ELECTRON TUBE TEST SET
MODEL KS-15874-L1 CARDMATIC TUBE TESTER
DESCRIPTION AND OPERATION

1. GENERAL

1.01 This section provides information on the operation and maintenance of the Model KS-15874-L1 Cardmatic Tube Tester.

1.02 The section consists of an instruction manual prepared by the Hickok Electrical Instrument Company, Cleveland, Ohio, for this tube tester.

1.03 This tube tester is for general Bell System use. It performs dynamic tests on practically all small sized low power tubes of Western Electric Company or other manufacture.

1.04 The test set is semi-automatic in operation. Testing of tubes is done by selecting and inserting a punched card that automatically programs the test conditions.

1.05 Parts will be made available for a minimum period of five years after the manufacture of this equipment has been discontinued. Parts include all materials, charts, instructions, diagrams, accessories, etc., which have been furnished in the standard model.

1.06 The tube test set should be returned to the nearest Western Electric Company Distributing House for repairs more extensive than those covered in Part 6 of the instruction manual.

Attached:
Instruction Manual for Model
KS-15874-L1 Cardmatic Tube Tester

ELECTRON TUBE TEST SET
CARDMATIC TUBE TESTER
MODEL KS-15874 L1 AND MODEL KS-15874 L2 WITH SERIAL NUMBERS UP TO AND INCLUDING 899
DESCRIPTION AND OPERATION

1. GENERAL

1.001 This addendum supplements Section 100-637-101, Issue 1.

1.002 This addendum is issued to change the title of the section, to include references in the section to the KS-15874 L2 Cardmatic Tube Testers with serial numbers up to and including 899, and to add information concerning special adapters.

1. GENERAL

The following changes apply to Part 1 of the section:

(a) 1.01—revised

(b) 1.07—added

(c) 1.08—added

1.01 This section provides information on the operation and maintenance of the Cardmatic Tube Tester, Models KS-15874 L1 and KS-15874 L2 with serial numbers up to and including 899.

1.07 The KS-15874 L2 Tester has the same circuitry, mechanical components, and testing features as the L1 model. The L2 testing unit is housed in a redesigned case arranged to hold tube test cards for all active Western Electric tubes, 54 calibration and maintenance test cards, 50 blank cards, and a hand punch. These items are included as a part of the KS-15874 L2 Tester. The KS-15874 L2 Tester does not include an additional card carrying case or tube test cards for commercial type tubes. These items are to be ordered separately, if required.

1.08 Special adapters are available for use with the Cardmatic Tube Testers to provide the capability of testing certain tubes used in the Motorola 150 MHz and General Electric 450 MHz solid state mobile units. The adapters with instruction manual and the test cards for the tubes are available from the Hickok Electrical Instrument Company, 10555 DuPont Avenue, Cleveland, Ohio 44108. The Hickok 1050-107 Adapter is available for checking the 5894 tube used in the Motorola KS-19609 Car Telephone, and either the Hickok 1050-135 CA4 or 1050-164 CA5 Adapter is available for checking the 8072, 8106, and 8156 tubes used in the General Electric ST-55 and ST-58 series mobile radio units.

MODEL KS-15874-L1
CARDMATIC TUBE TESTER

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Figure 1. KS-15874-L1 Tube Tester

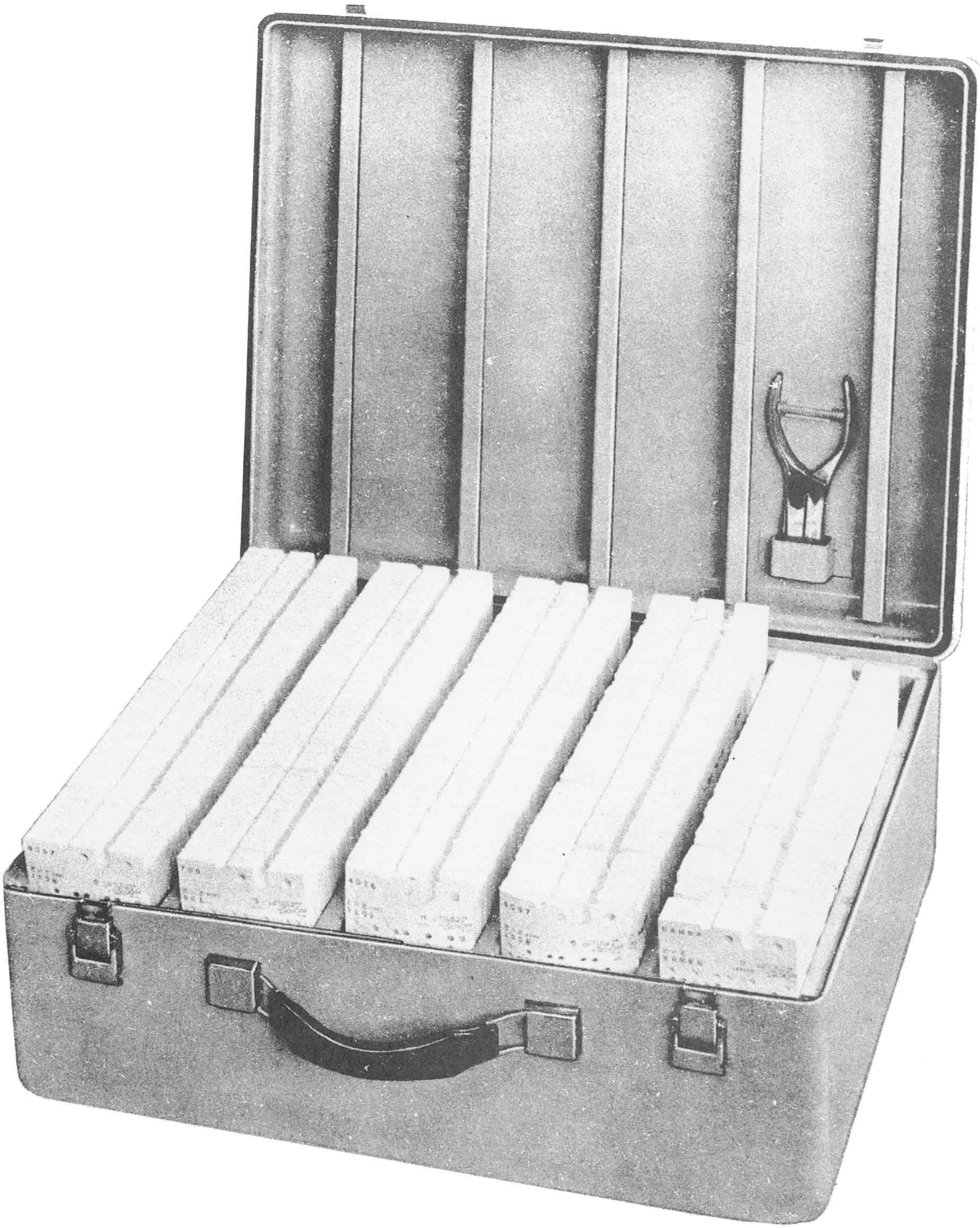


Figure 2. KS-15874-L1 Card Case

MODEL KS-15874-L1

CARDMATIC TUBE TESTER

1. GENERAL

1.01 This book describes the KS-15874-L1 Electron Tube Tester and gives the methods for operating and maintaining the set. A separate card case, which is part of the tester equipment, is also described.

1.02 This tube tester is for general Bell System use. It is capable of testing practically all small sized, low power tubes of Western Electric Company or other manufacture.

1.03 The set is manufactured by The Hickok Electrical Instrument Company, 10514 Dupont Avenue, Cleveland 8, Ohio.

1.04 The set is semi-automatic in operation. Testing of tubes is done by selecting and inserting a punched card which automatically programs test conditions. This is in lieu of roll charts and manual selectors which were used on previous testers.

1.05 Dynamic tests are performed under conditions which are as close as possible to the operating condition of the tube rather than a common operating point as was formerly done.

2. DESCRIPTION

A. General

2.01 The KS-15874-L1 Tester is self-contained in a portable aluminum carrying case with removable cover. The outside dimensions of the case are approximately 19½ inches wide by 9½ inches high by 16½ inches deep. The weight is about 42 pounds.

2.02 In the test set case there is a compartment which contains program cards for testing Western Electric tubes.

2.03 The cover of the tester case contains brackets for storing an instruction book, power cord and a calibration cell for checking the meter and short test.

2.04 A separate case having the same dimensions and construction as the main tester case is provided to store program cards. It contains approximately 1000 cards for testing common commercial tubes, also a group of calibration cards and 50 blank cards. Space is available for 1500 additional cards. A punch for making new cards is stored in the cover of this case.

B. Description of Front Panel

2.05 The front panel is shown in Figure 3. The largest feature is the card switch which has a receptacle for receiving the program cards. When a pre-punched card is fully inserted into the switch it actuates a micro-switch which in turn actuates a solenoid to move the card switch contacts to complete the circuit. When the card switch actuates, the large knob at the left of it pops up. This PUSH TO REJECT CARD knob must be pressed to open the switch contacts and release the card. The card switch actuates only when a card is in the proper position and operates on the principle that absence of a hole in the card makes a contact.

2.06 The meter contains four scales. The upper scale is graduated from 0 to 100 for direct numerical readings. The three lower scales numbered 1, 2 and 3 are read for LEAKAGE, QUALITY and GAS respectively. Each numbered scale contains green and red areas marked GOOD and REPLACE.

2.07 Inside the small hood, directly in front of the meter, are five neon lamps which indicate shorts between elements.

2.08 A push button, marked 2, is used for transconductance emission and other quality tests which are described later. In general when this button is pressed, results are read on scale 2 of the meter.

2.09 Another button, marked 3, is used for making grid current measurements which result when gas is present in the tube vacuum. Results of this test are read on scale 3 of the meter. This button is interlocked with button 2.

2.10 A button marked 4 is used for tests of dual tubes in which both halves are alike. A neon lamp lights when button 4 is to be used.

2.11 Eleven sockets which will take all common tubes plus pin straighteners for the 7 and 9 pin miniature tubes are on the panel.

2.12 The set is protected by an overload relay. There is an ON switch and an OFF switch that actuate the relay. A PILOT light appears next to these switches.

2.13 In the area above the OFF switch there are three fuses and lamps to indicate when they

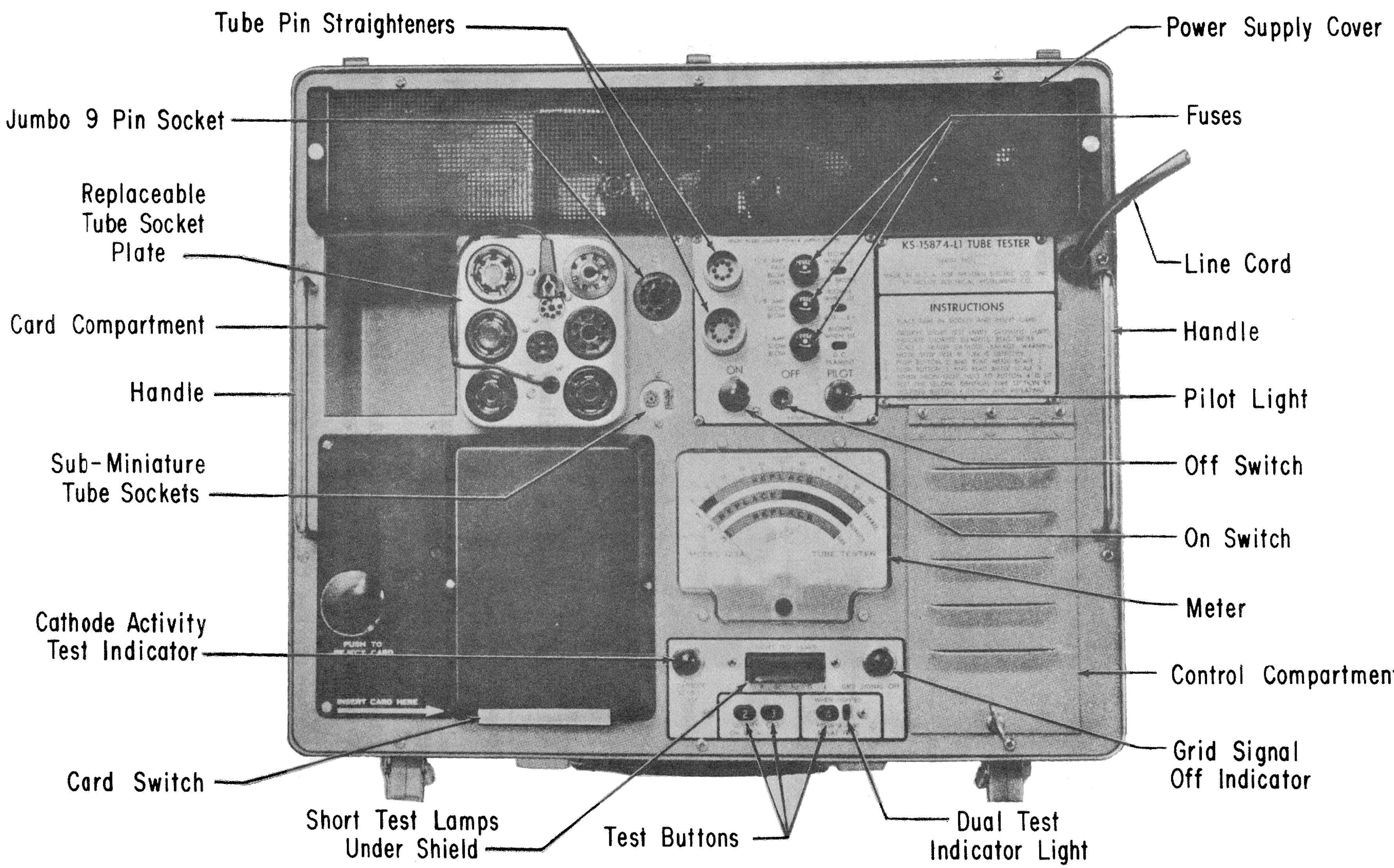


Figure 3. Identification of Controls and Components

have blown. These fuses protect portions of the circuit which do not go through the protective relay.

2.14 Brief operating instructions also appear on the front panel.

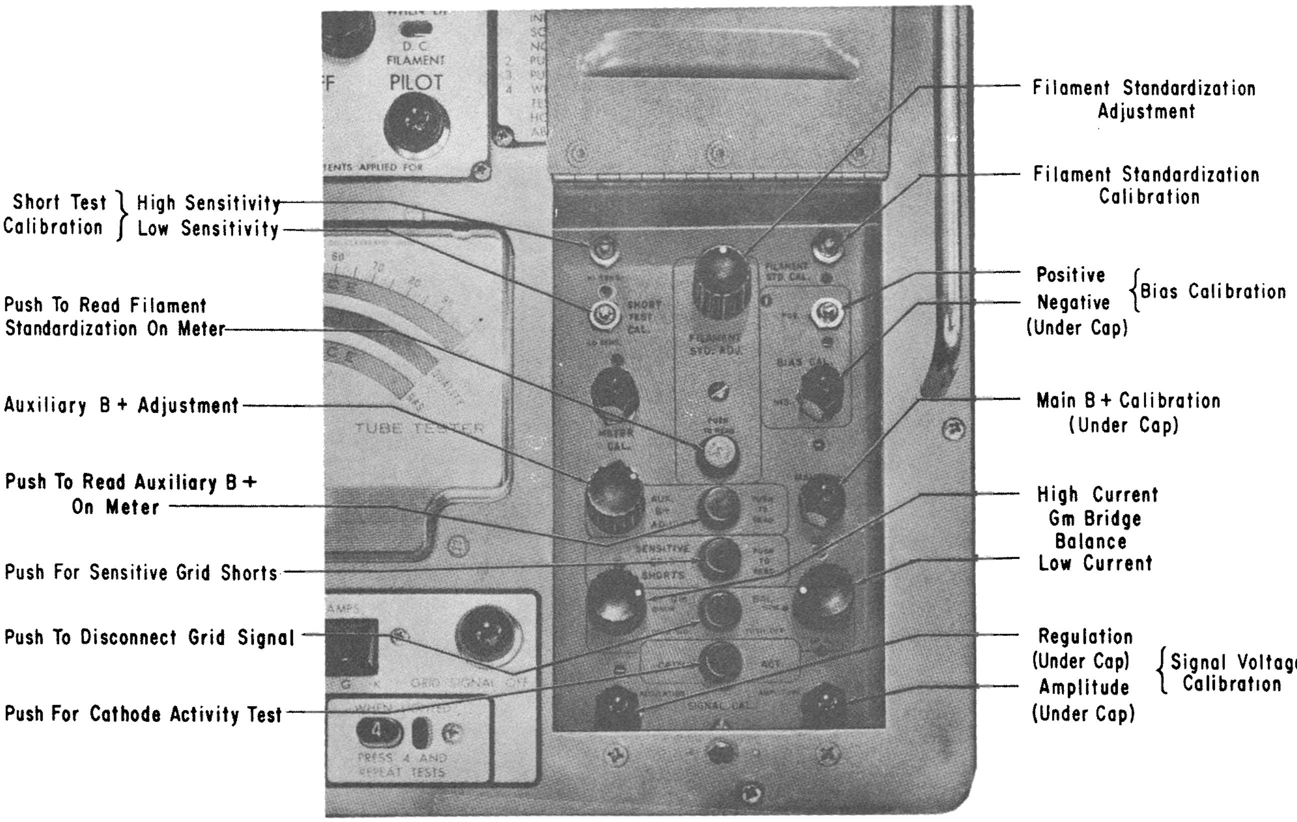


Figure 4. Auxiliary Compartment

C. Auxiliary Compartment

2.15 A hinged panel covers a group of auxiliary controls which are used for special tests and for calibration of the set.

2.16 Two of these controls marked SIGNAL CAL. are used with special test cards for adjusting the REGULATION and AMPLITUDE of the signal voltage.

2.17 A push button marked CATH ACT is used for making cathode activity tests. When this button is pressed the filament voltage is reduced 10 percent. Results of the test are read as a change in reading on the numerical meter scale. As a warning to the operator, when the CATH ACT button is pressed, a lamp on the main panel is lighted.

2.18 A push button and two potentiometers are used for balancing the Gm bridge circuit under actual tube operating current for any Gm test. When the button is pressed it removes the grid signal and allows a zero balance to be made with one potentiometer or the other depending on whether the the tube under test is passing HI or LO plate current. A lamp on the main panel is lighted when this adjustment is being made.

2.19 A button labeled SENSITIVE GRID SHORTS is used for checking grid to cathode shorts at a sensitivity much higher than the normal tests. The results of this test are observed on the short test lamps.

2.20 Certain special tests required the use of a continuously adjustable auxiliary power supply. By pressing the PUSH TO READ button the meter is used to monitor the voltage of the auxiliary power supply. This voltage may be adjusted by the use of the potentiometer labeled AUX B+ ADJ.

2.21 The rest of the potentiometer controls, marked MAIN B+ CAL, BIAS CAL NEG. BIAS CAL POS, FILAMENT STD CAL, METER CAL, SHORT TEST CAL, HI SENS, SHORT TEST CAL LO SENS, are calibration controls and are adjusted by the use of special calibration cards and a calibration cell, as covered in the section on routine calibration and also the maintenance section of this book.

2.22 The line voltage to the tester may vary over a wide range. All circuits in the tester are electronically regulated except the filament supply. To correct for this, a button is pressed and the FILAMENT STD ADJ switch is rotated until the meter reads midscale.

D. Program Cards

2.23 The circuitry in the tester which is to be utilized is selected by a pre-punched card. These cards are made of a tough vinyl plastic material.

2.24 The card switch in the tester has 186 single pole single throw switches. These are arranged in 17 rows with 11 switches in each row. The vinyl card is used to push the switches closed and therefore the absence of a hole in the card is required to actuate a switch.

2.25 The tube numbers are printed in color on the tabs of the cards. For convenience in the filing system the tube number is also printed at the edge of the card.

2.26 The cards are arranged in alpha-numerical order in both the tester compartment and the separate card carrying case. A special card is provided to be used as a marker when a card is removed for use.

2.27 A pack of calibration cards is supplied for use in routine calibration of this equipment. Another pack of cards is included for use in trouble shooting and complete calibration.

2.28 A pack of printed blank cards and a hand punch are provided so that additional tube test cards may be punched as new tubes are developed. Torn, broken or unserviceable cards may be replaced or duplicated with the hand punch and blank cards.

3. CALIBRATION

3.01 General. The tester is equipped with self-calibrating features which include calibration controls located in the auxiliary control compartment and corresponding calibration code cards. The calibration procedures are divided into two parts, Routine Calibration, listed below, and Complete Calibration, listed in the Maintenance Section.

3.02 Routine Calibration is quickly performed using the proper calibration cards and does not require external test equipment. It should be performed upon initial installation, after the first week of operation, and at least once a month thereafter.

3.03 Complete Calibration is also performed with the use of special calibration cards, however, additional test equipment is required for some of the checks.

3.04 The complete calibration may be performed at the time of installation, (in addition to Routine Calibration noted above), and should be checked at least twice a year and whenever trouble is suspected or maintenance work has been performed.

3.05 Routine Calibration Procedure.

a. Turn tester on and allow it to warm up for 15 minutes. Check that the meter is reading zero. If necessary, re-adjust the mechanical zero adjust so that the needle knife-edge rests over the zero line.

b. Select the Routine Calibration cards, 1 through 10, from the Card Storage case.

3.06 Meter Check.

a. Insert calibration card 1, METER, into the switch. Plug the calibration cell into the octal test socket, see Figure 3. (The calibration cell is normally stored in the cover of the tube tester.) The left short lamp will glow.

b. Press button 2 for check of meter microamp cal. The meter should read within $\pm$ 1 scale division of the figure written in the top blank on the calibration cell cover. If the reading is out of tolerance the meter should be checked against a meter standard for 50μ amp indication at mid-scale. If the error is significant, the meter should be repaired or replaced.

c. Hold down button 2 and press button 4 to check meter millivolt sensitivity. The meter should read within $\pm$ 1 scale division of the figure written in the bottom blank on the calibration cell cover. If the reading is out of tolerance, adjust the "METER CAL" control for proper reading.

NOTE: Routine Calibration Controls are located in the auxiliary control compartment. If the control has a protective cap, its setting should be rechecked after the cap is replaced.

3.07 Short Test Sensitivities.

DURING THE FOLLOWING FOUR TESTS (CARDS 2 THRU 5) LEAVE THE CALIBRATING CELL IN THE OCTAL SOCKET. DO NOT PRESS ANY BUTTONS.

a. Insert Calibration Card 2, SHORTS 2 MEG NO-GO. Observe that no short lamps are lighted. If any lamps are glowing adjust "LO SENS" short test control to just extinguish all lamps.

