COLD CATHODE TUBE
TEST SET J94731A
DESCRIPTION AND APPLICATION

1. GENERAL

1.01 This section describes the portable cold cathode tube test set per SD-96464-01.

1.02 This test set is used for testing both wired-in and socket mounted three-element cold cathode tubes and two-element voltage regulator tubes. Tubes provided with lead-in wires may also be tested by making connections to binding posts provided in the test set.

1.03 The principal application of this test set is to determine the voltage at which cold cathode tubes ionize, the voltage drop across the starter and anode gaps of three-element tubes, the current flow required in the starter gap to produce anode gap ionization of three-element tubes, and the voltage regulating characteristics of cold cathode two-element tubes.

1.04 Tubes other than the wire-in type may be tested by placing them in the proper sockets on the test set or by connecting to the binding posts provided on the test set. Wired-in three-element tubes having the high voltage connected directly to the main anode may be tested by connecting the TST jack of the test set to the tube by means of a patching cord provided with the test set.

2. EQUIPMENT FEATURES

2.01 The principal equipment of the test set consists of a voltmeter, a milliammeter, potentiometers, switches, keys, and jacks, all of which are encased in a standard metal portable test set box. The approximate dimensions of this box are 14 inches by 11 inches by 6 inches. The apparatus which is exposed to view when the cover is removed is shown in Fig. 1.

2.02 The set may be located on the steps of a rolling ladder if desired and fastened to the side of the ladder by means of a ladder strap.

2.03 The voltmeter may be either a Western Electric Co. G3N model or a Weston No. 301. Full range of the VM scale is 100, 200, or 300 volts, depending upon the position of the VM key. This meter is used as a voltmeter except in the TR I position of the SEL switch where it functions as a microammeter for measuring transfer current.

2.04 The milliammeter is a Western Electric Co. G2N Model and has a single scale range of 0 to 50 milliamperes. This meter is used for indicating cathode current flow.

2.05 One nonlocking lever type key is provided.

(1) The M key in the INC I (increase current) position provided for increasing the current reading when the CATH I potentiometer does not provide adequate range. The M key in the ION (ionize) position applies a voltage to start anode of three-element tubes for ionizing the tube or applies a small additional transient voltage in series with the dc test voltage for ensuring that an adequate breakdown voltage is provided when required for testing two-element tubes.

2.06 Three locking lever type keys are provided, as follows:

(1) The VR (voltage regulator) key is used only when measuring the ionizing voltage of voltage regulator tubes which have anode-cathode ionizing voltages of less than 135 volts.

(2) The μA (microamperes) key provides for current ranges of 0-100, 0-500, or 0-5000 microamperes, as read on the voltmeter when making transfer current measurements.

(3) The VM (voltmeter) key provides voltmeter ranges of 0-100, 0-200, or 0-300 volts.

