | 2000 | 1700 | 1600 | 1500 | 1400 |
| 640 | 540 | 510 | 480 | 450 | 2040 | 1735 | 1630 | 1530 | 1430 |
| 680 | 580 | 540 | 510 | 475 | 2080 | 1770 | 1665 | 1560 | 1460 |
| 720 | 610 | 575 | 540 | 505 | 2120 | 1800 | 1700 | 1590 | 1485 |
| 760 | 645 | 610 | 570 | 530 | 2160 | 1840 | 1730 | 1620 | 1510 |
| 800 | 680 | 640 | 600 | 560 | 2200 | 1870 | 1760 | 1650 | 1540 |
| 840 | 715 | 670 | 630 | 590 | 2240 | 1900 | 1790 | 1680 | 1570 |
| 880 | 750 | 705 | 660 | 615 | 2280 | 1940 | 1825 | 1710 | 1600 |
| 920 | 780 | 735 | 690 | 645 | 2320 | 1970 | 1860 | 1740 | 1625 |
| 960 | 815 | 770 | 720 | 670 | 2360 | 2000 | 1890 | 1770 | 1650 |
| 1000 | 850 | 800 | 750 | 700 | 2400 | 2040 | 1920 | 1800 | 1680 |
| 1040 | 885 | 830 | 780 | 730 | 2440 | 2080 | 1950 | 1830 | 1710 |
| 1080 | 920 | 865 | 810 | 755 | 2480 | 2110 | 1985 | 1860 | 1740 |
| 1120 | 950 | 900 | 840 | 785 | 2520 | 2140 | 2020 | 1890 | 1765 |
| 1160 | 985 | 930 | 870 | 810 | 2560 | 2180 | 2050 | 1920 | 1790 |
| 1200 | 1020 | 960 | 900 | 840 | 2600 | 2210 | 2080 | 1950 | 1820 |
| 1240 | 1050 | 990 | 930 | 870 | 2640 | 2245 | 2115 | 1980 | 1850 |
| 1280 | 1090 | 1020 | 960 | 900 | 2680 | 2280 | 2140 | 2010 | 1880 |
| 1320 | 1120 | 1060 | 990 | 925 | 2720 | 2315 | 2180 | 2040 | 1900 |
| 1360 | 1160 | 1090 | 1020 | 950 | 2760 | 2350 | 2210 | 2070 | 1930 |
| 1400 | 1190 | 1120 | 1050 | 980 | 2800 | 2380 | 2240 | 2100 | 1960 |
| 1440 | 1220 | 1150 | 1080 | 1010 | 2840 | 2420 | 2275 | 2130 | 1990 |
| 1480 | 1260 | 1180 | 1110 | 1040 | 2880 | 2450 | 2300 | 2160 | 2020 |
| 1520 | 1290 | 1220 | 1140 | 1060 | 2920 | 2480 | 2340 | 2190 | 2040 |
| 1560 | 1325 | 1250 | 1170 | 1090 | 2960 | 2520 | 2370 | 2220 | 2070 |
| | | | | | 3000 | 2550 | 2400 | 2250 | 2100 |