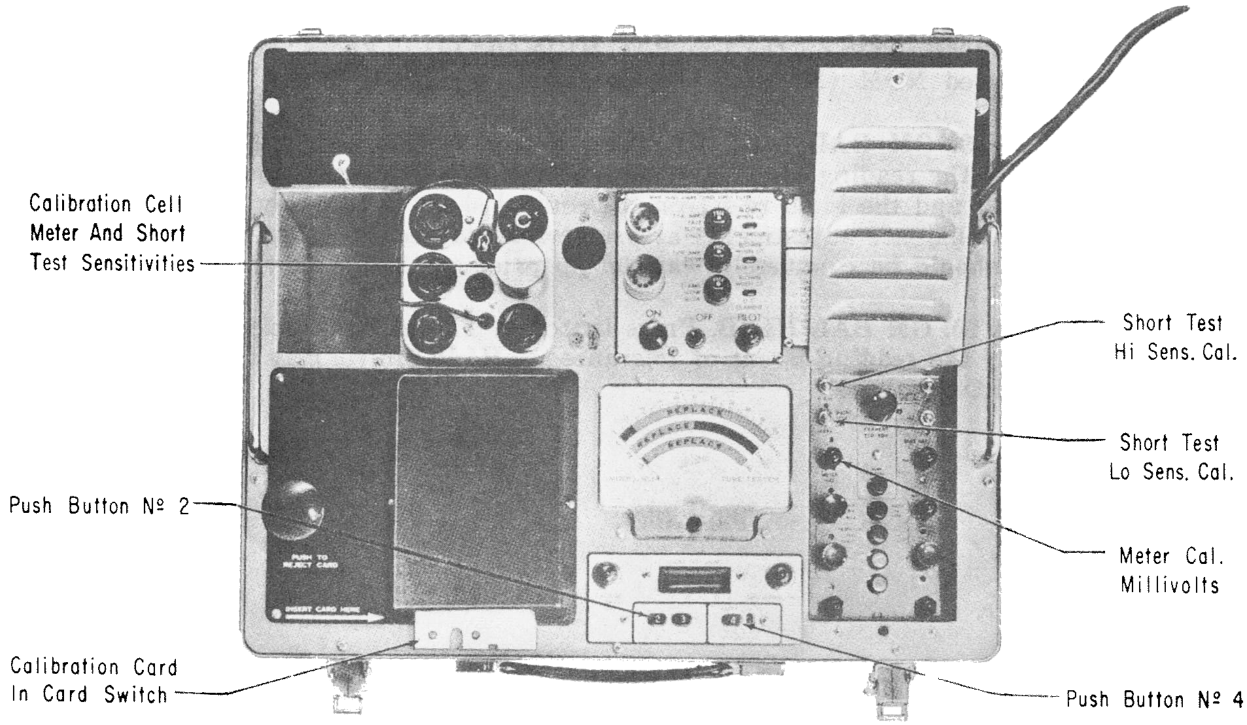


Figure 5. Meter Sensitivity

b. Insert Card 3, SHORTS 1 MEG GO. The left four lamps should glow. If they are not glowing re-adjust the "LO SENS" control until they glow with Card 3 and are extinguished with Card 2, as listed above.

c. Insert Card 4, SHORT 20 MEG NO-GO. Press SENSITIVE GRID SHORTS BUTTON. No short lamps should glow. If any are lighted adjust the "HI SENS" control.

d. Insert Card 5, SHORT 10 MEG GO. Press SENSITIVE GRID SHORTS BUTTON. The number 4 lamp only (counting left to right) should glow.
NOTE: The Lamp may flicker or glow dimly as compared to the "LO SENS" short indication. If the number 41 lamp is not glowing re-adjust the "HI SENS" control until it glows with card 5 and is extinguished with card 4, as before. REMOVE CALIBRATION CELL FROM OCTAL SOCKET.

3.08 Bias Calibration.

a. Insert Card 6, FIXED BIAS CAL NEG. No short lamps should glow. Press button 2. Meter should read half scale. If reading is other than half scale, adjust "BIAS CAL NEG" control for proper indication.

b. Insert Card 7, FIXED BIAS CAL POS. Short lamps 1 and 2 should glow. Press button 2. Meter should read half scale. If another reading is obtained, adjust "BIAS CAL POS" control.

3.09 Main B+ Power Supply Calibration.

a. Insert Card 8, MAIN B PLUS CAL. Short Lamps 1, 2, 3, and 5 should glow. Press button 2. The meter should read half scale. If meter reading is not proper, adjust MAIN B+ CAL for correct indication.

3.10 Gm Bridge Balance.
Check that the white dots on the Gm BAL HI Ib and LO Ib knobs are in line with the associated dots labeled NOM (Nominal) on the panel.

a. Insert Card 9, GM BAL LOW IB. Press button 2. Meter should read zero ± 3 scale divisions. If the reading is out of tolerance the LO Ib control may be adjusted for a zero reading and the knob re-set on the control shaft to properly align the dots.
NOTE: The balance adjustments are somewhat subject to temperature variation and the tester should be completely warmed up prior to these adjustments.

b. Insert Card 10, GM BAL HI IB. Press button 2. The meter should read zero ± 3 scale divisions. If the reading is out of tolerance the HI Ib control may be adjusted in manner noted for LO Ib above.

4. OPERATION

A. Normal

4.01 Before operating this set the calibration procedure, as outlined in 3.0 should be followed.

4.02 The tester is equipped with a three-conductor power cord, one wire of which is chassis ground. It should be plugged into a 105 to 120 volt 60 cycle outlet having a building ground.

4.03 Open the auxiliary compartment trap door and check for the following to be in the NOM position:

FILAMENT STD. ADJ. knob.
Gm BAL — 2 knobs. GRID SIG. button should be up, no red light at GRID SIGNAL OFF lamp.

CATH ACT — Button up and no red light at CATHODE ACTIVITY TEST lamp.
All other controls in this compartment should be left as is.

4.04 Turn on the tester and allow it to warm up for 5 or 10 minutes. This tester may be left on for extended periods without harm. Some heat will be noted from the ventilated section at the rear but this is normal.

4.05 Press PUSH TO REJECT CARD knob down until it locks and remove the non-test card from the switch. This card is used to keep the switch pins in place during the shipment and should be inserted before transporting the tester.

4.06 Plug the tube to be tested into its proper socket. Pin straighteners are supplied for use on 7 and 9 pin miniature tubes and should be used before these tubes are plugged in.

4.07 The tester is shipped with cards for Western Electric tubes in its case. Cards for commercial tubes are in the separate case. It is important that cards be kept in their proper order. A yellow plastic flag is provided to be used as a bookmark when cards are removed. It is expected that different locations may want to add more markers to separate card groups or to intermix Western and commercial cards in the tester case. However, this should be done with care so that other operators will not be confused. Probably it would be best to use the tester a few months before any refiling is done.

4.08 Select the proper card (or cards) for the tube to be tested. Insert it into the slot in the card switch until the PUSH TO REJECT CARD knob pops up.

> NOTE: The card will operate the tester only when it is inserted properly. This is when the printing is up and toward the operator. A blank card will not operate the set. Never put paper or other objects into the card switch as they may jam the switch contacts.

The tube is now being tested for shorts and leakage between heater and cathode. If there are no shorts lamps will not light. If two or more elements are shorted together the lamp or lamps between these elements will *not* light but the others will. The abbreviations for the tube elements are located on the panel just below the short test hood so that the neon lamps are between them, making it possible to determine what elements are shorted. For example, if all the lamps were lighted except the right hand one it would indicate a grid to cathode short. Heater to cathode shorts are indicated as leakage currents on the number 1 meter scale. If the meter reads above the green area the tube should be replaced. A direct heater to cathode short would cause the meter to go full scale.

4.09 The tube is now ready for the QUALITY test. This may be for trans-conductance, emission, plate current, voltage drop, etc., depending on the type of tube being tested. Push the number 2 button and read the number 2 meter scale which tells whether or not the tube is good. The actual Gm or milliampere reading can be interpreted with the aid of the TUBE TEST CONDITIONS booklet which is shipped with the tester. When the number 2 button is pressed the numerical meter scale may be read as a percentage of full scale. By referring to the booklet for the full scale reading the actual Gm can be determined. For example, if a tube read 70 and the booklet listed its full scale reading as 6800 umhos, the actual reading would be 70% of 6800 or 4760 umhos. Of course the reading for rectifiers and diodes would be interpreted in milliamperes instead of micromhos.

4.10 The tube may be checked for gas by pressing the number 3 button and reading the number 3 meter scale. The number 2 button also goes down when 3 is pressed.

4.11 If a tube such as a dual diode or dual triode which has two identical sections is being tested, the neon lamp next to the number 4 button will light. This lamp tells the operator that he may check both sections with one card. To do this the operator checks the tube for shorts, leakage, quality and gas which takes care of one section. He then holds down button 4 and repeats the checks for shorts, leakage, quality and gas on the second section.

4.12 Some tubes require more than one card. For example, a tube having dual diode sections and a triode section would have two cards, one for the triode and one to be used with button 4 for checking the diodes. If the two diode sections were not alike the tube would take three cards and the lamp by button 4 would not light. Some tubes have more than one card so that special tests may be made. Commercial voltage regulator tubes have four cards. The first card is an instruction card. The second card is for the dark current test or the point just below firing when the tube is at the maximum leakage point. Button 2 is pressed for this test but leakage is still read on the number 1 meter scale. Card 3 is the low current test. It flows minimum current through the tube and measures the voltage. Card 4 is the high current test. It flows maximum current through the tube and measures the voltage. The difference between the readings with cards 3 and 4 indicates the regulation ability of the tube. The closer the readings the better.

B. Auxiliary Tests

4.13 As seen from the foregoing paragraphs the normal testing procedure is extremely simple. All that is necessary is to insert the card, check shorts and leakage and then press two buttons and take readings. However, there are other tests which can be made. Controls for these are located in the auxiliary compartment. This compartment has been described in paragraphs 2 and 3 in detail. For testing tubes the only controls used are the five push buttons and the four knobs associated with them. Actually two of these (FILAMENT STD. ADJ. and Gm BAL.) are not really tests but are controls to obtain more accurate test results.

4.14 The FILAMENT STD. ADJ. controls the primary side of the filament transformer. It is used to compensate for variations in line voltage and for variations caused by tubes having large filament currents. For all tubes the white dot on the knob may be aligned with the dot labelled NOM. and left there. However, when the operator wishes to obtain very accurate tests the filament voltage may be standardized for every tube. To do this the PUSH TO READ button is held down and the knob is rotated until the meter reads as close to 50 as possible. When the operator has finished testing tubes, he should restore the knob to NOM.

4.15 The complete adjustment of the Gm bridge balancing controls is described in 3.0. To obtain the most accurate results, the balance should be checked every time a tube is tested for Gm. To do this press button 2 and the GRID SIG. button. The GRID SIGNAL OFF lamp on the tester panel will light. Adjust LO Ib or HI Ib knob until the meter reads as near zero as possible. Most tubes require the adjustment of the LO Ib knob, however, tubes that draw heavy plate current require the adjustment of the HI Ib knob. After completing the check, store the GRID SIG. button to normal by pressing any other button in the auxiliary compartment. When the operator is finished testing he should return both balance knobs to their NOM. positions.

4.16 The cathode activity test is used as an indication of the amount of useful life remaining in the tube. By reducing the filament voltage ten percent and allowing the cathode to cool off slightly the ability of the cathode as an emitter of electrons can be estimated. This test is made in conjunction with the normal quality test. After the tube has warmed up button 2 is pressed and the test meter is read on scale 2; also the numerical reading on the 0-100 scale is noted. The CATH. ACT. button is then locked down. A red light on the tester panel comes on. After a wait of about 1½ minutes button 2 is again pressed and the reading taken on the numerical scale. The tube should be rejected if this reading differs from the normal reading by more than 10 percent or if the reading drops into the red area on scale 2. After this test the button should be restored to normal by pressing any other push button in the auxiliary compartment.

4.17 It is often desirable to check tubes for shorts between grid and cathode at a sensitivity greater than normal. This is especially true for tubes used in oscilloscopes and television sets. To make this check merely press the SENSITIVE GRID SHORTS button and note carefully if any of the shorts lamps light.

4.18 The remaining control in the auxiliary compartment is the auxiliary B+ adjustment. This control varies the voltage of the auxiliary regulated supply. This supply is only used on special test cards such as for Western Electric cold cathode and voltage regulator tubes.

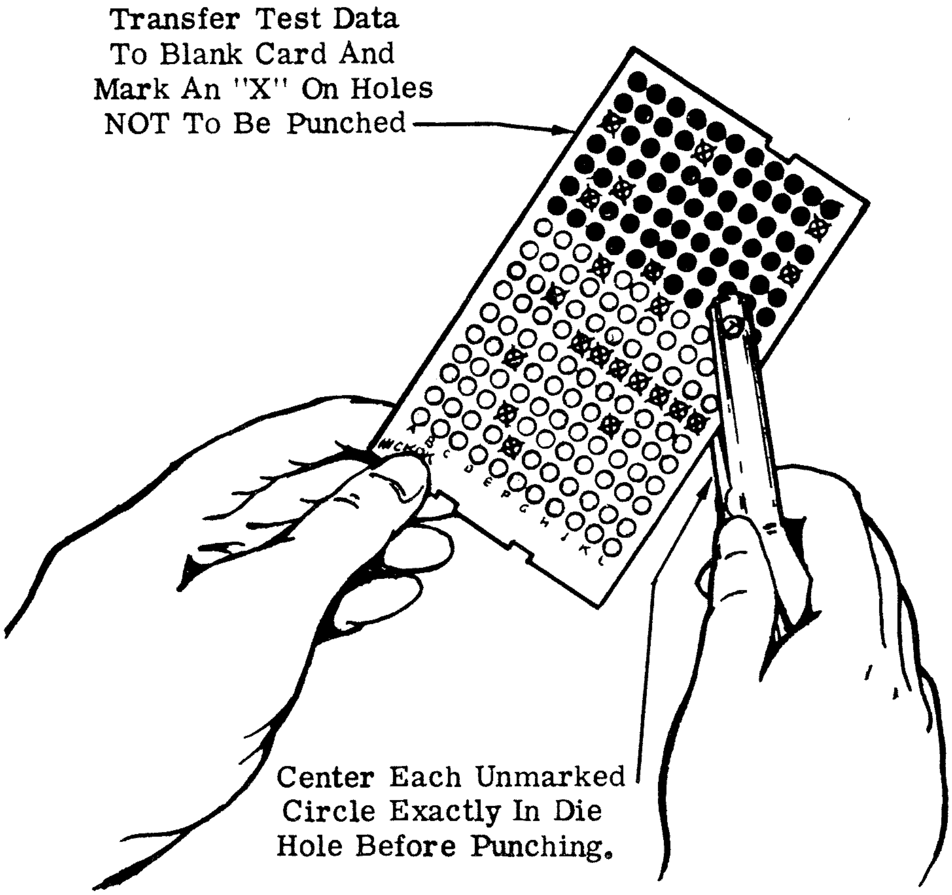


Figure 6. Punching New or Replacement Tube Test Code Cards

C. Hand Punch Card System

4.19 The Hickok hand punch card system consists of fifty printed blank cards, and one steel hand punch. Additional cards may be ordered under the Hickok Part No. 3122-80.

4.20 Preparation of Cards: The Hickok CARDMATIC switch is designed so the unpunched areas in a test card close contacts. Therefore, all the circles are punched in the card except the ones that close circuit switches.

a. Transfer the test data to the blank card and mark an "X" on the holes not to be punched.

b. A convenient way to locate the correct circles on the card is to find the desired lettered row and mark the circles that are not to be punched in that lettered row.

4.21 Punching the Card:

a. Locate the unmarked circle exactly in the die hole of the hand punch and punch the hole.

4.22 Replacing Broken Cards:

a. Place the parts of the broken card over a blank card and mark the holes to be punched.

b. Center the marked circles in the die hole of the hand punch and punch the holes.

5. CIRCUIT

A. Circuit Theory

5.01 Previous testers have checked tubes with circuits which were fixed in nature. When a tube having characteristics different from any other was developed it was necessary to test it on a compromise type circuit. In the KS-15874 Tester an effort has been made to include enough separate circuits so that by interconnecting them, nearly any tube may be tested for nearly any condition. The feature which makes this possible is the card switch with its 186 contacts. This switch may be thought of as a group of patch cords to interconnect a group of laboratory components. This group of components contains the following:

1. 1% R box — high current
2. ¼% meter
3. 1% meter shunt system
4. Black box — direct reading Gm
5. Fixed bias supply — 1%
6. Regulated B+ supplies
7. AC supplies
8. Decade filament supplies
9. Regulated signal
10. A group of capacitors

5.02 The card switch connects these components in nearly any configuration rather than following a fixed circuit pattern. Its functions are mainly as follows:

It applies the properly established voltages to the various pins of the tube sockets.
It chooses a high wattage decade resistance from 0 to 70,000 ohms, in 10 ohm steps.
It places certain fixed capacitors into the desired point in the circuits.
It puts the Gm bridge into the proper point of the circuit.
It connects the regulated signal of 222 millivolts.
It chooses half-scale meter shunts capable of resolving at mid-scale, Gm's of 250 to 13,000 micromhos in 50 micromho steps; 250 to 64,000 micromhos in 250 micromho steps; currents from 50 to 2600 microamps in 10 microamp steps; and from 1 to 255 milliamps in one milliamp steps; or voltages from 5 to 260 volts in one volt steps.
It places the meter and its shunts in the proper point of the test circuit.
It applies a high current, 500 volts AC supply, to the proper point of the test circuit.
It applies a regulated DC supply to the proper point in the circuit and selects its voltage from 10 to 250 volts in 10 volt steps.
It applies a high current, 500 volts AC supply, to the proper point of the test circuit.
It applies a regulated DC supply to the proper point in the circuit and selects its voltage from 10 to 250 volts in 10 volt steps.
It controls a decade fixed bias supply for bias voltages from 0 to 100 volts in 0.1 volt steps.
It chooses a decade filament voltage from 0 to 119.9 volts in 0.1 volt steps.

5.03 In this tester an effort has been made to test tubes under typical operating conditions and values recommended by tube handbooks. Instead of only Gm and emission tests being used, variations have been added to compliment them. Some examples of how the circuit selection system is used in testing various types of tubes are as follows:

5.04 The amplifying type tubes, which are those having control grids, are tested for Gm. Most of these are in the triode and pentode groups. Triodes are usually operated in either a fixed bias or self-bias circuit. Figure 7 illustrates that for triode fixed bias types the cathode is ground. The negative bias plus a small ac signal is added and applied to the grid. The plate of the tube is connected to one end of the Gm bridge circuit with the regulated DC or B+ connected to the other end. This cir-