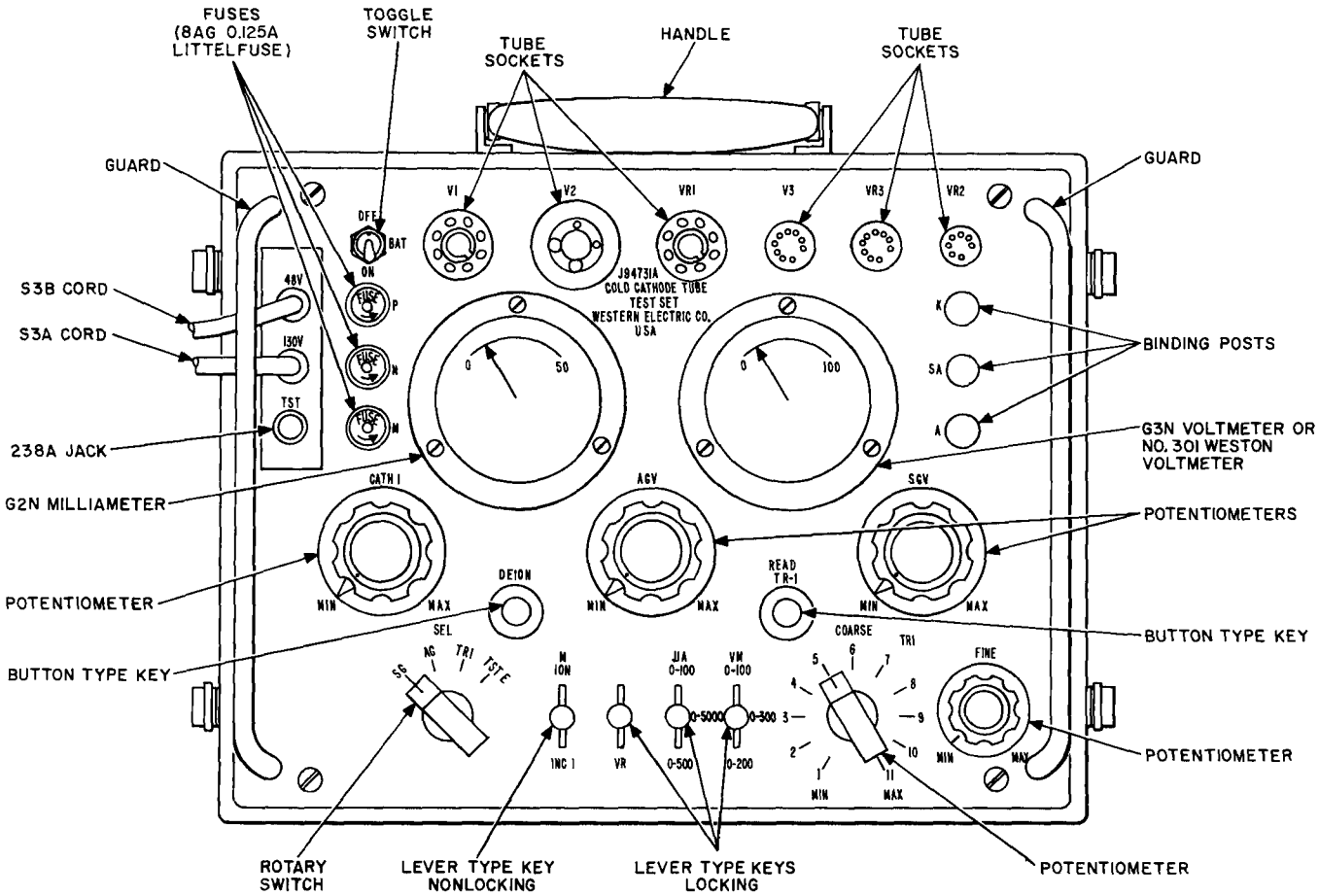

Fig. 1—Cold Cathode Tube Test Set—Front View With Cover Removed

2.07 Two nonlocking push button type keys are provided, as follows:

(1) The DEION (deionize) key opens both the starter anode and the cathode circuits to the tube to restore the tube from the ionized condition and prepare for a repeat test or for taking a voltmeter reading.

(2) The READ TR I (read transfer current) key interrupts the anode current and permits reading the transfer current for tubes other than wired-in tubes.

2.08 Two switches are provided:

(1) A toggle BAT (battery) switch is provided which when operated closes +130 volt, and either -48 volt or -130 volt battery to the test set.

(2) A rotary SEL (select) switch is provided which selects the proper testing conditions as determined by the tube characteristic to be tested. These positions are as follows:

SWITCH POSITION	TESTS PROVIDED
SG (starter gap)	Starter Gap Breakdown Voltage Starter Gap Voltage Drop
AG (anode gap)	Anode Gap Working Voltage and Anode Gap Voltage Drop for Three-Element Tubes. Breakdown Voltage Tests and Voltage Drop for Two-Element Tubes
TR I (transfer current)	Transfer Current Measurement
TST E (test voltage)	Test Voltage for External Testing

2.09 Five potentiometers are provided.

(1) The SG V (starter gap voltage) potentiometer regulates the voltage across the starter gap of three-element tubes.

(2) The AG V (anode gap voltage) potentiometer regulates the voltage across the anode gap of the tube under test.

(3) The CATH I (cathode current) potentiometer regulates the cathode current of the tube under test.

(4) The COARSE potentiometer, has eleven fixed stops and regulates the transfer current.

(5) The FINE potentiometer has a continuously variable resistance for adjusting the transfer current between steps of the COARSE control.

2.10 A TST jack of the 238-type is provided and is used for establishing connections to wired-in tubes. A 6-foot test cord equipped with a 310 plug on one end and a 360B and 360C tool and two KS-6278 connecting clips on the test end is used for this purpose. The 360C (white) tool is connected to the starter anode of the tube to be tested and the 360B (black) tool is connected to the cathode (usually through resistance) of the tube.