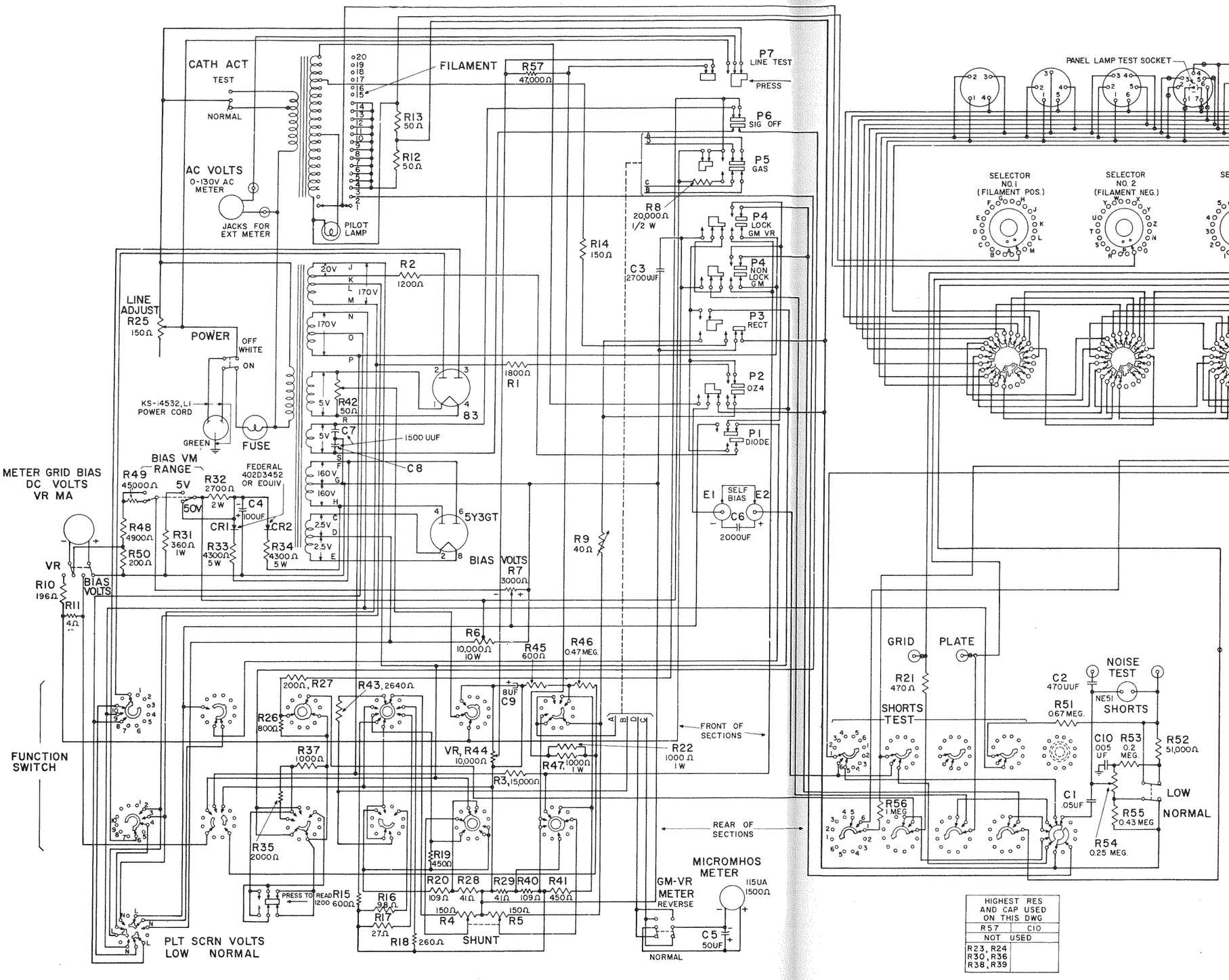
Per cent activity limits in this table computed to ±5 umhos (approximately).




**Tube Tester Panel Layout**
**Showing Subminiature In-line Tube Adapter in Place in Subpanel Socket (Serial Numbers below 800)**




**Tube Tester Panel Layout Showing Daven Type 4416B Self-bias Decade Resistor Unit Installed (Optional), Surface-mounted Subminiature Tube Sockets (Serial Numbers 800 and up) and 600X2 Push Button for 1200 Micromhos Range (Serial Numbers 1301 and up)**