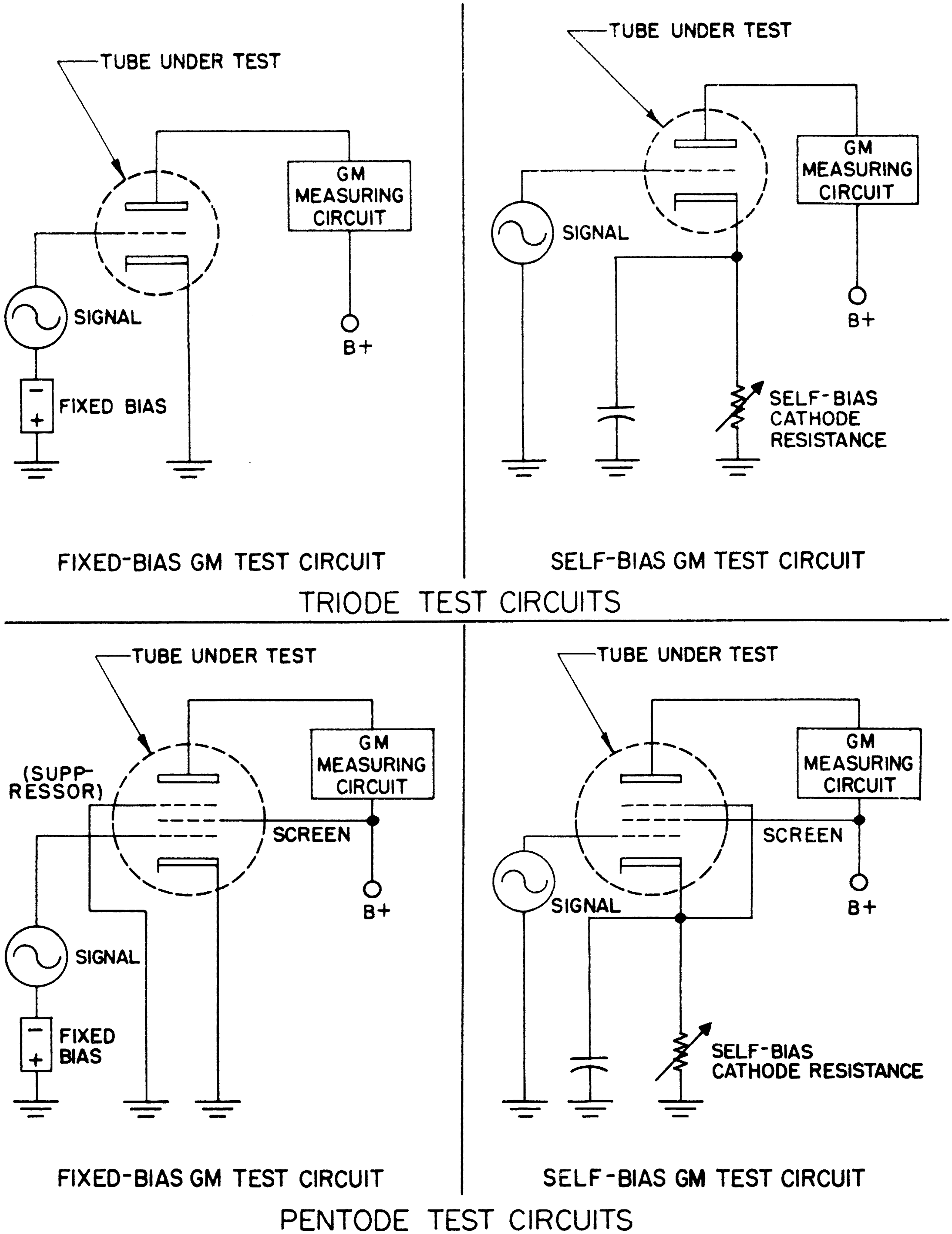


Figure 7. Test Circuits for Amplifying Tubes

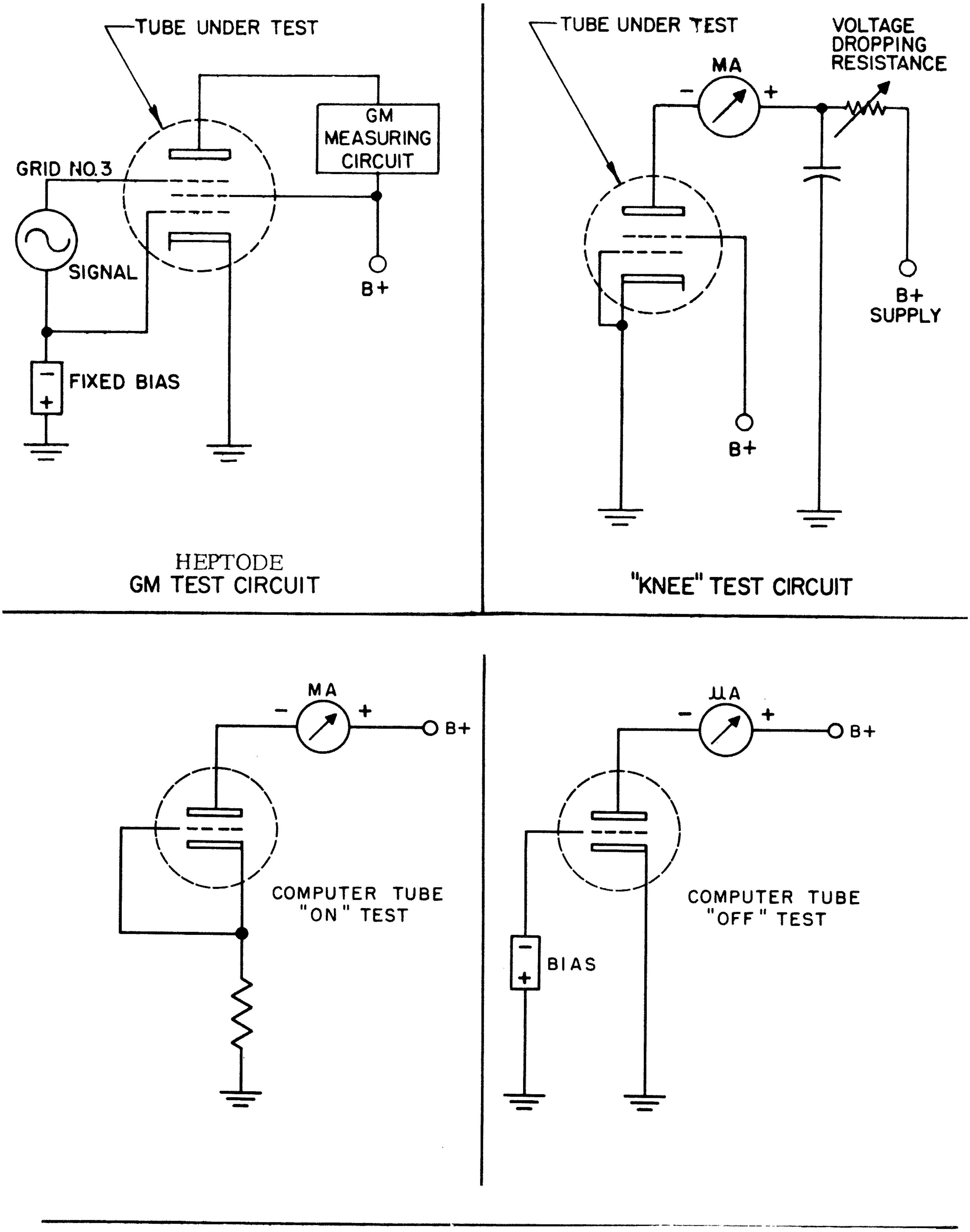


Figure 8. Special Test Circuits

cuit is set up by the card in the card switch and by pressing button 2 it is energized for the test.

Figure 7 shows that the triode self bias test resembles the fixed bias test except that the cathode is grounded through the biasing resistance which is shunted by a capacitor.

5.05 By referring to Figure 7 it is noted that pentodes are tested the same as triodes except for the addition of the screen and suppressor grids. In both cases the screen voltage is connected just before entering the Gm circuit. In fixed bias operation the suppressor grid is grounded directly while in the self bias case it is connected to the cathode.

5.06 Figure 8 shows a two-control grid type of heptode. In testing this tube the bias voltage is applied to each control grid but the signal is only applied to one at a time, which then makes a measurement of the respective grid to plate Gm. Two test cards are necessary for this type of tube.

5.07 Power pentodes used in pulse applications are given a normal Gm test but in addition receive a second test which is referred to as a "knee" test. In order to produce the necessary pulse power the place current of these pentodes must sweep from near cut-off to full saturation at the knee of the plate current-plate voltage curves. The Gm test is important but the knee test is necessary for a complete check. The "knee" test circuit is shown in Figure 8.

5.08 Figure 8 shows two special tests that are made for triodes intended for computer application. In addition to the normal Gm test these tubes are normally tested for zero bias plate current (ON test) and for high bias plate current (OFF tests). Since these tubes are intended for multivibrator application it has been found necessary to make these tests to assure proper operation.

5.09 DC Filament Tubes. Certain battery-operated tubes have directly heated or filamentary cathodes. These are tested the same as triodes or pentodes except in certain cases dc from the full wave silicon rectifier bridge is applied to the filament of the tube. Should shorts occur in this type of tube, the meter will deflect to the left under the leakage test. This can be disregarded as the shorts lamps will actually show the defect.

5.10 Diode type tubes are tested with several different circuits depending on the type of diode tested. In the full wave rectifier circuit shown in figure 9, the 250 volt center tapped ac is applied directly across the plates of the tube. A load resistance with filter capacitor is connected to the cathode of the tube. The output current is measured by the meter being connected as a dc milliammeter. The load resistor is adjusted so that the average indicated current or emission will be for the handbook condition.

5.11 The second rectifier test is for half-wave tubes in which the load resistance is adjusted in series with the milliammeter without the filter capacitor. The circuit for this test is shown in figure 9.

5.12 High voltage type rectifiers are tested on a circuit similar to that shown. High voltage ac is applied from the plate to the cathode in series with a load resistance and its filter capacitor and then through the dc milliammeter. A low voltage across the tube would reveal its emission characteristics but by using the load capacitor it is possible to develop approximately 1200 volts peak inverse which will show arcing conditions.

5.13 A high voltage diode may be checked for emission by the circuit shown in figure 9. The regulated power supply is connected directly across the tube and the current is metered through the tube. The reject value for this type of tube is fairly low and since the reject point is midscale on the meter most tubes will read near full scale.

5.14 Another type of emission circuit as shown in figure 9 is mainly for use in testing high-permeance detector diodes. Ten volts dc is applied across the tube with the milliammeter in series. This type of tube is rated for about 60 MA and is rejected at about 25% of this figure. Low permeance diodes are tested the same way except it is necessary to use a higher impedance 10V supply. Low permeance tubes are rated about 2 MA with a reject point of about 0.3 MA.

5.15 Voltage regulator tubes are checked for continuity, leakage, voltage drop at low current and volt drop at high current. The regulator tubes are tested by using four cards, one of which is an instruction card that is not inserted into the tester. The number 2 card measures leakage as shown in Figure 10.

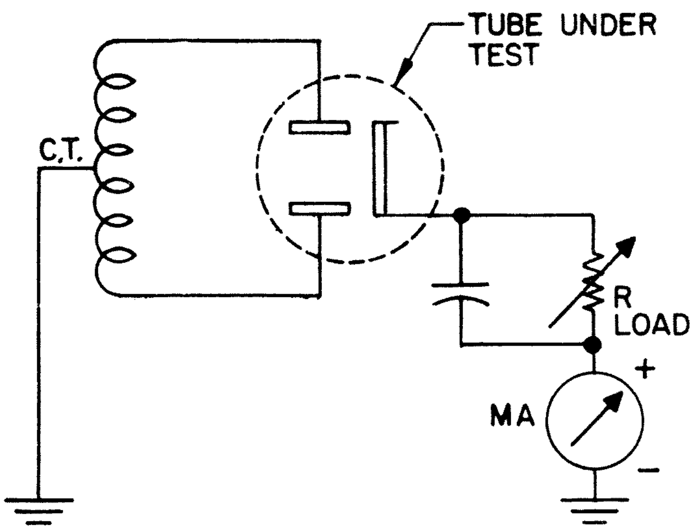
The tube jumpers are connected together and the voltage is applied across the tube in series with the meter. The reject point for these tubes is 10% of full scale. Card 3 is for measuring the voltage drop across the tube at low current while card 4 measures the drop at high current. The difference between the meter readings using these two cards is the regulating ability of the tube. The nearer to zero the difference the better the regulation. The number 1 card has test information to guide the operator in judging test results. Typical VR test circuits are shown in Figure 10. The shorts test lamps are used to check jumper continuity. The left lamp will glow on cards 3 and 4 indicating a plate to cathode short. Should a tube have discontinuity no reading will be obtained on the tester meter when button 2 is pressed. Normally a good tube will read half scale on the meter.

5.16 Short Test. When a tube is inserted into the set for test, it is immediately subjected to a gradient type of DC voltage as illustrated in Figure 11. This voltage gradient is adjusted so that all five neon lamps are extinguished unless a resistive path exists across them. The voltage gradient appears across a series of relaxation oscillator circuits, composed of a capacitor and resistor connected to each lamp and tube element. The short resistance determines the charging rate of the capacitor. The capacitor charges to the lamp starting voltage then discharges through the lamp. The cycle then repeats. The circuit is thus set up so that the lamps will flash intermittently for a high resistance and glow steadily for a low resistance short. The five neon lamps simultaneously indicate shorts between plate, suppressor, screen, grid and cathode. The DC voltage is polarized in such a way that if the tube exhibits grid emission the lamps will also flash. The sensitivity of the shorts test circuit is 1 megohm indication and 2 megohms no indication. A separate pushbutton in the auxiliary compartment is used to check critical grid-to-cathode shorts at a sensitivity of 10 megohms go and 20 megohms no-go.

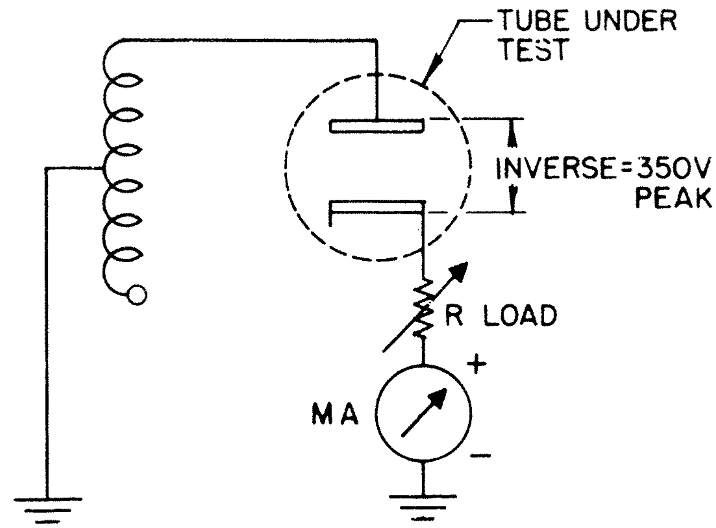
5.17 Leakage Test. This test is made by placing a microammeter in series with the heater and cathode. A sytem of shunts is available so that the reject point can be set up individually for the various types of tubes. The tester meter scale has definite reject point but actual current may be as low as 10 microamperes or as high as 150 microamperes depending on the type of tube. By using this system nearly any handbook condition can be duplicated. The amount of leakage tolerable is of course dependent on the application. As an example, a tube used in a cathode follower circuit with high cathode resistance may have to be rejected with as little as 10 microamperes of cathode to filament leakage. On the other hand a direct cathode to filament short in a tube used in a grounded cathode circuit may be insufficient cause for rejection.

5.18 Gas Test. Button 3 is used to test the tube for grid current due to gas. Pressing button 3 also actuates the button 2 through an interlock which operates the tube under normal bias and plate current conditions. If gas ions are present in the vacuum they will migrate to the negative grid and cause a current to flow which is read on the number 3 scale of the meter. The allowable grid current, due to gas, ranges from .5 to 3 microamps depending on the tube type. Of course, tubes having no grids cannot be tested for gas in this manner. In all of the tube tests a zero bias grid voltage is avoided because it would cause the meter to deflect to the left or opposite to that of gas current due to contact potential.

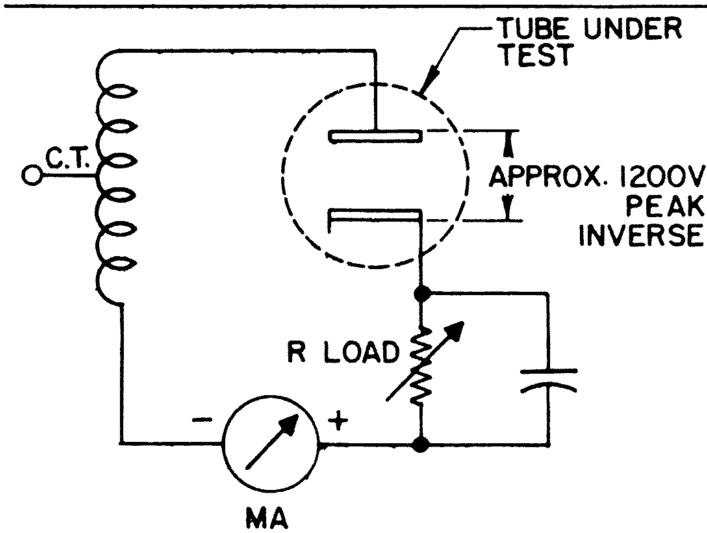
If the meter deflection is beyond the green sector of the meter under #3 test, the amplifier tube has a grid current in excess of 3 microamperes and it is definitely of no useful service. This reject point is based upon manufacturers specifications for a large number of tubes. However, in circuits where there is a high grid impedance present even a ½ microampere grid current is harmful, therefore any up scale deflection under #3 test should be regarded with question for a given tube.



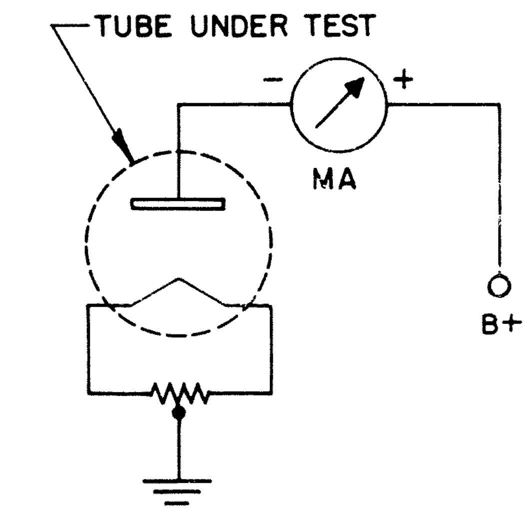
Full Wave Rectifier Test Circuit



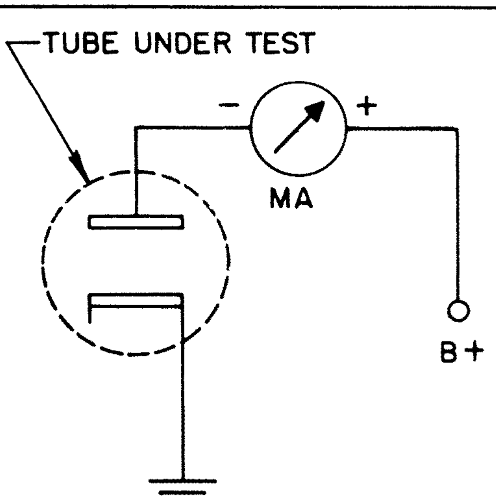
Half Wave Rectifier Test Circuit



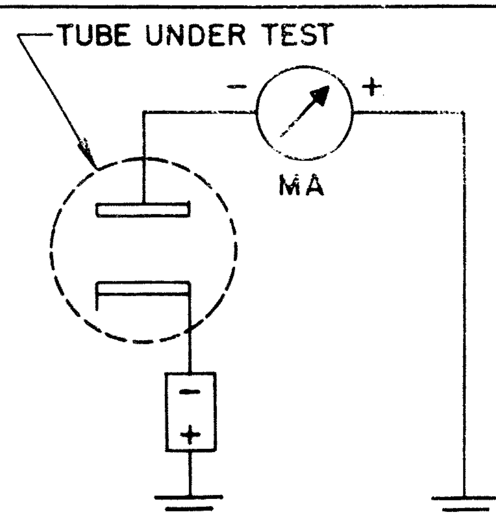
High Voltage Rectifier Test Circuit



High Voltage Diode Test Circuit



High Permeance Diode Test Circuit



Low Permeance Diode Section Test

Figure 9. Basic Types of Diode Test Circuits

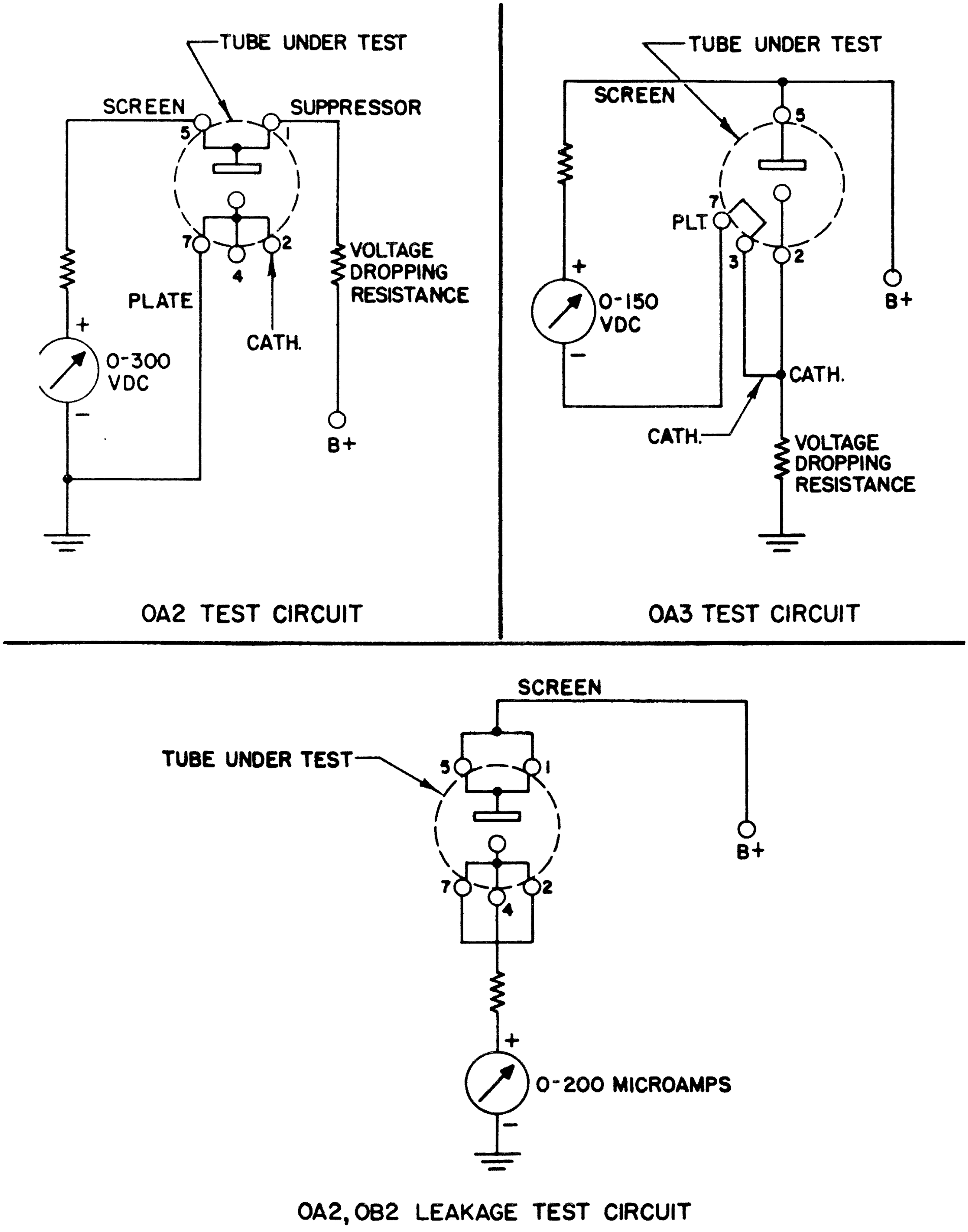


Figure 10. Voltage Regulator Test Circuits

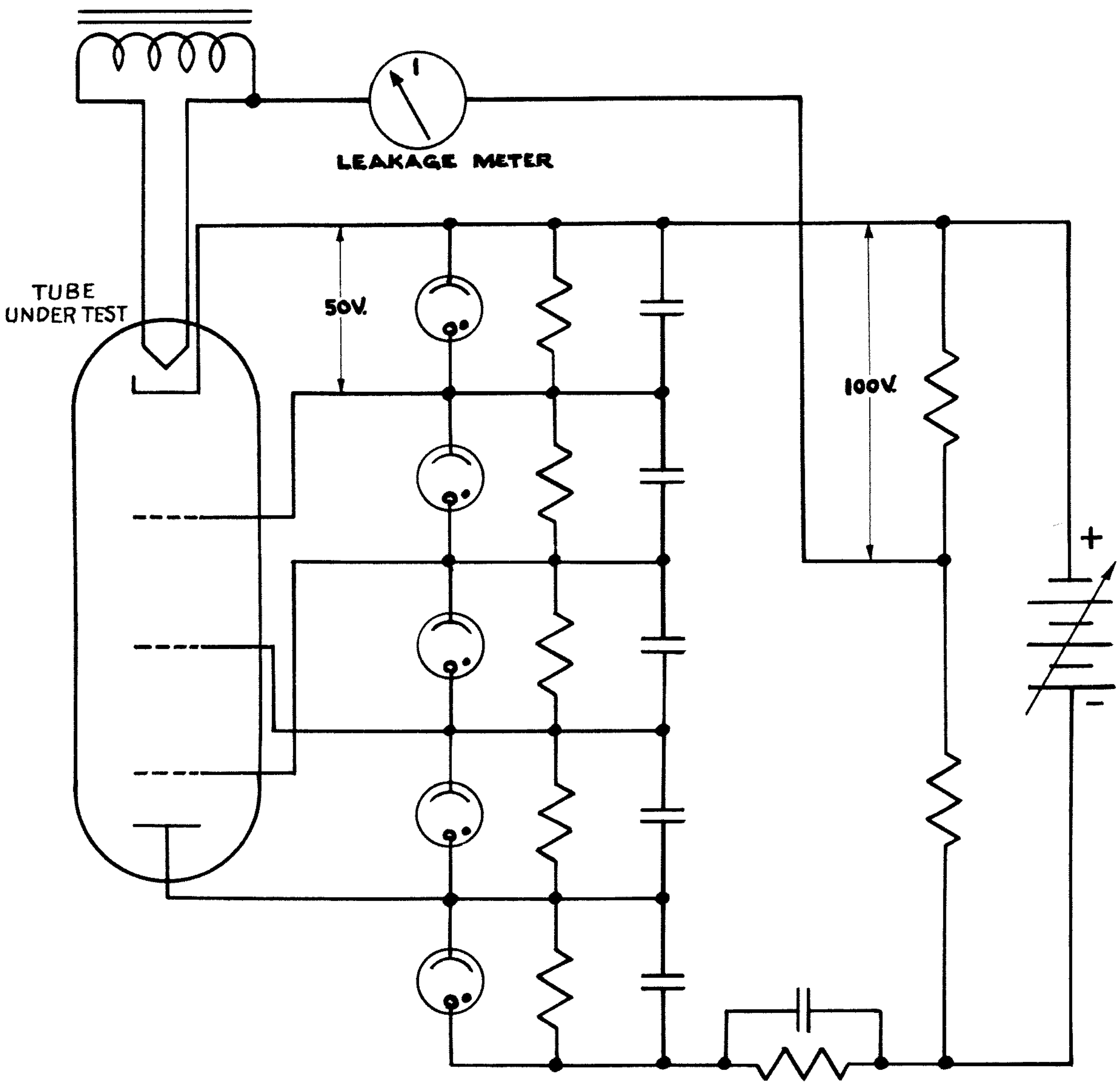


Figure 11. Shorts and Leakage Test Circuit

B. Circuit Description

5.19 For convenience the schematic circuit is divided into 3 parts. The power supply is shown on Sheet 1. Automatic circuit selection is on Sheet 2. Connections to the tube sockets, pushbuttons, shorts test and miscellaneous circuits are on Sheet 3.