2.11 Three binding posts are provided for making direct connections to tubes equipped with lead-in wires such as the 333A or 372A tubes, as follows:

(1) K binding post. Connection to yellow wire (Cathode)

(2) SA binding post. Connection to red wire (Starter Anode)

(3) A binding post. Connection to black wire (Main Anode)

2.12 Six tube sockets are provided as follows:

(1) V1 socket for 8-pin vacuum tubes with octal bases

(2) V2 socket for 4-pin vacuum tubes

(3) V3 Socket for vacuum tubes with 9-pin miniature bases

(4) VR1 socket for VR tubes with 8-pin octal bases

(5) VR2 socket for VR tubes with 7-pin miniature bases

(6) VR3 socket for VR tubes with 9-pin miniature bases.

2.13 Three fuses are provided for the purpose of protecting the test set against excessive currents.

2.14 The battery voltages required for operating the set are obtained through two attached cords. Normally these voltages are +130 volts, -48 volts and ground, thus providing a maximum test voltage of 183 volts when the office batteries are at nominal potentials of +134 and -49 volts, respectively. If a higher test voltage is found desirable it may be obtained by substituting -130 volts, for the -48 volts, on the tip of the 310 plug. This will then provide a maximum test voltage of 268 volts for nominal supply voltages of +134 and -134 volts.

3. CIRCUIT FEATURES

3.01 Drawing SD-96464-01 shows the circuit arrangement of the test set. A detailed circuit description is covered in CD-96464-01. Part 4 of this section describes the test arrangements which are used in applying various conditions to the tubes for making breakdown tests and determining the characteristics of the tubes.

4. TEST ARRANGEMENTS

PRECAUTIONS

4.01 In order to prevent operation of fuses, damage to meters, and damage to the tubes under test, the following precautions should be observed:

(a) All keys should be in the nonoperated position when connecting battery to the set.

(b) All variable controls should be operated to MIN when starting a test.

(c) The M key should not be operated to the INC I position while the CATH I control is at the MAX position.

(d) The COARSE TR I control should not be operated to the MAX position when the FINE control is at the MAX position.

Starter Gap Breakdown Voltage—Three-Element Tube Tests

4.02 The circuit arrangement for applying the breakdown test voltage to the starter gap of three-element tubes is shown in simplified form in Fig. 2.

4.03 When a tube is connected to the test set in one of the several ways indicated, with the SEL switch operated to SG, the SG V potentiometer controls the voltage which is applied to the control anode of the tube. At the same time the milliammeter (MI) is connected to the cathode circuit and the voltmeter (M2) is connected in the circuit between the control anode and the cathode.

4.04 The test voltage is gradually increased by turning the SG V potentiometer toward the MAX position until the tube ionizes as indicated by the sudden appearance of a reading on the milliammeter.