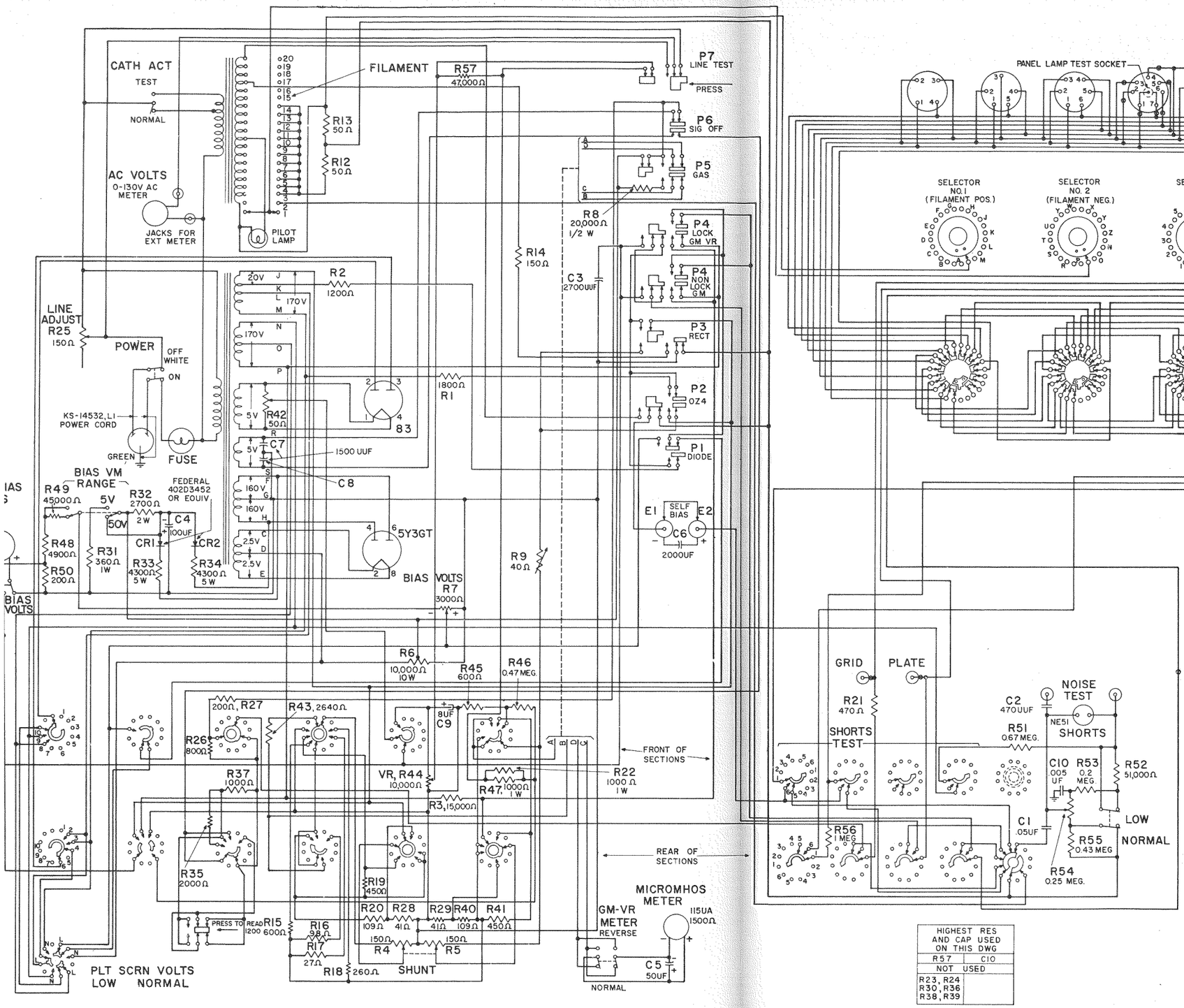



| HIGHEST RES AND CAP USED ON THIS DWG | |
|---|---|
| R57 | C10 |
| NOT USED | |
| R23, R24 R30, R36 R38, R39 | |

| SWITCH POS | SELECTOR NO. 1 | SELECTOR NO. 2 | SELECTOR NOS. 3-7 | SHORTS | FILAMENT | FUNCTIO |
|---|---|---|---|---|---|---|
| 1 | A FIL OFF | P | O | 1 | OFF | SHUNT |
| 2 | B | R | 1 | 2 | BLST | 3000 HIGH |
| 3 | C | S | 2 | 3 | 6 | 6000 HIGH |
| 4 | D | T | 3 | 4 | 11 | 15000 HIGH |
| 5 | E | U | 4 | 5 | 1.5 | 60,000 LOW |
| 6 | F | V | 5 | TUBE TEST | 2.0 | 30,000 LOW |
| 7 | G | W | 6 | | 2.5 | 15,000 LOW |
| 8 | H | X | 7 | | 3.0 | 6000 LOW |
| 9 | J | Y | 8 | | 4.3 | 600 LOW |
| 10 | K | Z | 9 | | 5.0 | VR |
| 11 | L | N | X | | 6.3 | |
| 12 | M | O | Y | | 7.5 | |
| 13 | | | | | 10 | |
| 14 | | | | | 12.6 | |
| 15 | | | | | 20 | |
| 16 | | | | | 25 | |
| 17 | | | | | 35 | |
| 18 | | | | | 50 | |
| 19 | | | | | 75 | |
| 20 | | | | | 117 | |