5.20 The power supply, Sheet 1, has two transformers (filament and power) which supply the various voltages required. These transformers have a relay circuit for protection against overloads. The relay is mechanically latched when the ON switch is pressed. A separate OFF button unlatches it electrically. The relay has three windings, one for overloads in the Power transformer primary, one for overloads in the power transformer secondary and a third for meter protection. The meter has contacts at both the high and low ends of its scale. A heavy overload in either direction will close one of the contacts and trip the protective relay. The third relay coil just mentioned as the meter protection coil is also used to unlatch the relay when the OFF button is pressed.

5.21 The filament transformer is protected by a 100 watt electric light bulb in series with the relay circuit. This lamp functions as a non-linear resistance network to assure that the filament drain never exceeds 20 watts. When a direct short circuit is applied to the secondary of this transformer the lamp absorbs the overload.

5.22 The filament transformer supplies ac voltages for tubes under test. These voltages are reduced 10% through a switch in the primary winding for cathode activity tests.

5.23 The filament transformer primary also has a selector switch that is used to compensate for variations in line voltage over a range of 97.5 to 125 volts. This switch may be used for critical tests or for tubes having heavy filament drains. However, for normal tests it is left at the 115 volt point.

5.24 The tester has three operational B+ supplies which are: the main B+, auxiliary B+ and unregulated B+. The main B+ is used as the plate and screen supply for the tube under test. Referring to the power supply schematic, the 250V taps of the power transformer supply the 5U4 rectifier which is in turn connected to the plate of the 6CD6 series regulator tube. The pentode section of the 6AW8 is an amplifier for the feedback loop which controls the grid of the 6CD6 by sensing the output voltage called for or by sensing a need for regulation because of voltage change. The triode section of the 6AW8 is a voltage reference tube to establish a constant potential at the cathode of the pentode section. The 6C4 is a low impedance control tube for the screen of the series regulator and is driven from the plate circuit of the amplifier tube. Both grids of the series regulator are being driven but the control is directly to the screen by a voltage from the 6X4 through the 6C4 control tube. The only filtering is through the screen supply from the 6X4. The output voltage from this supply is controlled by the group of resistors in series which is shown on Schematic Sheet 2. By closing various switch combinations a voltage from 10 volts to 260 volts in 10 volt steps may be selected. The current drain of the voltage selection network is constant at 1 MA.

5.25 The auxiliary B+ supply is used primarily in cold cathode tube tests but may be used for other special data requirements. It is supplied by the 6X4 rectifier with the 6CL6 being used as the series regulator. The pentode section of the 6AU8 is the loop amplifier for the feedback circuit. The circuit is manually controlled by the auxiliary B+ potentiometer. It is monitored by pressing a button and reading the tester meter. The voltage may be interpreted by multiplying the meter reading by three (the monitoring meter reads 300 volts full scale). The supply is fused and does not operate through the protective relay circuit. The supply is variable from 10 volts to 300 volts at currents up to 30 MA.

5.26 The unregulated B+ is obtained from the cathode of the 5U4 through a simple filter. It provides approximately 350 volts which varies with line and load. It is used in tests where the voltage is immaterial but a high current is desired. An example of this would be in a high emission "knee" test of a pulse power pentode.

5.27 The tester has a low current regulated positive supply of approximately 150 volts which has four uses as follows: a positive reference grid supply, a voltage for turning off the tester, supplies part of the shorts test and part of the heater to cathode leakage test circuits. It is derived from the 6X4 through the 6AU8 triode connected as a shunt regulator. A feedback system of neon lamps establishes the +150 volts. The positive reference is taken off a resistive network from 0 volts to +150 volts. This supply can be used as a reference voltage for the grid of a tube under test. It allows the use of larger self bias resistance while the equivalent tube bias is still negative.

5.28 The negative 150 volt supply is stabilized and is the basic reference voltage for all other regulator supplies. It forms the negative potential for the shorts test and heater to cathode leakage test circuits and is also used as the bias supply. It is derived from 275 volts each side of the center tap and through rectifiers CR101 and CR102. The OA2 shunt regulator controls the negative supply and is the voltage reference for all regulated supplies.

5.29 The fixed bias supply, for tubes under test, is obtained directly across the OA2 tube. It has a range of 0.1 volt to 100V in approximately 0.1 volt steps by using a decade resistor system which is shown on Schematic Sheet 2.

5.30 The bias off supply is similar to the fixed bias supply. It is used to hold off a section of a tube while another section is being tested. An example of its use would be for testing a pentode with common screen and common cathode.

5.31 The power supply furnishes a grid signal of 0.222 volts from the 10 volt winding of the transformer and an ac bridge type regulating circuit.

5.32 Other voltages from the power supply are:

(a) 250 volts ac used mainly for rectifier tests

(b) 10 volts ac for driving the transconductance bridge

(c) Filament supplies for tubes within the power supply.

5.33 The secondary of the transformer which supplies voltages to the filaments of tubes under test is shown on Schematic Sheet 2. These voltages may be varied from 0.1 volt to 119.9 volts in 0.1 volt steps. Sheet 2 also shows a full wave bridge rectifier which supplies up to 1.0 ampere of dc for filamentary type tubes. This dc filament supply is fused and does not depend on the protective relay circuit for protection.

5.34 Referring to Schematic Sheet 2 it may be seen that it is largely composed of single pole single throw switches and resistors. These switches are labelled according to their positions in the card switch. By closing various combinations of these switches, the program card automatically selects the circuits to be used on the tube under test.

5.35 The group of switches and resistors (R215 to R229 and R231) along the bottom of the sheet form a decade resistance network. This network is used for applying the proper fixed bias to the tube under test up to 100 volts in 0.1 volt steps by closing various switches to short out unwanted resistors. This decade system has many uses other than negative grid bias. By referring to the circuit theory section it may be seen that it is used as cathode resistance in self bias tests; it is applied to both control grids in heptodes and is often used as voltage dropping resistance in other tests.

5.36 Referring again to Schematic Sheet 2 there is another group of switches and resistors

(R234 to R240) located in the lower left hand corner of the drawing. This group of switches and resistors is used to establish the output voltage of the regulated B+ supply. The following table lists the switch combinations which are closed to obtain the various output voltages:

Volts	*Close Switch*	*Volts*	*Close Switch*
10	D-17, L-3, L-4	140	B-17, L-4
20	D-17, E-17, L-4	150	B-17, E-17
30	D-17, L-4	160	B-17
40	D-17, E-17	170	L-2, L-3, L-4
50	D-17	180	L-2, E-17, L-4
60	C-17, E-17, L-3, L-4	190	L-2, L-4
70	C-17, L-3, L-4	200	L-2, E-17
80	C-17, E-17, L-4	210	L-2
90	C-17, L-4	220	L-3, L-4
100	C-17, E-17	230	E-17, L-4
110	C-17	240	L-4
120	B-17, L-3, L-4	250	E-17
130	B-17, E-17, L-4	260	None

5.37 The switches and resistors (R203 to R205) are used as shunts to the meter for establishing sensitivity of the leakage test.

5.38 The switches and resistors in the center of Schematic Sheet 2, are used as shunts and multipliers for the meter when used in the quality test. These shunts and multipliers make it possible to provide broad ranges of sensitivities as discussed in the section on circuit theory.

5.39 The group of components near the center of Schematic Sheet 2 form the Gm bridge circuit. For purposes of analyzing this circuit consider the meter and its shunts connected across condensers C401 and C402 and a 10 volt transformer winding connected across C403. The transformer winding acts as a bias source to alternately turn on diodes CR401 and CR403 while turning off diodes CR402 and CR404 and vice versa. By this action all the DC current that enters the bottom end of the bridge is chopped into alternating current, sent through the meter and its shunts, and put back together again into a DC current as it flows out of the top of the bridge. The meter, which is a direct current average reading device, will respond to the difference in the magnitude of the two alternating current pulses. By modulating the grid of the tube under test with an AC signal of the same phase relationship as the 10 volt bias winding in the bridge, these two current pulses will be of different magnitude and the meter can be calibrated directly in micromhos inasmuch as it is responding to a minute change in plate current with minute change in grid voltage which is by definition, transconductance. The resistor network, consisting of R402 to R406, is of a high impedance nature and is used to balance out the back resistance characteristics of the diodes. Potentiometer R405 is then called Gm balance low current. Potentiometer R401 is of very low value and is in series with the diodes. This potentiometer is called Gm balance high current and is used to balance the bridge for the forward characteristic of the diodes at a high current. This circuit is separately fused in order to prevent damage to the bridge under certain short circuit conditions that cannot be sensed by the relay protection circuit.

5.40 The rest of the contact groups appearing on Schematic Sheet 2 are used to establish the test configuration and to control miscellaneous other circuits.

5.41 Sheet 3 of the schematic circuit drawing contains a group of card switch contacts which provide connections to the pins of the tube under test. The short, leakage and gas test circuits are shown on this figure but are completely described in 5.16, 5.17 and 5.18. The remainder of sheet 3 consists of the push button and meter circuits. It should be noted that when button 3 (GAS) is pressed it also actuates button 2 (QUALITY). This maintains normal operating conditions on the tube but switches the meter to the grid circuit.

6. MAINTENANCE

A. General

6.01 Most maintenance on this equipment can be accomplished with the aid of the Routine Calibration Procedure, the Complete Calibration Procedure, the Trouble Shooting Procedure, and the Voltage and Resistance Chart. All these procedures make use of test cards normally stored in the card case.

B. Complete Calibration

6.02 Perform the Routine Calibration Procedure as listed in section 3. Then proceed as follows:

6.03 Signal Adjustments:

a. Connect the tube tester to the power line thru a Variac set to 115 volts. See figure 12. Turn the instrument on.

Insert Card 11, SIG. REG. AND AMPL, into the Card Switch. Connect a high impedance, sensitive AC voltmeter from pin 3 to pin 6 on any convenient socket. NOTE: THIS MUST BE A HIGH IMPEDANCE AC VACUUM TUBE VOLTMETER, CAPABLE OF ACCURATE MEASUREMENT OF 0.222 VOLTS RMS. BALLANTINE MODEL 300 OR EQUIVALENT IS RECOMMENDED.

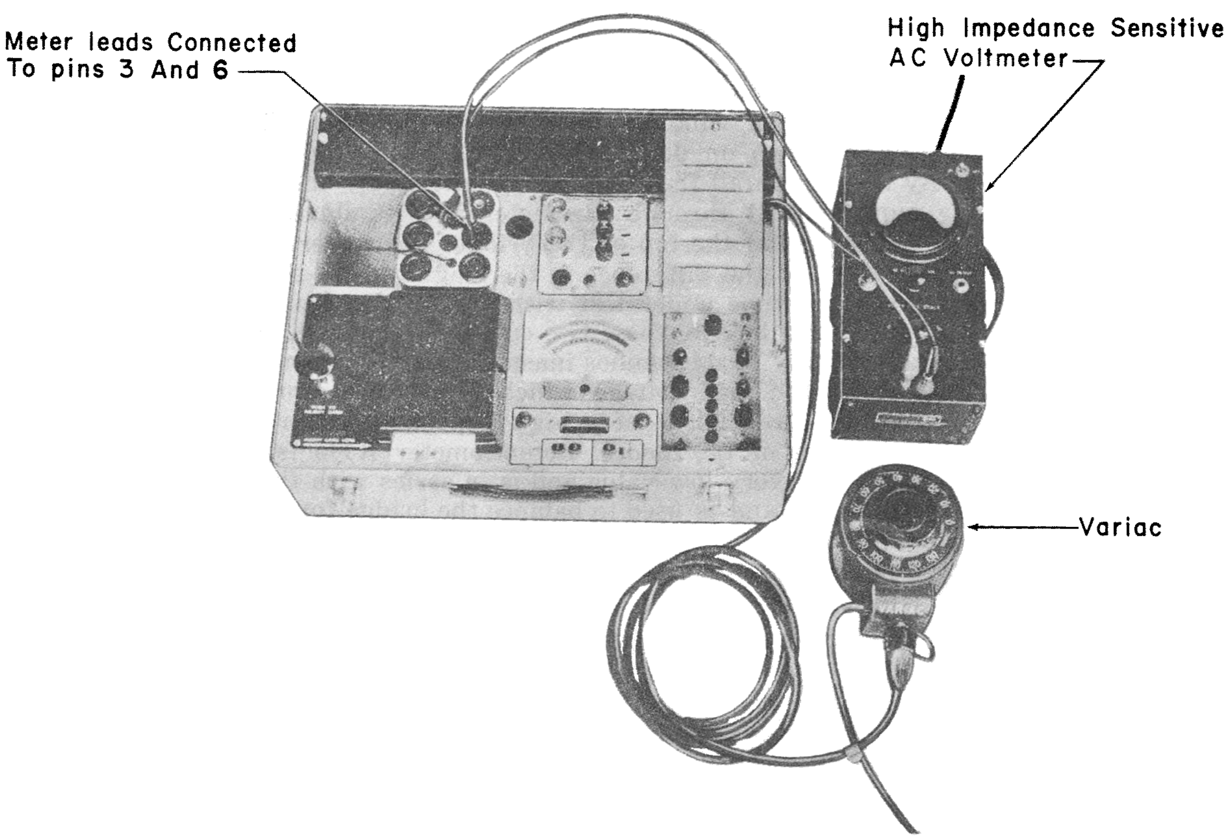


Figure 12. Signal Regulation and Amplitude Check

b. While holding down button 2, vary the line voltage from 105 to 125 volts. Note reading indicated on the vacuum tube voltmeter. The indicated voltage at 105 and 125 should be identical and should not vary more than 1% from the indicated voltage at 115 volts line. If the circuit is not regulating as specified, adjust the SIGNAL CAL REGULATION control and vary the line voltage to attain the desired regulation.

c. After the signal regulation is properly adjusted, set the exact signal level of 0.222 volts rms by adjusting the SIGNAL CAL AMPLITUDE control.

6.04 Filament Standardization Adjust.

a. Method One.

Connect the instrument to the power line thru a Variac. Turn instrument on. Monitor the voltage delivered to the instrument with an AC voltmeter and adjust the Variac to deliver 115 V RMS.

Insert Card 12, FIL STD ADJUST.

Set the FILAMENT STD ADJ located in the auxiliary control compartment, to the NOM 115V position (white dot on knob lines up with dot on panel).

Press the FILAMENT STD ADJ push button. The meter should read half scale ±1 scale division.

If correction is necessary adjust the FILAMENT STD *CAL* control located in the upper right corner of the control compartment, for proper indication.

b. Method Two.

Connect the instrument to the power line and turn it on. Connect an AC voltmeter capable of accurately measuring 5 volts RMS to pins 3 and 6 on any convenient tube socket. (The Ballantine Model 300 or equivalent used for signal adjustments can also be used for this measurement.) See Figure 12.

Insert Card 12, FIL. STD ADJ. into switch.

Set the FILAMENT STD ADJ. knob so that the external AC voltmeter indicates 5 volts. Press the FILAMENT STD ADJ. push button. The tester meter should read half-scale ±1 division.

If correction is necessary adjust the FILAMENT STD *CAL* control, located in the upper right corner of the control compartment, for proper indication.

6.05 Main B+ Power Supply.

a. Feedback current adjust:

Remove the black perforated cover over the power supply tubes. Remove the 6CD6GA, V103, and the 6AW8A, V105, from their sockets. See Figure 13. Insert Card 13, FEEDBACK B PLUS.

WARNING: BE SURE TUBES ARE REMOVED BEFORE INSERTING CARD 13.

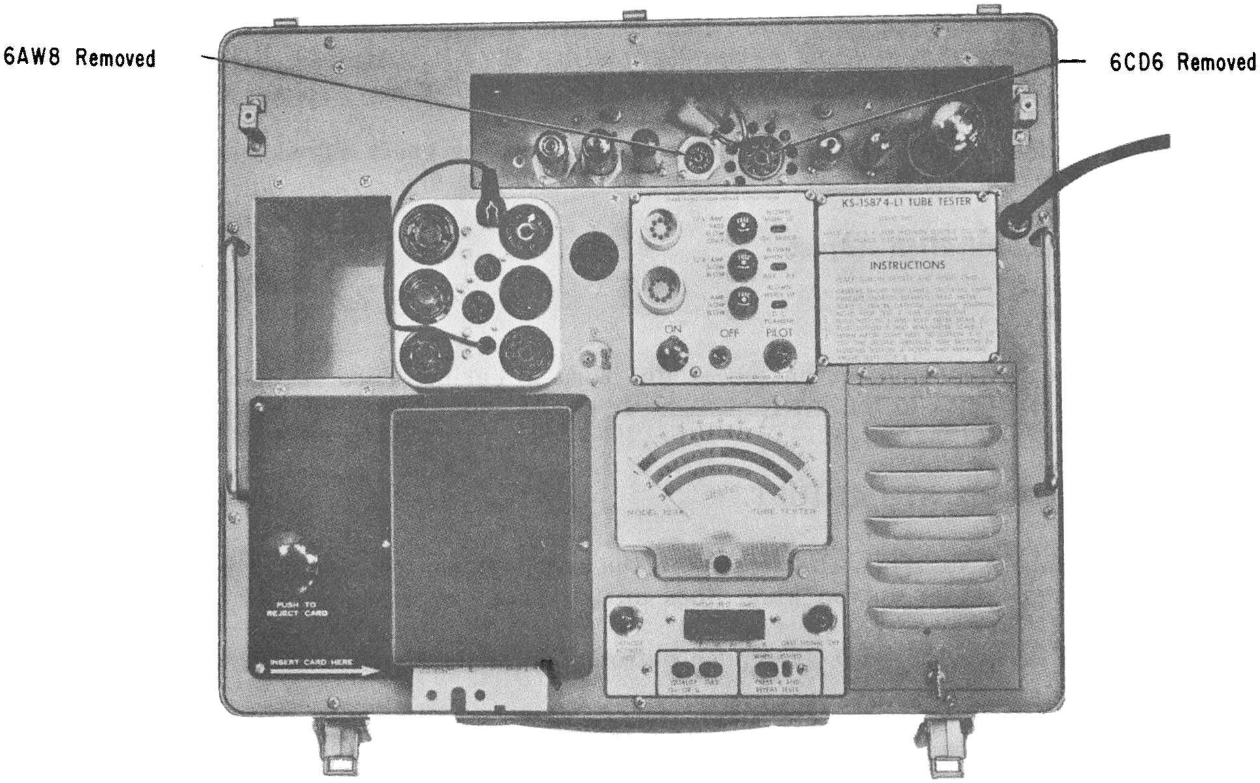


Figure 13. B+ Power Supply Feedback Current Test

Press button 2. The meter should read mid-scale (1 MA feedback current). If reading is not correct, adjust the FEEDBACK CAL control, R123, located on the power supply chassis, for proper indication.

After proper adjustment — REMOVE CARD 13 FROM THE CARD SWITCH BEFORE RETURNING THE 6CD6GA AND 6AW8A TO THEIR PROPER SOCKETS.

Insert Card 8, MAIN B PLUS CAL. Press button 2 and check for a mid-scale reading. Readjust the MAIN B+ CAL control if necessary.

b. Series Regulator Screen Voltage Adjustment.

Insert Card 14, 6CD6 SCRN ADJUST. Press button 2. The meter reading should be approximately mid-scale. While holding down button 2, slowly rotate the SCREEN VOLTAGE CAL control, R109, (located on the power supply chassis near the 6CD6GA) counterclockwise until the meter indication just starts to drop from its normal mid-scale position. Then turn the control clockwise just enough to restore the mid-scale reading and leave it at this setting.

C. Trouble Shooting Procedure

6.06 General.

The following procedures will aid in isolating defective parts in various circuits used in this equipment.

6.07 Main B+ Power Supply Tracking.

Insert Cards 15 thru 22 successively into the card switch. Push button 2. The meter should indicate mid-scale ±2 scale divisions in each case.

During these tests an accurate DC voltmeter (20,000 ohms per volt, Hickok Model 456, or equivalent) may be connected to pins 3 and 6 on any convenient socket as shown in Figure 14. The voltage readings on the external meter should be as follows:

Card #	*Indicated Voltage*	*Component*	
15	10	R238	10K ± 1%
16	20	R239	20K ± 1%
17	20	R240	20K ± 1%
18	60	R237	62K ± 1%
19	110	R236	52K ± 1%
20	160	R235	52K ± 1%
21	210	R234	52K ± 1%
22	260		

If the readings are not mid-scale ±2 scale divisions on the tester meter and not within 3% plus meter tolerance on the external meter, the associated resistor listed in the component column should be checked for proper value.

If the readings are improper on the tester meter while the external meter indicates proper tracking, check the meter shunts and multipliers (See Meter Circuits Checks, paragraph 6.11).

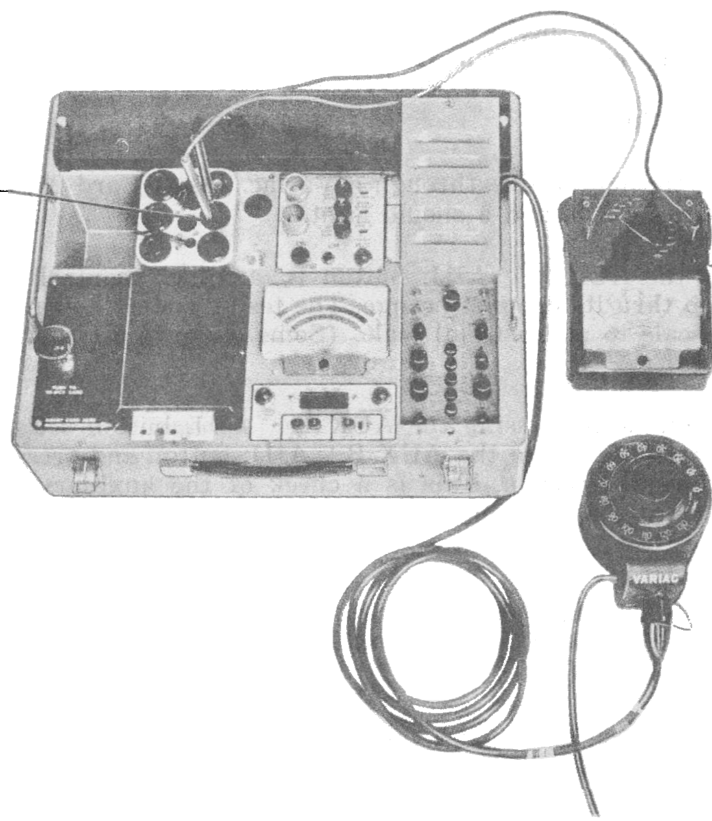


Figure 14. Checking Main B+ Power Supply With the Aid of an External Meter.

6.08 Main B+ Power Supply Regulation.

Connect the tube tester to the power line through a Variac set to 115 volts. Insert Card 23, MAIN B PLUS REG. Press button 2. The tester meter should read mid-scale ±2 scale divisions. Note the exact reading, then check the readings at 105 and 125 line voltages. These readings should not vary more than ±1 scale division for the 115 volt indication.

Reset Variac for 105 volt line. Again note reading indicated on meter (150 volts at 1.5 MA load). While holding down button 2, press button 4 (150 volts at 140 MA load). The meter indication should not vary more than 1 division from the 1.5 MA load (button 2 only) to the 140 MA load (buttons 2 and 4).

If circuits are not regulating properly check tubes V103, 6CD6GA; V105, 6AW8A, (both sections), and V108, OA2. Also check for proper voltage and resistance values as listed in the Power Supply Voltage and Resistance chart, (Figure 21).

6.09 D.C. Filament-Cath. Activity Checks.

Insert Card 24, DC FIL-CATH ACT, into card switch. The left short lamp should light.

Standardize the filament supply with the FILAMENT STD. ADJ.

Press button 2. The meter should read mid-scale ±3 scale divisions.

If reading is out of tolerance check the D.C. filament rectifiers CR-201, CR-202, CR-203, and CR-204.

Hold down button 2 and press the CATH ACT switch located in the auxiliary control compartment. The meter reading should drop 5 scale divisions.

6.10 Auxiliary B+ Power Supply.

Connect the tester to the power line through a Variac. Insert Card 25, AUX B PLUS REG, in card switch. Short lamps 1, 2, 3, and 5 should light.

Supply Range: Press the AUX B+ ADJ. button in auxiliary control compartment. Rotate the associated control knob thru its complete range. The tester meter indication should vary from approximately 10 on the scale to at least full scale. (Some overswing is permissible at both ends of the control adjustment).

Voltmeter Circuit: While still pressing the AUX B+ ADJ. button set the control to give a mid-scale reading on the meter. Release the AUX B+ ADJ. button and press button 2. The meter should read mid-scale ±1 scale division. This is a check of the auxiliary B+ supply metering circuit which is separate from the main metering circuits. If the reading is out of tolerance, check R-320, 3 megohm ±1%.

Line Regulation: While holding down button 2 vary the line voltage from 115 to 125 then to 105. The meter readings at 105 and 125 volts should not vary more than ±3 scale divisions from the reading at 115 volts line.

Load Regulation: Set line voltage at 105 volts. Push button 2. Note the reading on the meter (it should still be at mid-scale, from the previous steps). This is a 150 volt indication at a low output current. While holding button 2, press button 4. The meter will indicate the output voltage with rated output current being drawn from the supply. The deviation between the two readings should not exceed ±3 scale divisions.

If indications during the above tests are not proper, check V106, 6X4; V104, 6CL6; and V107B, 6AU8 pentode section. Also check voltage and resistances at tube sockets against values listed in the voltage and resistance chart.

If desired a 20,000 ohms per volt meter (Hickok Model 456 or equivalent) may be connected from pin 3 (+) to pin 6 (—) on any convenient socket to externally monitor the same output voltage being measured on the tester meter.

6.11 Meter Circuit Checks.

The first test in Routine Calibration, together with the Trouble Shooting procedure listed below, form complete tests of the basic meter sensitivity, the meter shunts and the meter multipliers.

Each of these tests is designed to check a particular "primary component". However, additional components are also used in the test circuit and are "secondary components" in each test.

The following table lists the test card number, function, the primary component number and values, and the secondary components involved. When a number of tests give improper readings a comparison of the primary and secondary components involved will help isolate the defective part. Questionable parts can then be checked with a resistance bridge or an accurate ohmmeter. In each of the following tests insert the proper card in the switch press button 2. The meter should read mid-scale ±2 scale divisions.

Card No.	*Primary Component*	*Secondary Components*
	Meter Shunts	
26	R207, 1280Ω ± 1%	R206, R215, R216, R218, R226, R270, R241
27	R208, 640Ω ± 1%	R206, R216, R219, R223, R224, R225
28	R209, 320Ω ± 1%	R206, R217, R220, R222, R223
29	R210, 160Ω ± 1%	R206, R216, R221, R225
30	R211, 80Ω ± 1%	R206, R215, R216, R219, R226
31	R212, 40Ω ± 1%	R206, R215, R216, R218, R220, R221
32	R213, 20Ω ± 1%	R206, R216, R219, R223, R225, R241
33	R214, 10Ω ± 1%	R206, R219, R224, R241
	Meter Multipliers	
34	R206, 25, 344Ω ± 1%	
35	R241, 1067Ω ± 1%	R206
36	R230, 100K ± 1%	

6.12 Decade Resistor Checks.

The following tests are similar to the Meter Circuit checks listed above except that the decade resistors are the "Primary Components". The "Secondary Components" involved are also listed.

a. Procedure for test cards 37 through 40:

Insert proper card into card switch, the left three short lamps should light. Press the FILAMENT STD ADJ. push button and set FILAMENT STD ADJ switch for mid-scale indication on the tester meter. Press button 2, meter should read mid-scale ±2 scale divisions.

Card No.	*Primary Component*	*Secondary Components*
37	R218, 10Ω± 1%	R206, R210, R213, R214
38	R217, 20Ω± 1%	Same as card 35
39	R216, 30Ω± 1%	Same as card 35
40	R215, 40Ω± 1%	Same as card 35

b. Procedure for test cards 41 and 42:

Insert proper test card into card switch. The left three short lamps should light. Press the FILAMENT STD ADJ push button and set FILAMENT STD ADJ switch for mid-scale indication on the tester meter. Press button 2, adjust the HI Ib Gm BAL control to indicate zero on the tester meter. Hold down button 2 and press button 4 for actual test. The tester meter should indicate mid-scale ±2 scale divisions.

Card No.	*Primary Component*	*Secondary Components*
41	R219, 100Ω± 1%	R206, R208, R209, R212, R214, R241
42	R220, 200Ω± 1%	R206, R207, R209, R210, R212, R214, R241

c. Procedure for test cards 43 through 48:

Insert proper test card. The extreme left short lamp should light. Press button 2. Read mid-scale ±2 scale divisions.

Card No.	*Primary Component*	*Secondary Components*
43	R221, 300Ω± 1%	R206, R208, R209, R210, R211, R212
44	R222, 400Ω± 1%	R206, R207, R208, R209, R210, R212
45	R226, 1000Ω± 1%	R206, R207, R208, R211
46	R225, 2000Ω± 1%	R206, R207, R208, R209, R213, R214
47	R224, 3000Ω± 1%	R206, R209, R214, R241
48	R223, 4000Ω± 1%	R206, R207, R208, R212, R213, R241

d. Procedure for test Cards 49 thru 51 is the same as above except tolerance is mid-scale ±4 scale divisons.

Card No.	*Primary Component*	*Secondary Components*
49	R227 & R231 in parallel 10K ± 5%	R207, R208, R213, R214
50	R228, 20K ± 5%	R207, R208, R209, R210, R211, R213
51	R229, 30K ± 5%	R208, R209, R210, R211, R212

6.13 Relay Checks: Insert test Card 52, RELAY NO GO Short lamps 1, 2, and 3 should light. Press button 2. The overload relay ("ON" switch) should not "kick out". During this test a large but not excessive current is drawn. The relay should hold. If the relay "kicks out" it is too sensitive. Readjust the relay sensitivity as directed in the Relay Adjustment Procedure.

Insert Card 53, RELAY DC GO. Short lamps 1, 2, and 3 should light. Press button 2. The overload relay should "kick out" turning off the tester. During this test an excessive current is drawn by the tester. If the tester does not turn off, release button 2 and follow the Relay Adjustment Procedure (paragraph 6.14).

Insert Card 54, RELAY AC GO. Short lamp 1 only should light. Press button 2. The overload relay should "kick out" and turn off the tester. If the relay does not turn off, follow the same procedure as for Card 53.

D. Miscellaneous Adjustment Procedures

6.14 Relay Adjustment Procedure.

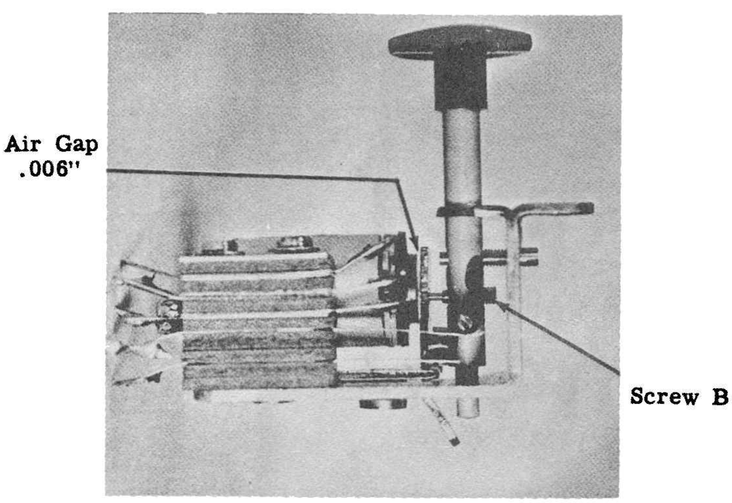


Figure 15. Relay in "up" position.

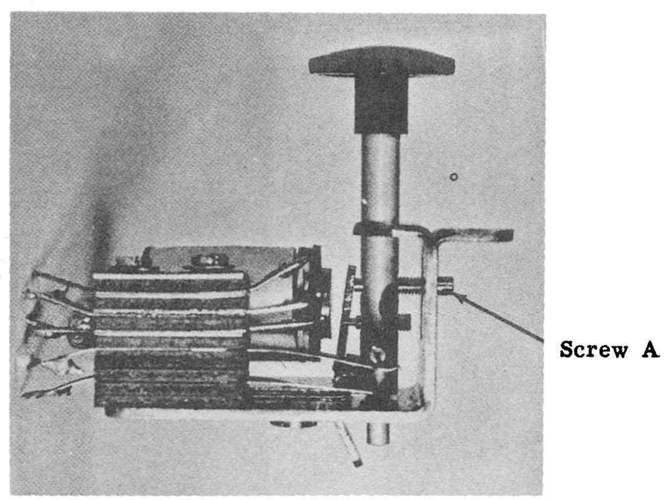


Figure 16. Relay in "down" position.

a. Mechanical Adjustment:

With the relay up, check that the air gap is set to .006 inches by use of proper feeler gages. (See Figure 15). Air gap can be reset by adjusting lower screw "B". The glyptal sealing the adjusting screw should be softened with thinner before resetting. The screw should be resealed with glyptal after adjustment.

With the relay in the down (engaged) position, check that the end of the lower screw "B", is in line with the inside edge of the armature. Any required adjustment is accomplished with the upper screw "A". Soften glyptal with thinner before adjustment and reseal with glyptal after adjustment as before. (See Figure 16).

b. Electrical Adjustment:

Disconnect the plug to the power supply chassis. Connect a temporary short circuit between terminals A & B of the female section of this plug. (See the plug drawing on the power supply schematic diagram for location of plug terminals A and B.)

Connect the line cord in series with a 0-5 amp ac ammeter to a variable source of low voltage ac. This source can be a Variac or preferably a Variac in the primary of a step down transformer. A filament transformer is suitable for this purpose.

Slowly increase the current to the tube tester by raising the output voltage from the Variac. The overload relay should "kick out" between 3.2 and 3.4 amps ac. If the relay kicks out below 3.2 amps ac, increase the tension on the spring by turning lug "C", Figure 17. Recheck and readjust spring tension until relay kicks out within proper limits.

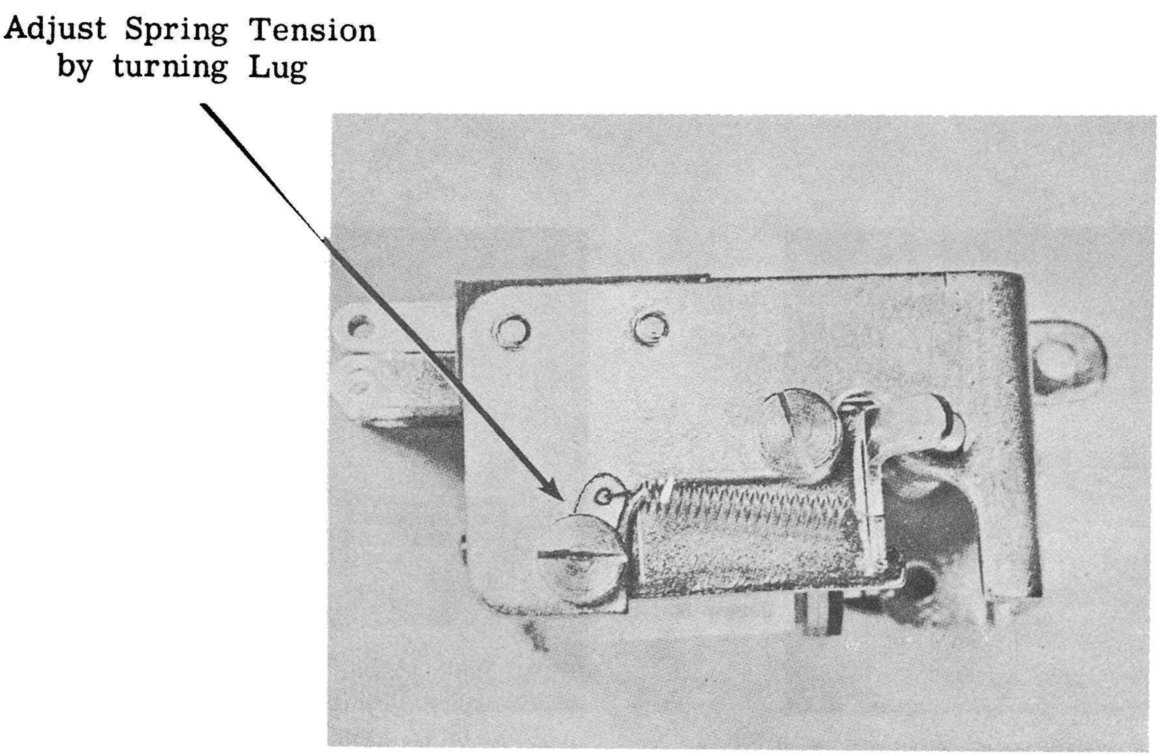


Figure 17. Bottom View Relay

If the relay kicks out above 3.4 amps ac, decrease tension on the spring by turning the lug until desired setting is reached.

Be sure to lock spring adjustment with glyptal after resetting.

6.15 Adjustment of Upper Micro Switch.

The microswitch is adjusted at the factory prior to shipment, consequently adjustment should not be attempted unless absolutely necessary. There are two ways in which to properly adjust the micro switch. The first procedure requires two 1/8" diameter pins, but is more accurate than the second procedure.

WARNING

Line voltage is present across upper micro switch terminals. Disconnect line cord from power source before adjustment.

a. First Procedure:

1. Remove card switch cover and insert non-test code card into card switch.

2. Insert two .125 inch diameter (1/8 inch diameter) pins or drill shanks into the switch plate holes A-1 and L-1 to retain the code card. (See Figure 18).

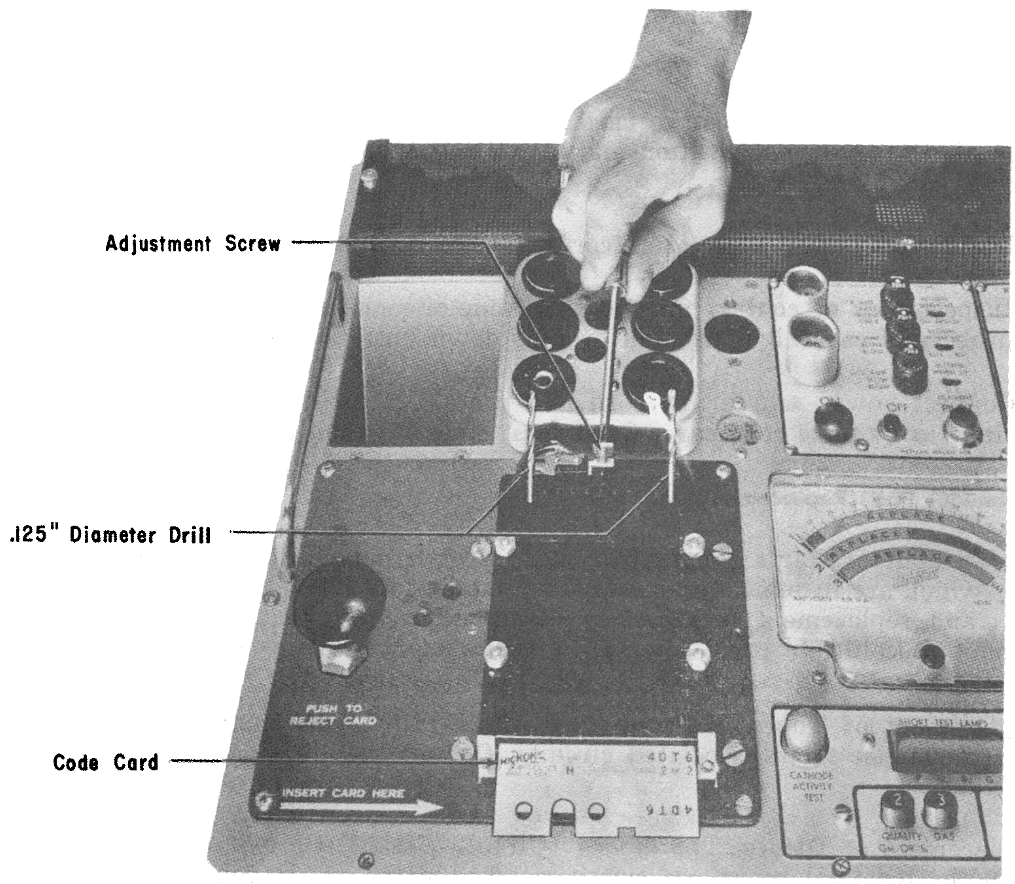


Figure 18. Adjustment of Upper Micro Switch

3. Gently pull on the code card to remove all clearance between the two pins and holes A-1 and L-1 in the code card.

4. Adjust the micro switch inward (toward the card switch) with the adjustment screw

(see Figure 18) until the micro switch actuates (an audible CLICK can be heard).

5. Reverse direction of the adjustment screw and move the micro switch out until it de-actuates (an audible CLICK will be heard). Approximately ½ turn of the adjustment screw will be necessary to de-activate a properly operating microswitch.

6. Connect tester to power source and press ON switch. Retest the action of the switch with the code card. Replace the card switch cover.

b. Second Procedure:

1. Remove card switch cover and insert code card into card switch.

2. Observe the code card holes through the row 1 holes in the top switch plate. The code card material should just disappear (.005 inch) at the top of the row 1 switch plate holes when the micro switch actuates (an audible CLICK will be heard). If adjustment is necessary, turn the adjustment screw. (See Figure 18) until alignment is correct.

3. Connect the tester to power source and press ON switch. Retest the action of the switch with the code card. Replace the card switch cover.

6.16 Adjustment of Contact Pins.

If code card will not come out of card switch when reject knob is pressed, a contact pin has moved above its normal position and is projecting through a hole in code card. Correct as follows:

a. Disconnect power source line cord. Remove switch cover.

b. Inspect tops of contact pins to see if one or more has moved above normal position. Use probe and carefully push pin or pins down until they clear code card.

c. Connect power source line cord and press ON switch. Reactivate card switch several times with same code card. Card must slide out each time reject knob is pressed.

E. Miscellaneous Parts Replacement

6.17 Replacement of Parts. The replacement instructions contained herein are limited to high mortality parts which are in some way unusual in installation. When trouble shooting procedures reveal defective parts and replacement is necessary, every effort must be made to duplicate original condition of equipment. Recalibrate tube tester after replacement of parts to assure accuracy of tube test readings.