NOTES:
1. THIS SCHEMATIC APPLIES TO LIST 1 SETS WITH SERIAL NO. 1301 O
2. THE MAIN SELECTOR SWITCHES NO. 1, 2, 3, 4, 5, 6, & 7 HAVE NO STO SHOWN IN THEIR ZERO OR "OFF" POSITION. ALL OTHER ROTARY SHOWN IN EXTREME COUNTER CLOCKWISE POSITION (POSITION AND REAR OF SECTIONS ARE SHOWN AS VIEWED FROM THE KNOB
3. IN CASES WHERE FALSE LAMP GLOW INDICATIONS PERSIST WITH N IN ANY TEST SOCKET, POTENTIOMETER R54 LOCATED BENEATH TH BE READJUSTED BY SCREWDRIVER TO CHANGE THE AC DIVIDER I IMPRESSED BETWEEN THE SHORTS TEST CIRCUIT AND THE NE5
4. COMBINATION IN LINE AND OCTAL SUB MIN PREWIRED SOCKET A NO. 19350-220) PROVIDED.
5. ⊗ THIS SYMBOL DENOTES APPROXIMATE LOCATIONS OF ANTI-PA OF FERRAMIC Q MATERIAL (GENERAL CERAMICS CO.) TO SUPPRES

**Schematic of KS-15750,L1 Tu**
**(Serial Numbers 1301 an**




| HIGHEST RES AND CAP USED ON THIS DWG | |
|---|---|
| R57 | C10 |
| NOT USED | |
| R23, R24 R30, R36 R38, R39 | |

| SWITCH POS | SELECTOR NO. 1 | SELECTOR NO. 2 | SELECTOR NOS. 3-7 | SHORTS | FILAMENT | FUNCTION |
|---|---|---|---|---|---|---|
| 1 | A FIL OFF | P | 0 | 1 | OFF | SHUNT |
| 2 | B | R | 1 | 2 | BLST | 3000 HIGH SIG. |
| 3 | C | S | 2 | 3 | 6 | 6000 HIGH SIG. |
| 4 | D | T | 3 | 4 | 1.1 | 15000 HIGH SIG. |
| 5 | E | U | 4 | 5 | 1.5 | 60000 LOW SIG. |
| 6 | F | V | 5 | TUBE TEST | 2.0 | 30000 LOW SIG. |
| 7 | G | W | 6 | | 2.5 | 15,000 LOW SIG. |
| 8 | H | X | 7 | | 3.0 | 6000 LOW SIG. |
| 9 | J | Y | 8 | | 4.3 | 600 LOW SIG. |
| 10 | K | Z | 9 | | 5.0 | VR |
| 11 | L | N | X | | 6.3 | |
| 12 | M | O | Y | | 7.5 | |
| 13 | | | | | 10 | |
| 14 | | | | | 12.6 | |
| 15 | | | | | 20 | |
| 16 | | | | | 25 | |
| 17 | | | | | 35 | |
| 18 | | | | | 50 | |
| 19 | | | | | 75 | |
| 20 | | | | | 117 | |

NOTES:

1. THIS SCHEMATIC APPLIES TO LIST 1 SETS WITH SERIAL NO. 1301 OR HIGHER.
2. THE MAIN SELECTOR SWITCHES NO. 1,2,3,4,5,6, & 7 HAVE NO STOPS AND ARE SHOWN IN THEIR ZERO OR "OFF" POSITION. ALL OTHER ROTARY SWITCHES SHOWN IN EXTREME COUNTER CLOCKWISE POSITION (POSITION 1.). FRONT AND REAR OF SECTIONS ARE SHOWN AS VIEWED FROM THE KNOB END.
3. IN CASES WHERE FALSE LAMP GLOW INDICATIONS PERSIST WITH NO TUBE IN ANY TEST SOCKET, POTENTIOMETER R54 LOCATED BENEATH THE PANEL MAY BE READJUSTED BY SCREWDRIVER TO CHANGE THE AC DIVIDER POTENTIALS IMPRESSED BETWEEN THE SHORTS TEST CIRCUIT AND THE NE51 NEON LAMP.
4. COMBINATION IN LINE AND OCTAL SUB MIN PREWIRED SOCKET ASSEMBLY (PART NO. 19350-220) PROVIDED.
5. ⊗ THIS SYMBOL DENOTES APPROXIMATE LOCATIONS OF ANTI-PARASITIC BEADS OF FERRAMIC Q MATERIAL (GENERAL CERAMICS CO.) TO SUPPRESS OSCILLATION.

**Schematic of KS-15750,L1 Tube Tester (Serial Numbers 1301 and up)**