6.18 Replacement of Tubes. Exercise care when removing or installing electron tubes to assure high quality performance from associated circuits. Observe handling precautions which are common to all vacuum tubes.

6.19 Replacement of Diodes. The diodes (CR401, CR402, CR403 and CR404 Schematic Sheet 2), mounted on the terminal board are either matched pairs or all four are matched together and must be replaced as matched units. They shall be physically mounted in the same manner as those which are removed. Note direction of arrow printed on diodes and position replacement part in identical relationship to terminals.

C A U T I O N

Do not overheat diodes during soldering operation. Hold lead wire with pliers positioned between diode body and point being soldered.

6.20 Replacement of Upper Micro-Switch. (See figure 19). Unsolder leads from terminals on micro-switch. Remove nuts, washers and screws securing micro-switch to bracket. Remove micro-switch. Exercise care not to lose small actuating pin in card switch. Install new micro-switch in reverse order of removal procedure.

6.21 Replacement of Lower Micro Switch. Remove screws and spacers securing terminal board to card switch. Lift terminal board away from card switch to gain access to lower micro switch. Unsolder leads to micro switch terminals. Remove nuts, washers, screws and defective micro switch. Position new micro switch in place and install it in reverse order of removal procedure. Check to see that switch actuating screw engages micro switch as required when card-reject knob is pressed. If adjustment is required, loosen lock nut, make adjustment, and retighten lock nut.

6.22 Replacement of Card Switch Solenoid. (See Figure 20). Unsolder leads to terminals on solenoid. Disengage spring from clip on plunger and remove cotter pin and clip. Remove screws from face of panel and disengage solenoid from solenoid actuating arm. Install new solenoid and reconnect associated parts in the reverse order of removal.

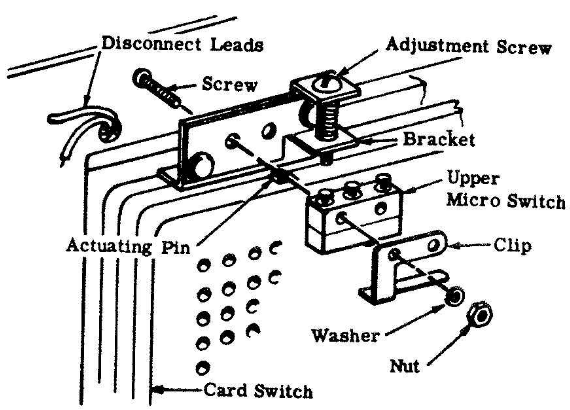


Figure 19. Replacement of Upper Micro Switch

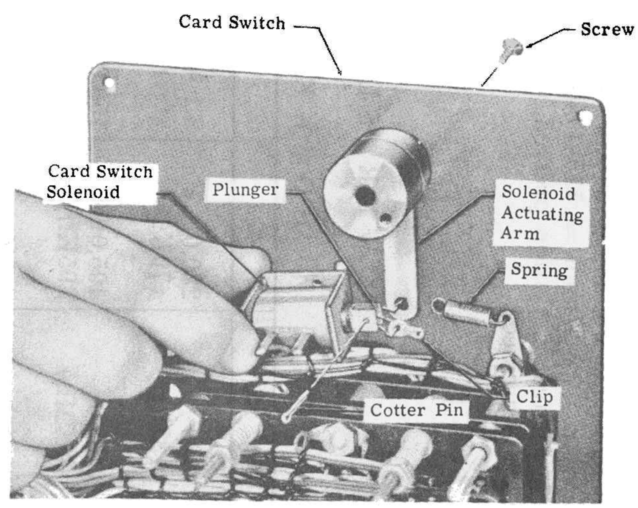


Figure 20. Replacing Card Switch Solenoid

6.23 Figures 23 through 30 have been provided to aid in the location of components.

1. Voltages & Resistance at socket contacts (Power Supply) with zero volts as reference point.
2. Pin 1 of OA2 socket = Zero   Input = 115 Volts
3. Maintenance Card 23 in Switch. 2 Button pressed. Aux B+ Supply set to 150 Volts (mid-scale on meter when Aux B+ Button is pressed)

POWER SUPPLY KS-15874

SOCKET PIN NO.

TUBE	1	2	3	4	5	6	7	8	9
6AU8	0 (0Ω)	–40 (3MΩ)	230.0 (70KΩ)	3.1 AC (0Ω)	3.1 AC (0Ω)	–86.0 (40KΩ)	–87.0 (160KΩ)	–28.0 (115KΩ)	97.0 (10MΩ)
6CL6	150.0 (650KΩ)	100.0 (10MΩ)	405.0 (95KΩ)	150.0 (650KΩ)	150.0 (650KΩ)	405.0 (95KΩ)	150.0 (650KΩ)	NC	NC
OA2	0 (0Ω)	NC	NC	–150.0 (34KΩ)	NC	NC	–150.0 (34KΩ)	—	—
6AW8 A	–100 (50KΩ)	–99.0 (63KΩ)	0 (0Ω)	3.1 AC (0Ω)	3.1 AC (0Ω)	–100.0 (60KΩ)	–100.0 (70KΩ)	–55.0 (60KΩ)	121.0 (600KΩ)
6CD6 GA	NC	156.0 (80KΩ)	150.0 (80KΩ)	198.0 (450KΩ)	121.0 (580KΩ)	NC	150.0 (80KΩ)	275.0 (Infinity Ω)	—
6C4	400.0 (95KΩ)	NC	150.0 (80KΩ)	150.0 (80KΩ)	400.0 (95KΩ)	260.0 (350KΩ)	275.0 (Infinity Ω)	—	—
6X4	305.0 AC (73Ω)	NC	150.0 (660KΩ)	150.0 (660KΩ)	NC	305.0 AC (73Ω)	406.0 (100KΩ)	—	—
5U4 GB	NC	370.0 (510KΩ)	NC	260.0 AC (67Ω)	NC	260.0 AC (67Ω)	NC	370.0 (510KΩ)	—

Figure 21. Voltage and Resistance Data

CALIBRATION AND MAINTENANCE TEST CARDS

CARD	1	METER
CARD	2	SHORTS 2 MEG NO GO
CARD	3	SHORTS 1 MEG GO
CARD	4	SHORTS 20 MEG NO GO
CARD	5	SHORTS 10 MEG GO
CARD	6	FIXED BIAS CAL NEG
CARD	7	FIXED BIAS CAL POS
CARD	8	MAIN B PLUS CALIB
CARD	9	GM BAL LOW IB
CARD	10	GM BAL HI IB
CARD	11	SIG REG AND AMPL
CARD	12	FIL. STAND. ADJUST
CARD	13	FEEDBACK B PLUS
CARD	14	6CD6 SCRN ADJUST
CARD	15	MAIN B PLUS 10 V
CARD	16	MAIN B PLUS 20 V
CARD	17	MAIN B PLUS 20 V
CARD	18	MAIN B PLUS 60 V
CARD	19	MAIN B PLUS 110 V
CARD	20	MAIN B PLUS 160 V
CARD	21	MAIN B PLUS 210 V
CARD	22	MAIN B PLUS 260 V
CARD	23	MAIN B PLUS REG
CARD	24	DC FIL-CATH ACT.
CARD	25	AUX B PLUS REG.
CARD	26	METER SHUNT 1280
CARD	27	METER SHUNT 640
CARD	28	METER SHUNT 320
CARD	29	METER SHUNT 160
CARD	30	METER SHUNT 80
CARD	31	METER SHUNT 40
CARD	32	METER SHUNT 20
CARD	33	METER SHUNT 10
CARD	34	METER MULT 25344
CARD	35	METER MULT 1067
CARD	36	METER MULT 100K
CARD	37	DECADE RES. 10
CARD	38	DECADE RES. 20
CARD	39	DECADE RES. 30
CARD	40	DECADE RES. 40
CARD	41	DECADE RES. 100
CARD	42	DECADE RES. 200
CARD	43	DECADE RES. 300
CARD	44	DECADE RES. 400
CARD	45	DECADE RES. 1000
CARD	46	DECADE RES. 2000
CARD	47	DECADE RES. 3000
CARD	48	DECADE RES. 4000
CARD	49	DECADE RES. 10K
CARD	50	DECADE RES. 20K
CARD	51	DECADE RES. 30K
CARD	52	RELAY NO GO
CARD	53	RELAY DC GO
CARD	54	RELAY AC GO

Figure 22. List of Calibration & Test Cards Furnished

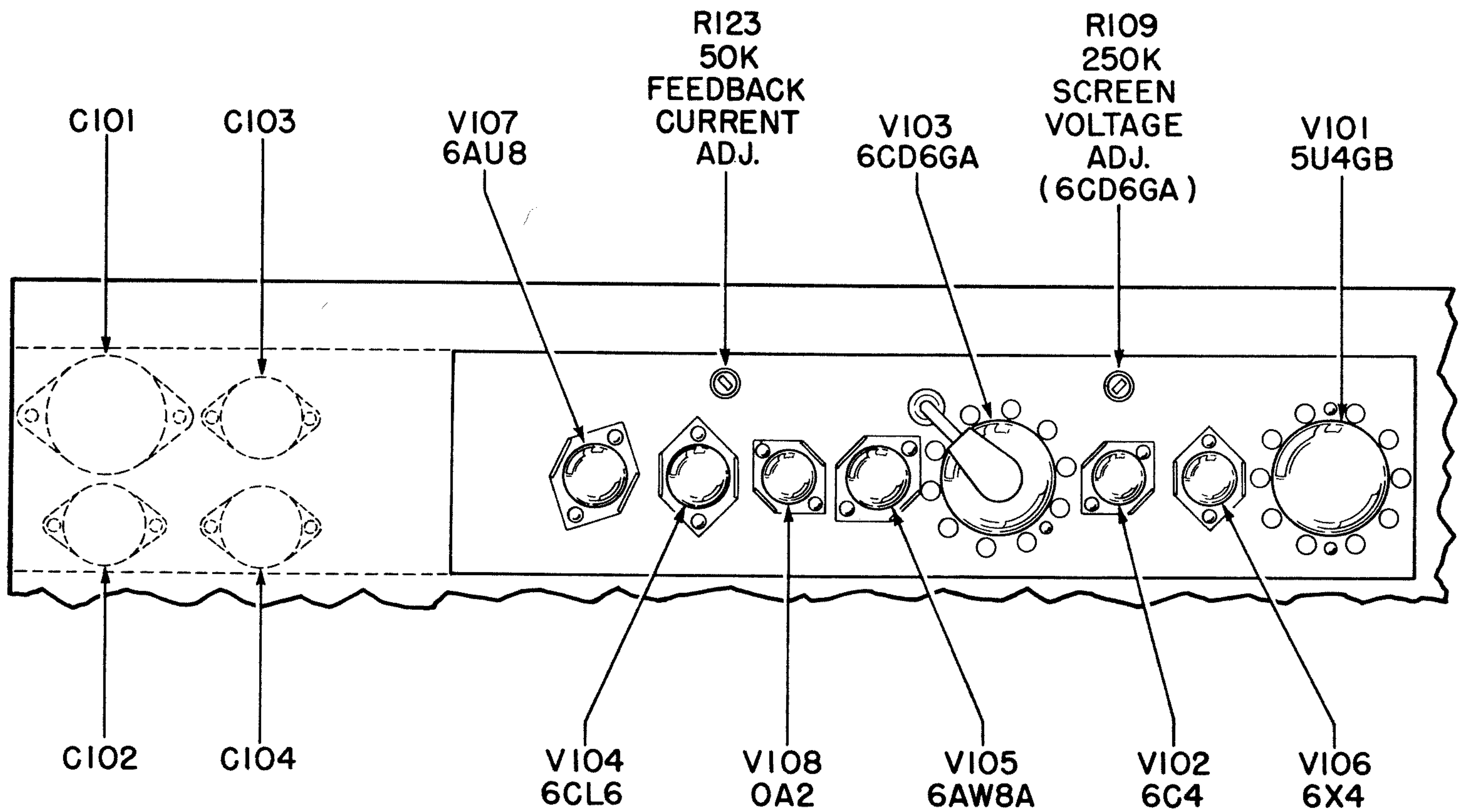


Figure 23. Placement of Tubes, Controls and Filter Condenser

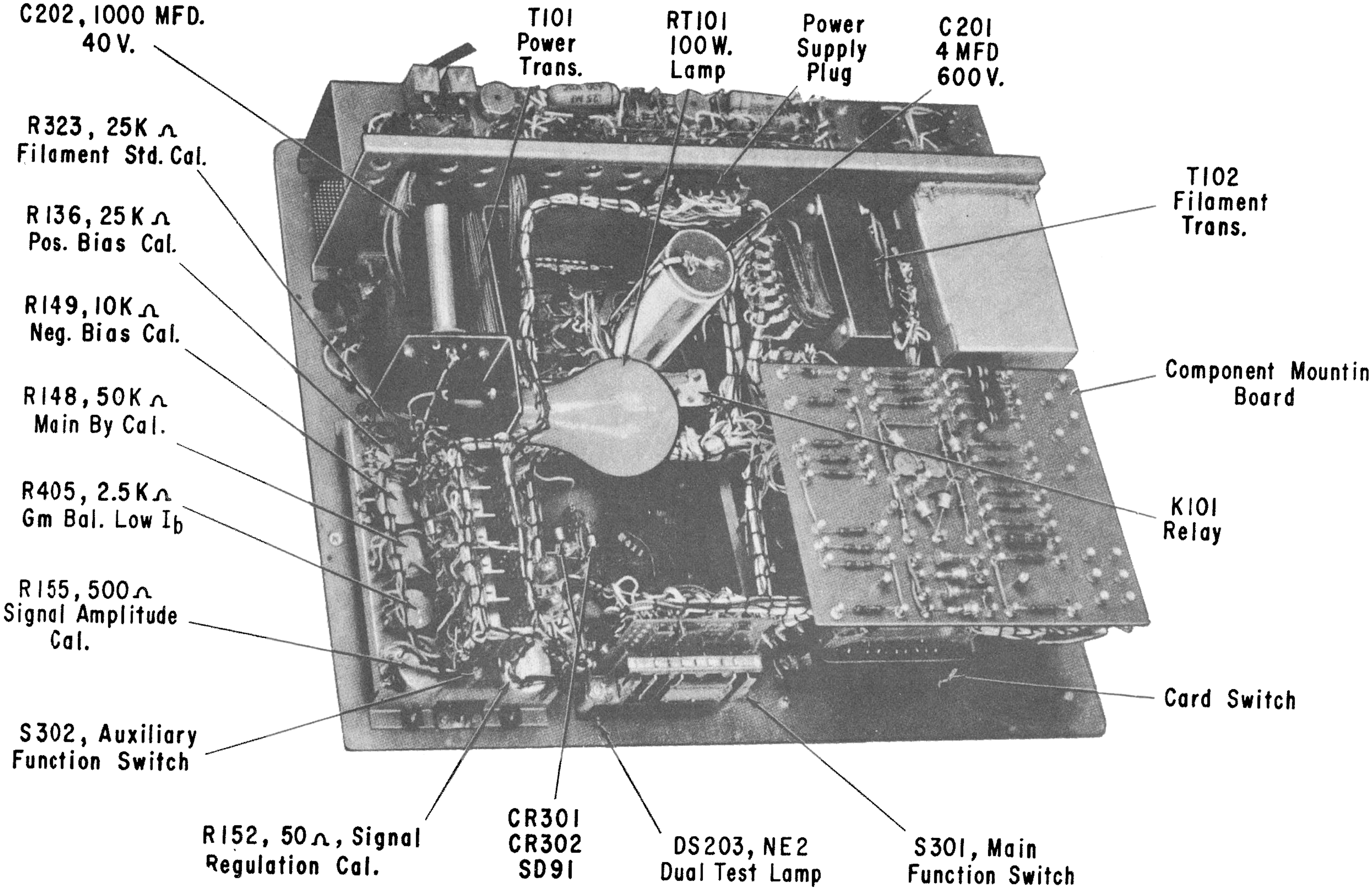


Figure 24. Assembly Identification and Miscellaneous Parts

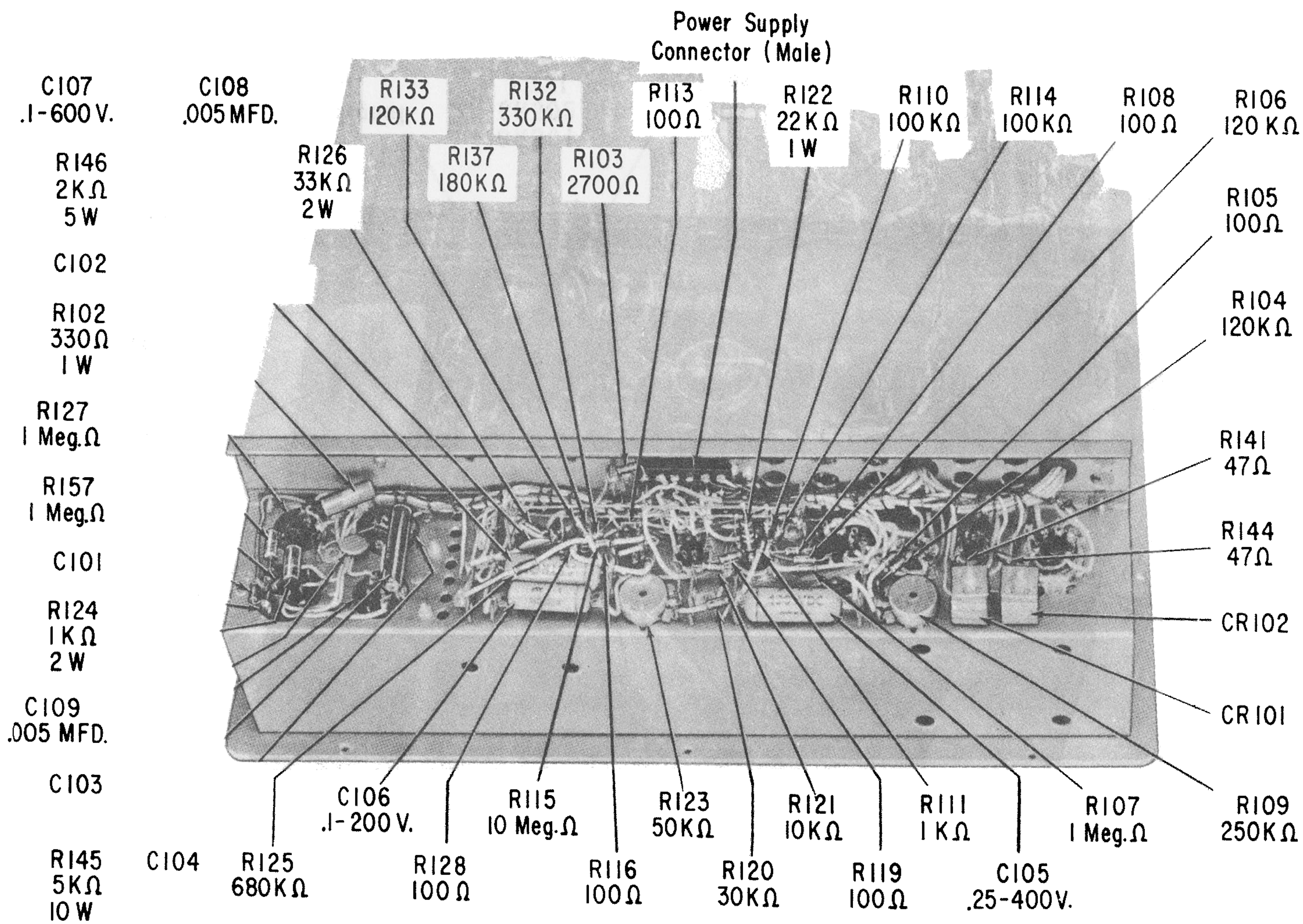


Figure 25. Power Supply Component Location

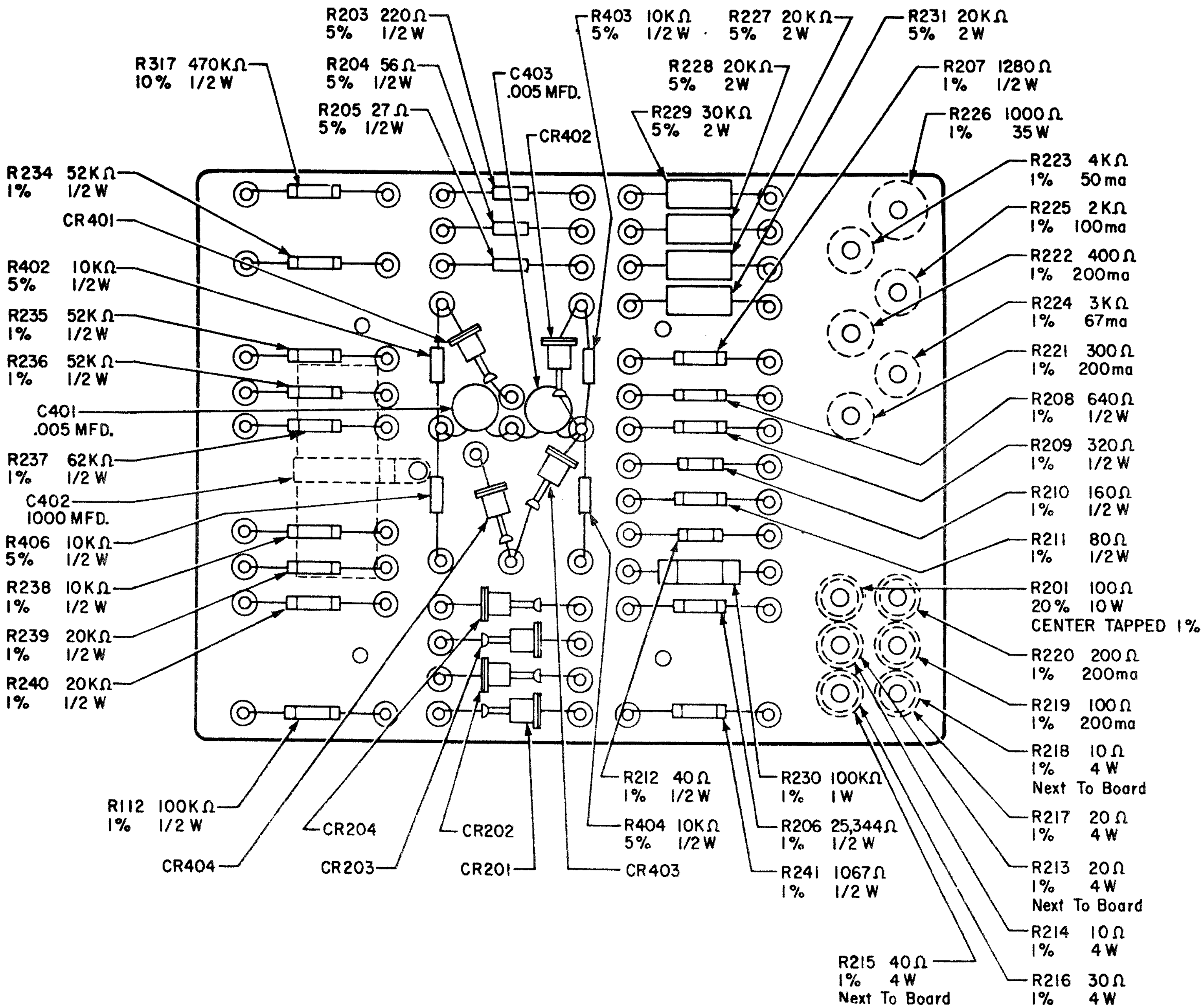


Figure 26. Component Mounting Board

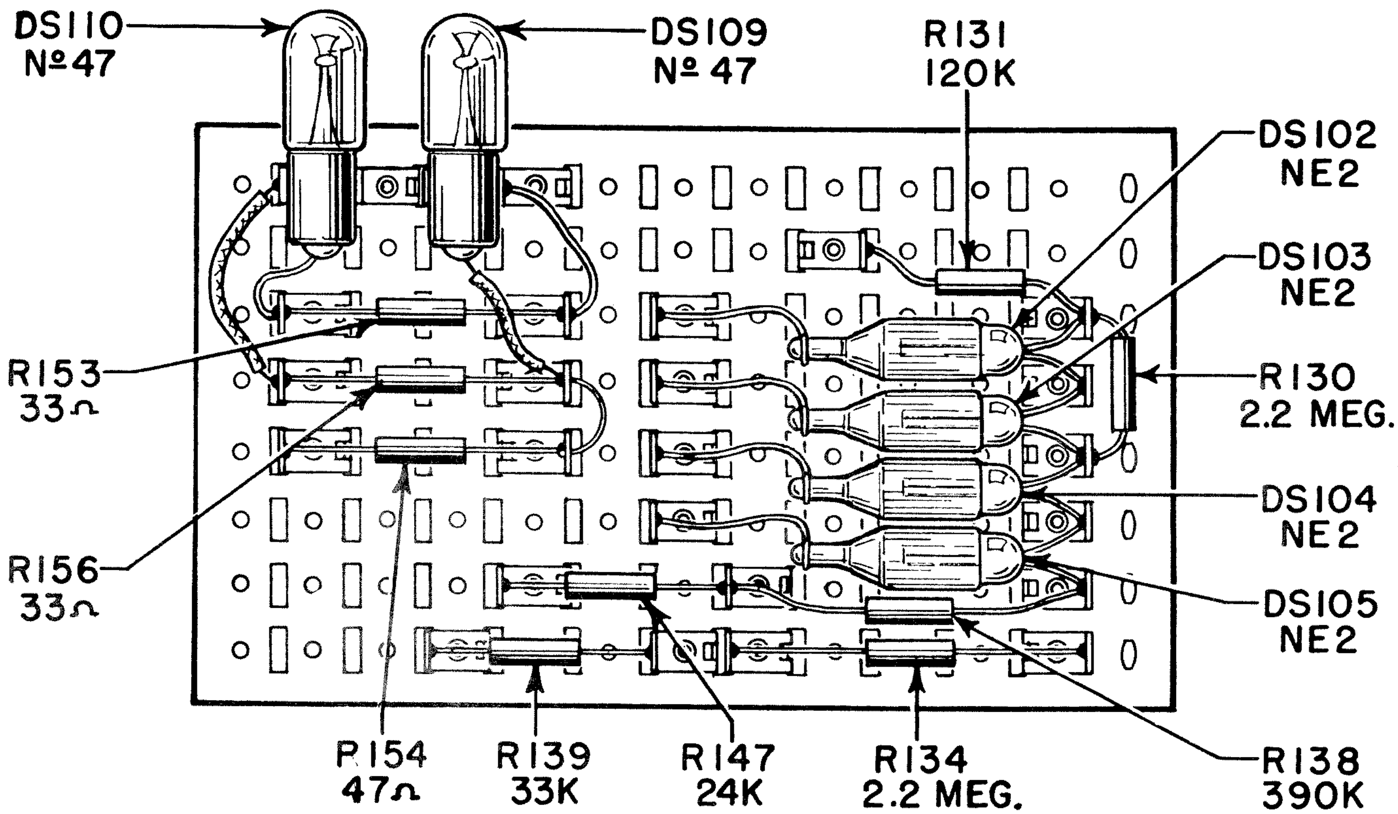


Figure 27. Auxiliary Function Switch - Inside View

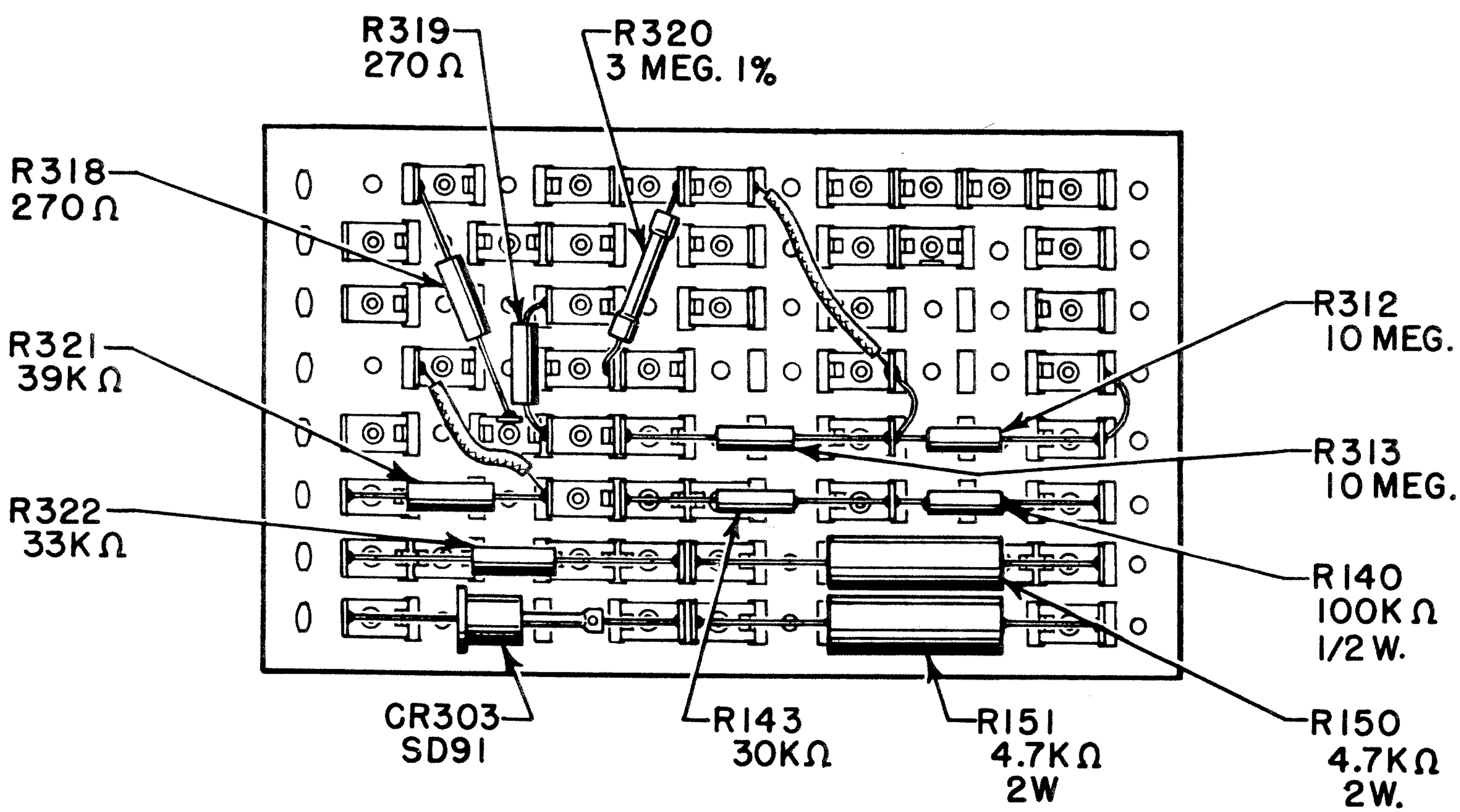


Figure 28. Auxiliary Function Switch - Outside View

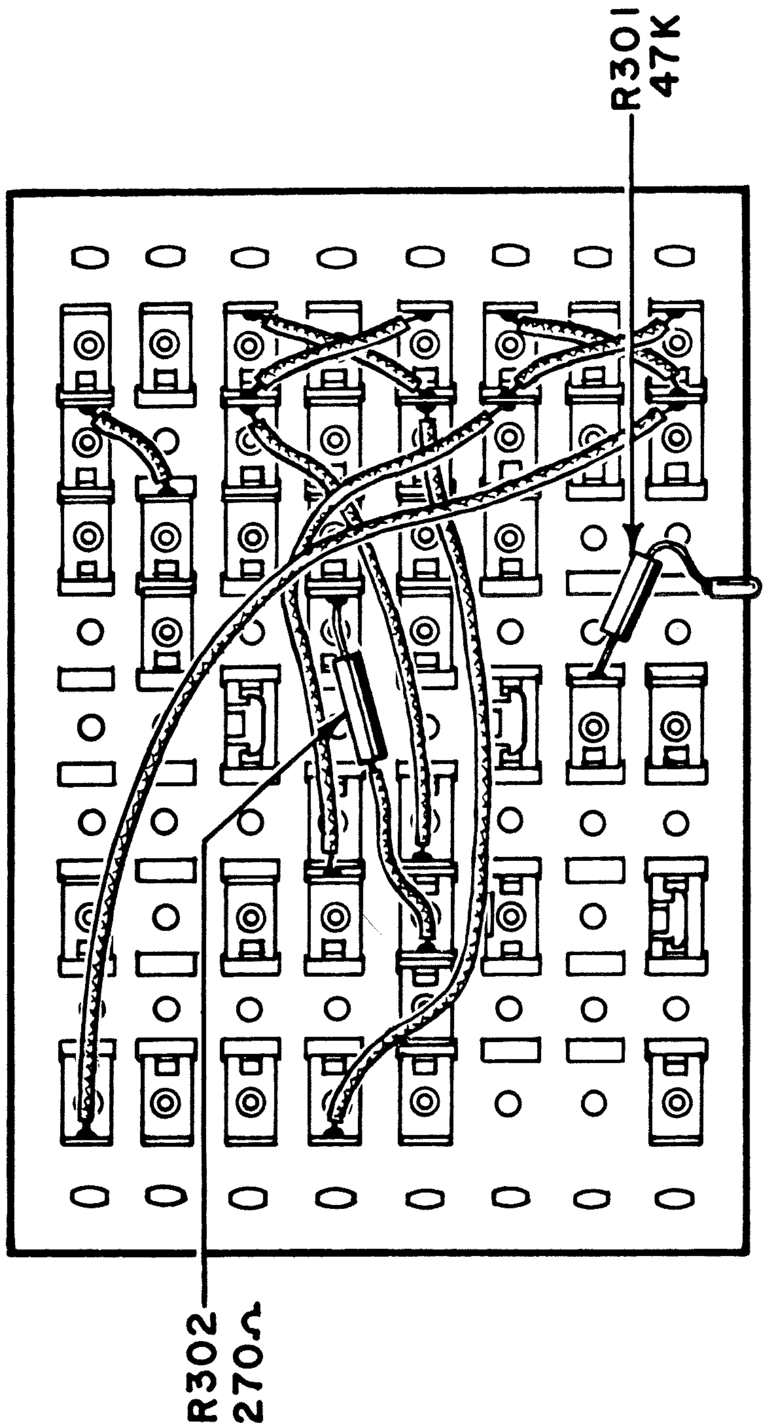


Figure 29. Main Function Switch

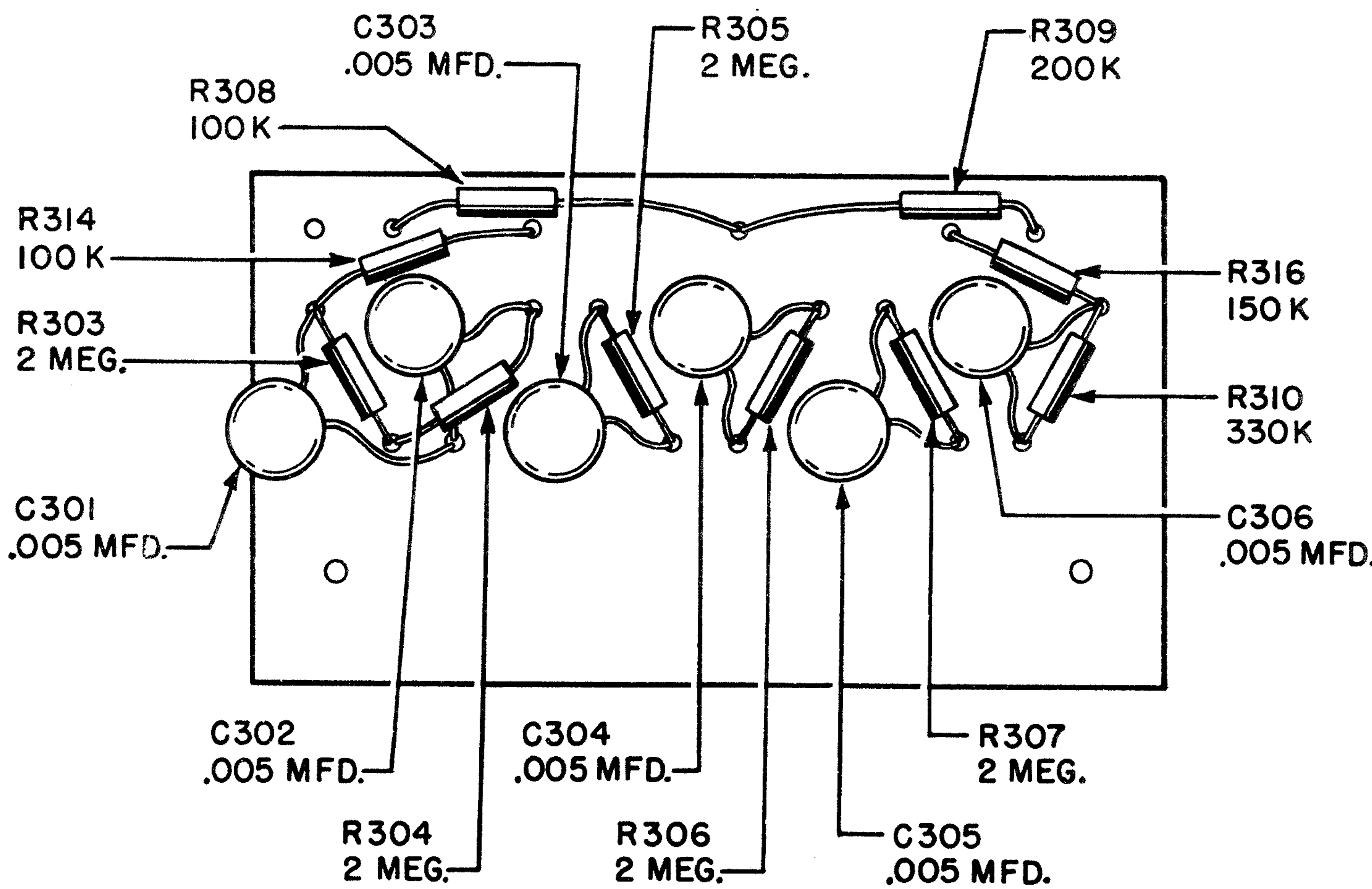


Figure 30. Short Test Assembly

PARTS LIST

Reference Symbol	*Hickok Code No.*	*Description*	*Quan. Req. per Unit*
M-301	660-135	METER: 66W Microammeter, 0-100 microamps	1
	906-017	CARD SWITCH:	1
	2490-359	BOOKLET: Instruction	1
	3047-1	CALIBRATION CELL: (Meter & Short Test Sensitivity)	1
	3322-4	COIL ASSEMBLY: Relay	1
CR-401 thru CR-404	3870-42	CRYSTAL: matched set of 4	1
DS-109, DS-110	12270-35	LAMP: aged #47	2
DS-301 thru DS-305	12272-2	LAMP: matched set of 5 NE-2, aged, striking voltage of all 5 must be within 2 VDC of each other	1
DS-101 thru DS-105, DS-201 thru DS-203	12270-43	LAMP: aged neon, NE 2	1
	12450-238	LEAD ASSEMBLY	1
	18400-11	RELAY ASSEMBLY	1
V-101	20878-141	TUBE: 5U4GB, tested	1
V-102	20878-62	TUBE: 6C4, tested-aged-tested	1
V-103	20878-154	TUBE: 6CD6-GA, tested-aged-tested	1
V-104	20878-105	TUBE: 6CL6, tested-aged-tested	1
V-105	20878-138	TUBE: 6AW8A, tested-aged-tested	1
V-106	20878-68	TUBE: 6X4, tested	1
V-107	20878-143	TUBE: 6AU8, tested-aged-tested	1
V-108	20878-78	TUBE: OA2, tested	1
	2250-1	BEAD: anti-parasitic, General Ceramics and Steatite Corp. #Feramic Q Material in accordance with Dwg. #F754/	64
	2920-7	BUTTON: push, black	3
	2920-8	BUTTON: push, red	2
	2920-11	BUTTON: molded, push, oval, Harry Davies No. 5149-A, stamped #2, black phenolic	1
	2920-12	BUTTON: molded, push, oval, Harry Davies No. 5149-A, stamped #3, black phenolic	1
	2920-15	BUTTON: molded, push, oval, Harry Davies No. 5149-A, stamped #4, red phenolic	1
	3075-28	CAP: Potentiometer D. and M. Products, Item CGB, black bakelite	5
C-201	3105-263	CAPACITOR: paper, 4 μfd, 600 volts, Astron ARH-5744 (metal can) supplied with mtg. clamp 3275-266 unassembled	1
C-202	3085-79	CAPACITOR, electrolytic: 1000 μfd, 40 volts, 1⅜″ x 3″, supplied with insulating sleeve	1
C-402	3085-101	CAPACITOR, electrolytic: 1000 μfd, 6 volts axial wire leads, supplied with mtg. strap, Astron Minimite MM-1000-6	1

Reference Symbol	*Hickok Code No.*	*Description*	*Quan. Req. per Unit*
	3475-87	CONNECTOR: male, 24 contact, Elco Varicon #RM22420-5	1
	6050-23	FEET: rubber, Philpott Cat. #BH-2095-W	8
	8330-8	HANDLE: for case, Specialty Leather. Consists of: 8330-11 Strap (1), 8220-12 Holder (2), 8330-13 Clamp-spring (2), 8330-14 Support (2)	1
	16277-2	PIN STRAIGHTENER: 9 pin #D9, Duro Specialty Co.	1
	16277-3	PIN STRAIGHTENER: 7 pin #D7, Duro Specialty Co.	1
R149	16925-244	POTENTIOMETER: 10,000 ohms, 2 watt, wire wound, 3/8″ bushing, 5/8″ shaft FMS, screw driver slot, Chicago Telephone type 252 (neg. bias adj.)	1
R155	16925-287	POTENTIOMETER: 500 ohms, 2 watt, wire wound, 3/8″ bushing, 5/8″ shaft FMS, screw driver slot, Chicago Telephone type 252 (sig. amplitude)	1
R401	16925-288	POTENTIOMETER: 2 ohms, wire wound, 2 watt, 3/8″ bushing, 5/8″ shaft FMS, screw driver slot, Chicago Telephone type 252 (GM Bal. HI Current)	1
R152	16925-289	POTENTIOMETER: 50 ohms, 2 watt, wire wound, 3/8″ bushing length, 5/8″ shaft FMS, screw driver slot, Chicago Telephone type 252 (Sig. Reg.)	1
R311	16925-358	POTENTIOMETER: 100 ohms, 2 watt, wire wound, 3/8″ bushing, 5/8″ shaft FMS, Chicago Telephone type 252 (Meter Cal.)	1
R148	40100-503	POTENTIOMETER: 50,000 ohms, linear, carbon 2 watt, screw driver slot, 3/8″ bushing, 7/8″ shaft FMS, Allen Bradley type J (Main B+ volt adj.)	1
R405	40300-252	POTENTIOMETER: 2500 ohms, linear, carbon, 1/2 watt, Centralab type 2, 3/8″ bushing, 7/8″ shaft FMS (GM Bridge Bal. — Lo Ib)	1
R142	40300-503	POTENTIOMETER: 50K ohms, linear, carbon, 1/2 watt, Centralab type 2, 3/8″ bushing, 7/8″ shaft FMS (Aux. B+ Control)	1
R323, R136	40400-253	POTENTIOMETER: 25K ohms, .2 watt, linear, carbon, 3/8″ shaft, 1/4″ bushing, Chicago Telephone type 70 (Fil. Std Cal. — Poss. Bias Adj.)	2
R135	40400-255	POTENTIOMETER: 2.5 megohms, .2 watt, linear, carbon, 3/8″ shaft, 1/4″ bushing, Chicago Telephone type 70 (SH test Low Sens.)	1
R315	40400-503	POTENTIOMETER: 50,000 ohms, .2 watt, linear, carbon, 3/8″ shaft, 1/4″ bushing, Chicago Telephone type 70 (SH test High Sens.)	1
CR101, CR102	18150-53	RECTIFIER: selenium, Radio Receptor 20 J7, 65 ma, 320 VRMS, 900 V. P1V	2
R109	40500-254	POTENTIOMETER: 250K ohms, linear, carbon, 1/2 watt, Centralab Model 2, snap-in type (6CD6) (Screen Adj.)	1
R123	40500-503	POTENTIOMETER: 50K ohms, linear, carbon, 1/2 watt, Centralab Model 2, snap-in type (Main B-Feed-back Current Adj.)	1
R241	18537-162	RESISTOR, deposited film: 1.067K ohms, 1% 1/2 watt, Electra DC1/2A, marked with part number and value	1
R211	18537-69	RESISTOR, deposited film: 80 ohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value	1
R209	18537-70	RESISTOR, deposited film: 320 ohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value	1

Reference Symbol	*Hickok Code No.*	*Description*	*Quan. Req. per Unit*
R208	18537-71	RESISTOR, deposited film: 640 ohms, 1%, ½ watt, Electra DC1/2A, marked with part number and value	1
R207	18537-72	RESISTOR, deposited film: 1280 ohms, 1%, ½ watt, Electra DC1/2A, marked with part number and value	1
R206	18537-73	RESISTOR, deposited film: 25,344 ohms, 1%, ½ watt, Electra DC1/2A, marked with part number and value	1
R320	18537-88	RESISTOR, deposited film: 3 megohms, 1%, ½ watt, Electra DC1/2A, marked with part number and value	1
R230	18539-8	RESISTOR, deposited film: 100,000 ohms, 1%, 1 watt, Electra DC1, marked with part number and value	1
R145	18575-150	RESISTOR, 5000 ohms, 10W, 3/16" ID, 5/16" OD, 1¾" long, Lectrohm	1
R226	18575-164	RESISTOR, wire wound: 1000 ohms, 1%, 35 watt, Lectrohm, silicone ceramic	1
R214, R218	18575-169	RESISTOR: 10 ohms, 4 watt, 1%, 5/16" x 1", Lectrohm	2
R213, R217	18575-170	RESISTOR: 20 ohms, 4 watt, 1%, 5/16" x 1", Lectrohm	2
R216	18575-171	RESISTOR: 30 ohms, 4 watt, 1%, 5/16" x 1", Lectrohm	1
R215	18575-172	RESISTOR: 40 ohms, 4 watt, 1%, 5/16" x 1", Lectrohm	1
R201	18575-173	RESISTOR: 100 ohms, 10 watt, 20%, Center-tapped, 1%, Lectrohm	1
R219	18575-179	RESISTOR: 100 ohms, W.W., 1%, 200 MA, buffed for vert. mtg.	1
R220	18575-180	RESISTOR: 200 ohms, W.W., 1%, 200 MA, buffed for vert. mtg., Lectrohm silicone ceramic	1
R221	18575-181	RESISTOR: 300 ohms, wire wound, 1%, 200 MA, buffed for vert. mtg., Lectrohm	1
R222	18575-182	RESISTOR: 400 ohms, wire wound, 1%, 200 MA, buffed for vert. mtg., Lectrohm	1
R225	18575-183	RESISTOR: 2000 ohms, wire wound, 1%, 100 MA max., Lectrohm, ends buffed for vert. mtg.	1
R224	18575-184	RESISTOR: 3000 ohms, wire wound, 1%, 67 MA	1
R223	18575-185	RESISTOR: wire wound, 4000 ohms, 1%, 50 MA	1
R146	18575-234	RESISTOR: wire wound, 2000 ohms, 10%, 5 watt, Lectrohm XC5 — 2000 or equiv.	1
R153, R156	18410-331	RESISTOR, fixed: composition, 33 ohms, 5%, ½ watt, Allen Bradley type EB	2
R205	18410-271	RESISTOR, fixed: composition, 27 ohms, 5%, ½ watt, Allen Bradley type EB	1
R203	18411-221	RESISTOR, fixed: composition, 220 ohms, 5%, ½ watt, Allen Bradley type EB	1
	18412-101	RESISTOR, fixed: composition, 1000 ohms, 5%, ½ watt, Allen Bradley type EB	1
R402, R403, R404, R406	18413-101	RESISTOR, fixed: composition, 10,000 ohms, 5%, ½ watt, Allen Bradley type EB	4
R147	18413-241	RESISTOR, fixed: composition, 24,000 ohms, 5%, ½ watt, Allen Bradley type EB	1
R143, R120	18413-301	RESISTOR, fixed: composition, 30,000 ohms, 5%, ½ watt, Allen Bradley type EB	2
	18413-271	RESISTOR, fixed: 27,000 ohms, 5%, ½ watt	1
R322, R139	18413-331	RESISTOR, fixed: composition, 33,000 ohms, 5%, ½ watt, Allen Bradley type EB	2
R110, R114, R308, R314, R140	18414-101	RESISTOR, fixed: composition, 100,000 ohms, 5%, ½ watt, Allen Bradley type EB	5

Reference Symbol	*Hickok Code No.*	*Description*	*Quan. Req. per Unit*
R316	18414-151	RESISTOR, fixed: composition, 150,000 ohms, 5%, ½ watt, Allen Bradley type EB	1
R309	18414-201	RESISTOR, fixed: composition, 200,000 ohms, 5%, ½ watt, Allen Bradley type EB	1
R303, R304, R305, R306, R307	18415-201	RESISTOR, fixed: composition, 2 megohms, 5%, ½ watt, Allen Bradley type EB	6
	18416-201	RESISTOR, fixed: composition, 20 megohms, 5%, ½ watt	1
R227, R288, R231	18433-201	RESISTOR, fixed: composition, 20,000 ohms, 5%, 2 watt, Allen Bradley type HB	3
R229	18433-301	RESISTOR, fixed: composition, 30,000 ohms, 5%, 2 watt, Allen Bradley type HB	1
R210	18537-31	RESISTOR, deposited film: 160 ohms, 1%, ½ watt, Electra DC1/2A, marked with part number and value	1
R238	18537-47	RESISTOR, deposited film: 10,000 ohms, 1%, ½ watt, Electra DC1/2A, marked with part number and value	1
R239, R240	18537-48	RESISTOR, deposited film: 20,000 ohms, 1%, ½ watt, Electra DC1/2A, marked with part number and value	2
R212	18537-68	RESISTOR, deposited film: 40 ohms, 1%, ½ watt, Electra DC1/2A, marked with part number and value	1
R112	18537-26	RESISTOR, deposited film: 100,000 ohms, 1%, ½ watt, Electra DC1/2A, marked with part number and value	1
R234 thru R236	18537-164	RESISTOR, deposited film: 52K ohms, 1%, ½ watt, Electra DC1/2A, marked with part number and value	3
R237	18537-165	RESISTOR, deposited film: 62K ohms, 1%, ½ watt, Electra DC1/2A, marked with part number and value	1
S105	19910-115	SWITCH: push button, Switchcraft type 201, black button, non-locking "Littel" switch, SPST, normally open	1
S301	19910-137	SWITCH: push button, Oak #94889-130	1
S302	19910-139	SWITCH: push button, auxiliary function	1
S106	19912-399	SWITCH: rotary, 1 section, 12 pos. Fil. Adjust	1
T102	20800-227	TRANSFORMER: filament	1
T101	20800-228	TRANSFORMER: power	1

CIRCUIT NOTES:

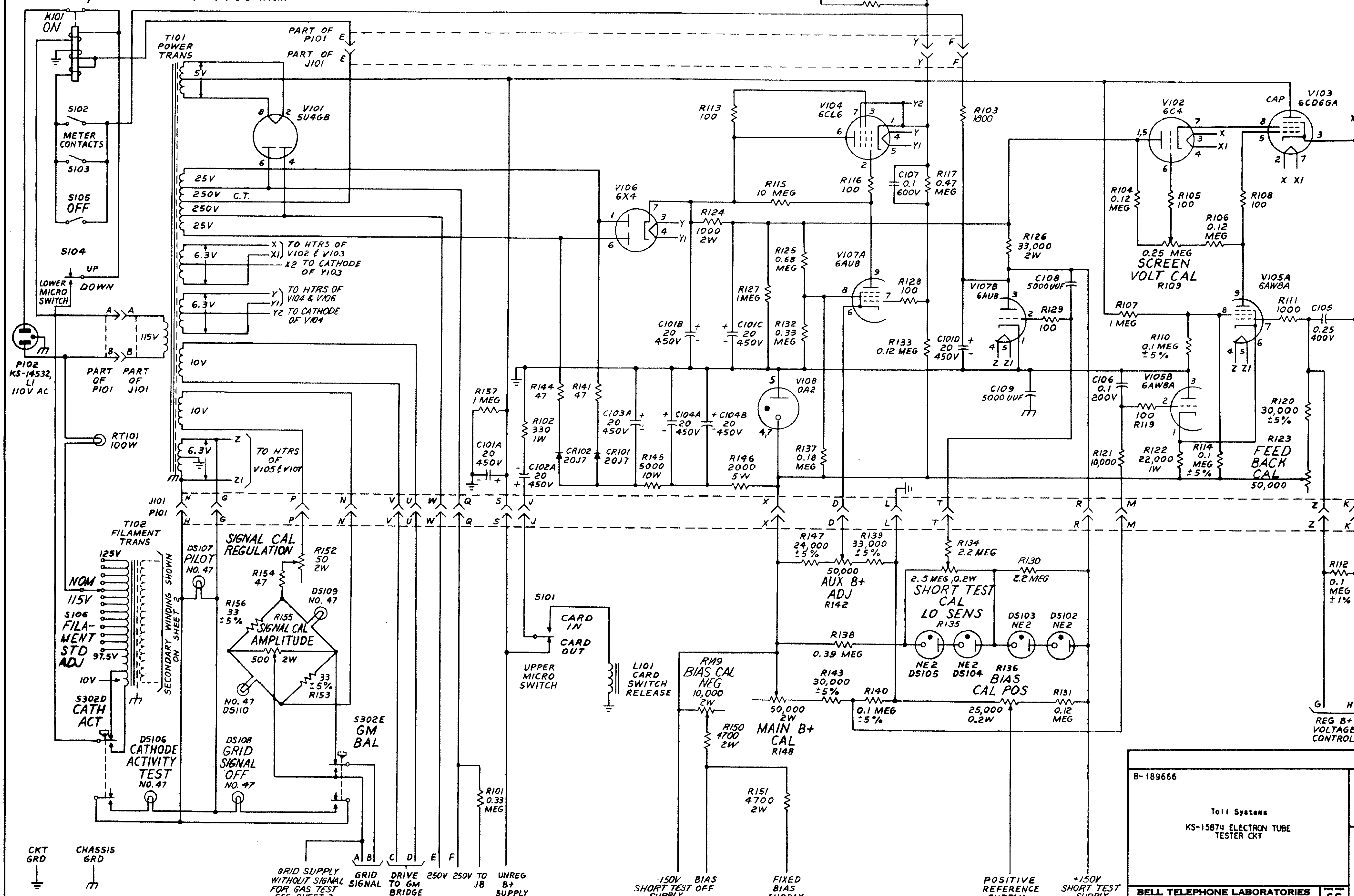
101. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE 1/2W AND ARE ±10%.

102. DOTTED COMPONENT, PRESENTLY SHORT CIRCUITED, IS PLANNED FOR FUTURE USE.

103. VALUE OF RX, WHICH TRIMS R308 FOR 100V DROP, TO BE DETERMINED DURING CALIBRATION.

INFORMATION NOTES:

301. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE IN MICROFARADS.



ISSUE	ISSUE	ISSUED		
1		8-25-59	AA HMW	IMD INF

B-189666

Toll Systems

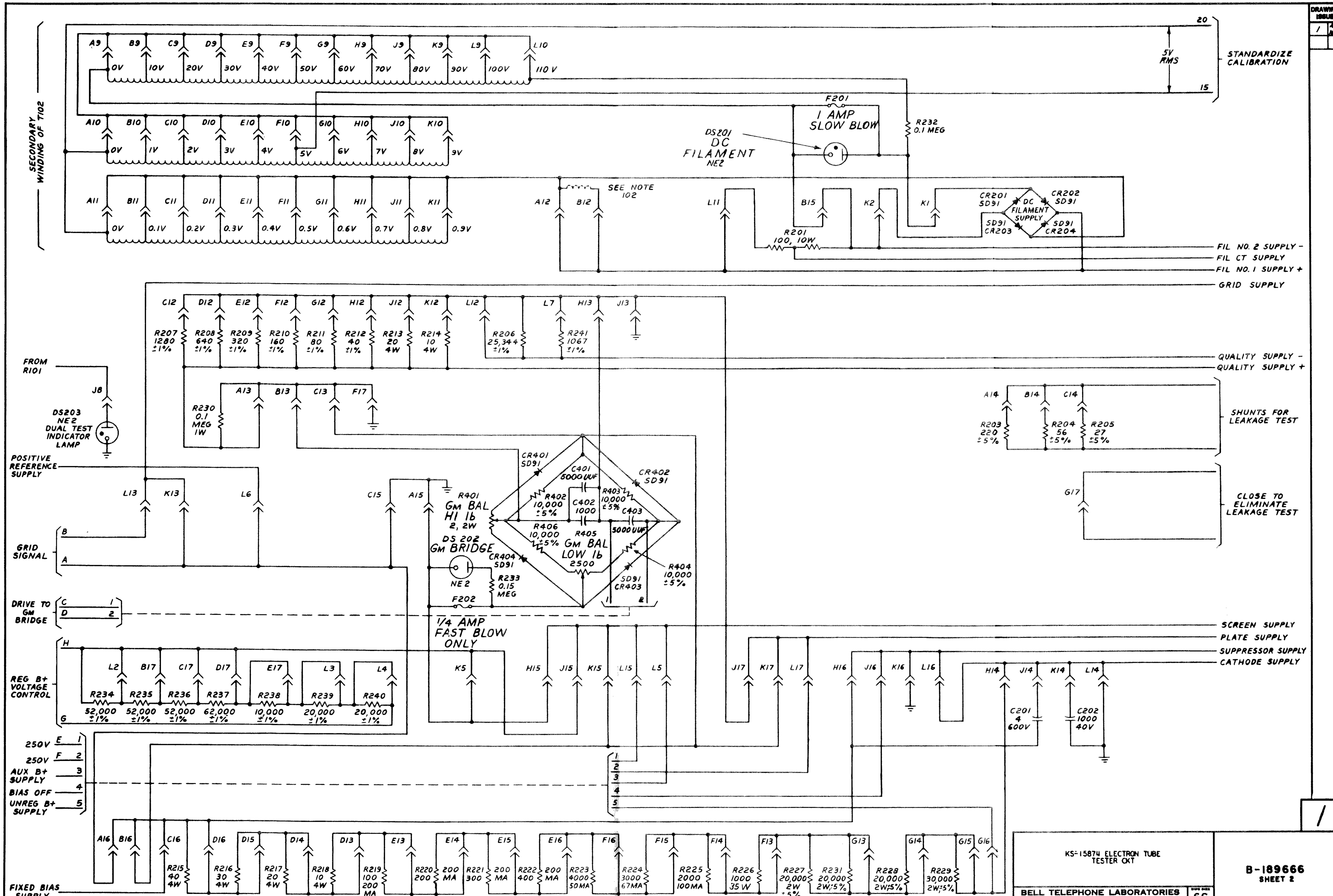
KS-15874 ELECTRON TUBE TESTER CKT

STANDARD

B-189666
3 SHEETS

BELL TELEPHONE LABORATORIES INCORPORATED

6S


SECONDARY WINDING OF T102
STANDARDIZE CALIBRATION
5V RMS
F201
1 AMP SLOW BLOW
DS201 DC FILAMENT NE2
R232 0.1 MEG
SEE NOTE 102
R201 100, 10W
CR201 SD91
CR202 SD91
DC FILAMENT SUPPLY
SD91 CR203
SD91 CR204
FIL NO. 2 SUPPLY -
FIL CT SUPPLY
FIL NO. 1 SUPPLY +
GRID SUPPLY
QUALITY SUPPLY -
QUALITY SUPPLY +
FROM R101
DS203 NE2 DUAL TEST INDICATOR LAMP
POSITIVE REFERENCE SUPPLY
R230 0.1 MEG 1W
SHUNTS FOR LEAKAGE TEST
CLOSE TO ELIMINATE LEAKAGE TEST
R401 GM BAL HI Ib 2, 2W
DS 202 GM BRIDGE NE2
R233 0.15 MEG
F202
1/4 AMP FAST BLOW ONLY
R405 GM BAL LOW Ib 2500
C401 5000 UUF
C402 1000
C403 5000 UUF
GRID SIGNAL
DRIVE TO GM BRIDGE
REG B+ VOLTAGE CONTROL
250V
AUX B+ SUPPLY
BIAS OFF
UNREG B+ SUPPLY
FIXED BIAS SUPPLY
SCREEN SUPPLY
PLATE SUPPLY
SUPPRESSOR SUPPLY
CATHODE SUPPLY
C201 4 600V
C202 1000 40V
KS-15874 ELECTRON TUBE TESTER CKT
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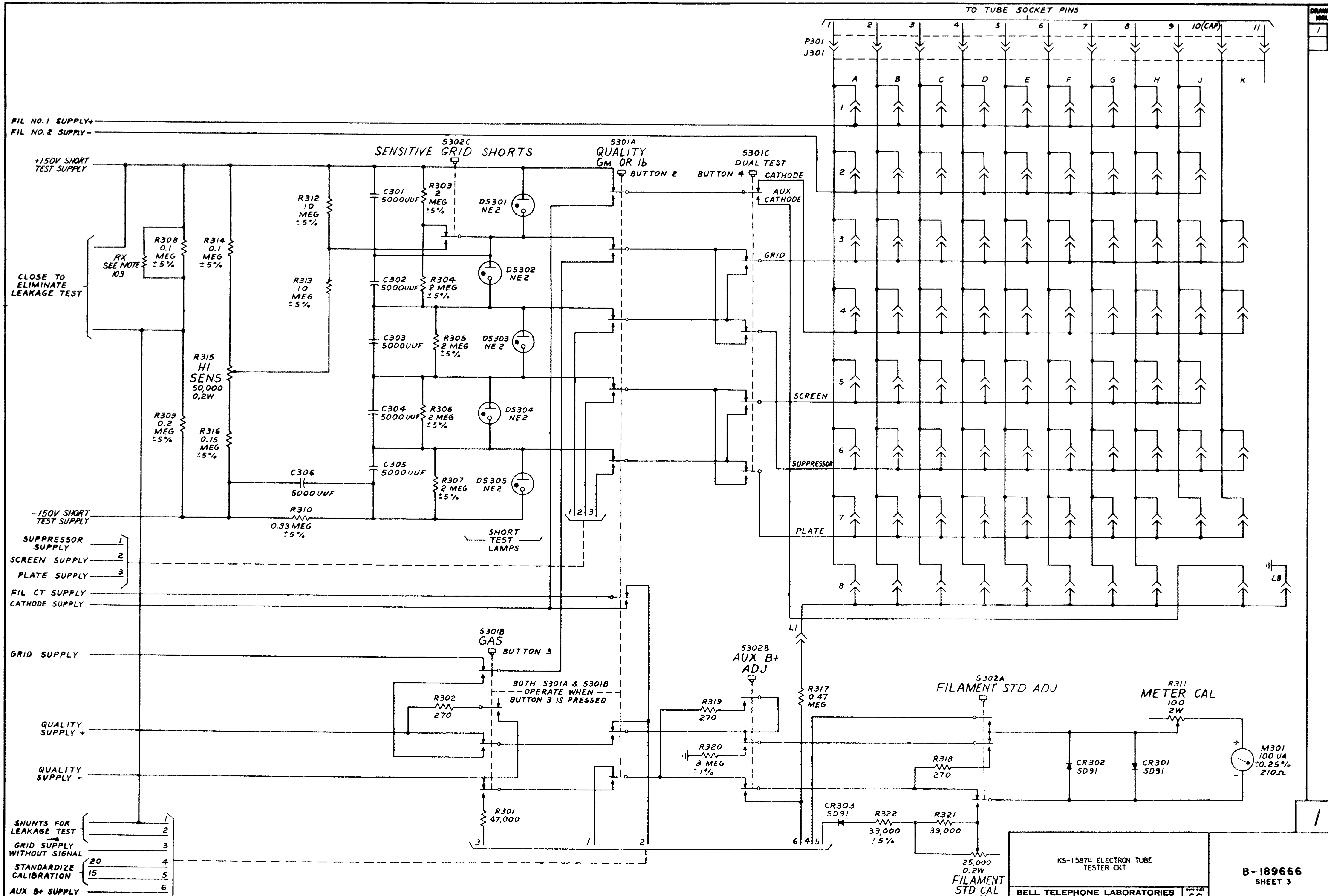
B-189666
SHEET 2
6S


TO TUBE SOCKET PINS
1 2 3 4 5 6 7 8 9 10(CAP) 11
P301
J301
A B C D E F G H J K
FIL NO. 1 SUPPLY+
FIL NO. 2 SUPPLY-
+150V SHORT TEST SUPPLY
SENSITIVE GRID SHORTS
S302C
S301A
QUALITY
Gm OR Ib
BUTTON 2
S301C
DUAL TEST
BUTTON 4
CATHODE
AUX CATHODE
GRID
SCREEN
SUPPRESSOR
PLATE
R312 10 MEG ±5%
R313 10 MEG ±5%
C301 5000UUF
C302 5000UUF
C303 5000UUF
C304 5000UUF
C305 5000UUF
R303 2 MEG ±5%
R304 2 MEG ±5%
R305 2 MEG ±5%
R306 2 MEG ±5%
R307 2 MEG ±5%
DS301 NE2
DS302 NE2
DS303 NE 2
DS304 NE2
DS305 NE2
R308 0.1 MEG ±5%
R314 0.1 MEG ±5%
RX SEE NOTE 103
CLOSE TO ELIMINATE LEAKAGE TEST
R315 HI SENS 50,000 0.2W
R309 0.2 MEG ±5%
R316 0.15 MEG ±5%
C306 5000 UUF
R310 0.33 MEG ±5%
-150V SHORT TEST SUPPLY
SHORT TEST LAMPS
SUPPRESSOR SUPPLY
SCREEN SUPPLY
PLATE SUPPLY
FIL CT SUPPLY
CATHODE SUPPLY
GRID SUPPLY
S301B
GAS
BUTTON 3
BOTH S301A & S301B OPERATE WHEN BUTTON 3 IS PRESSED
R302 270
QUALITY SUPPLY +
QUALITY SUPPLY -
R301 47,000
SHUNTS FOR LEAKAGE TEST
GRID SUPPLY WITHOUT SIGNAL
STANDARDIZE CALIBRATION
20
15
AUX B+ SUPPLY
L1
L8
S302B
AUX B+ ADJ
R317 0.47 MEG
R319 270
R320 3 MEG ±1%
S302A
FILAMENT STD ADJ
R311
METER CAL
100 2W
CR302 SD91
CR301 SD91
M301 100 UA ±0.25% 210Ω
R318 270
CR303 SD91
R322 33,000 ±5%
R321 39,000
25,000 0.2W
FILAMENT STD CAL
R323
KS-15874 ELECTRON TUBE TESTER CKT
BELL TELEPHONE LABORATORIES INCORPORATED
6S
B-189666
SHEET 3