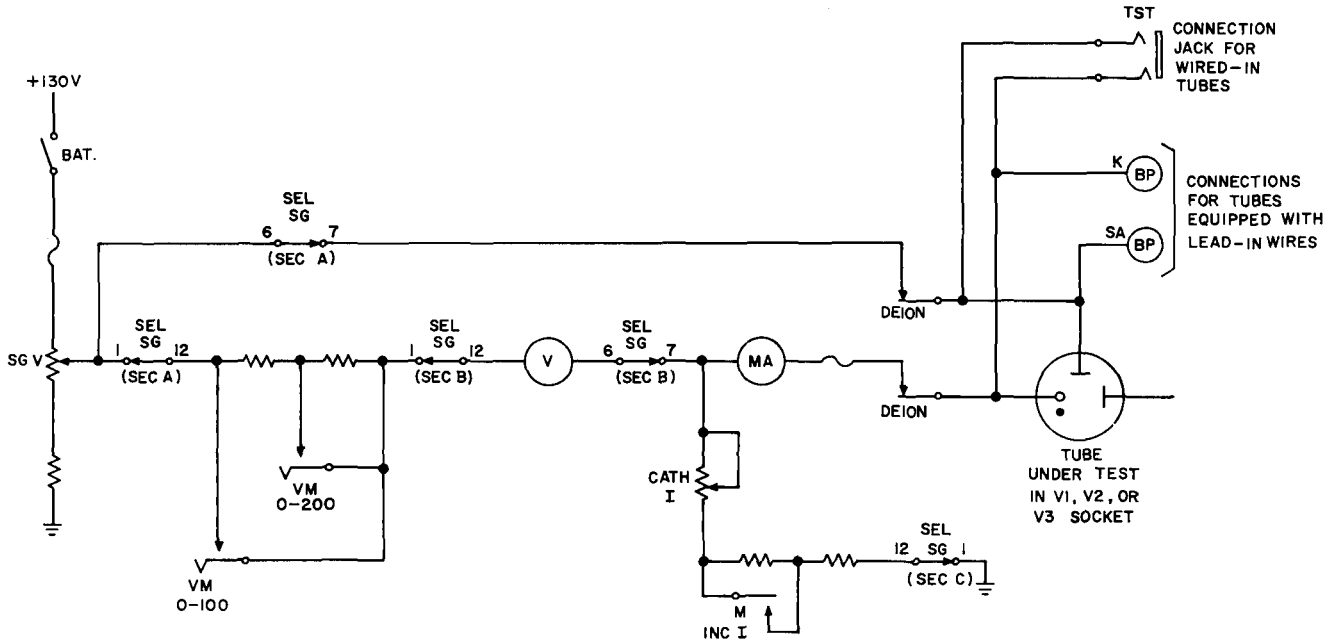

Fig. 2—Starter Gap Tests—Three-Element Tubes

4.05 When the DEION key is held operated, the voltmeter reading corresponds to the open circuit voltage at which the tube ionized.

4.06 The SG V potentiometer is then restored to the MIN position and the DEION key is momentarily operated causing the tube to deionize.

4.07 In order to improve the accuracy of the reading, it is desirable to repeat the test described in 4.03 to 4.06 five or six times and take the average of all the voltmeter readings except the first.

> *Note:* The reading of the first test is eliminated because the tube under test may not have been ionized during the previous 24 hours and might therefore give an incorrect reading due to "shelf" effect.

Starter Gap Voltage Drop—Three-Element Tubes

4.08 The circuit arrangement for measuring the voltage drop across the starter gap after the tube has ionized is shown in Fig. 2.

4.09 When the SEL switch is operated to SG and the SG V potentiometer is turned to the MAX position, the circuit is arranged so that the starter gap current may be adjusted by means of the CATH I potentiometer in combination with the M key in the INC I position if necessary to the specified value for the tube under test.

4.10 The voltmeter reading under this condition corresponds to the starter gap voltage drop.

4.11 This test cannot be applied to wired-in tubes having the +130 volt potential connected to the main anode of the tube. When making this test on tubes of the 346B type not in the circuit, it is necessary that the tip connection be made directly to the control anode rather than through the 100,000 ohm protective resistance in the tube.

Anode Gap Forward or Working Voltage—Three-Element Tubes

4.12 The circuit arrangement for applying the forward or working voltage is shown in Fig. 3.

4.13 When the SEL switch is operated to AG, the AG V potentiometer controls the voltage which is connected across the main gap of the tube under test and this voltage is indicated directly on the voltmeter.

4.14 Under this condition, the tube should not ionize as indicated by no reading being obtained on the milliammeter.

> *Note:* The maximum voltage available for this test is either 185 volts if the negative supply voltage to the test set is 45-50 volts, or 270 volts if the negative supply voltage is 125-135 volts.

Anode Gap Voltage Drop—Three-Element Tubes

4.15 The circuit arrangement for measuring the anode gap voltage drop is shown in Fig. 3.

4.16 When the SEL switch is operated to AG and the SG V potentiometer is turned to its MAX position, momentary operation of the M key to ION may be necessary to cause the tube under test to ionize. The anode gap current may be adjusted by means of the CATH I and AG V potentiometers. If the specified current cannot be obtained in this manner the CATH I potentiometer should be returned to MIN and the M key operated to INC I. The current should then be adjusted by the CATH I potentiometer.

> ***Caution: Never operate the M key to INC I when the CATH I potentiometer is at, or near, MAX position because of danger of damage to tube and meter.***

4.17 The voltmeter reading under this condition corresponds to the anode gap voltage drop.

Breakdown Voltage Tests—Two-Element Tubes Ionizing at 135 Volts or More

4.18 The circuit arrangement for applying the breakdown test voltage when testing two-element tubes ionizing at 135 volts or more is shown in Fig. 4.

4.19 When the SEL switch is operated to AG with the AG V potentiometer set at MIN, the AG V potentiometer controls the voltage which is applied across the control gap of the tube under test. If the tube does not ionize at the MAX position of the AG V potentiometer, the M key is momentarily operated to ION which causes a

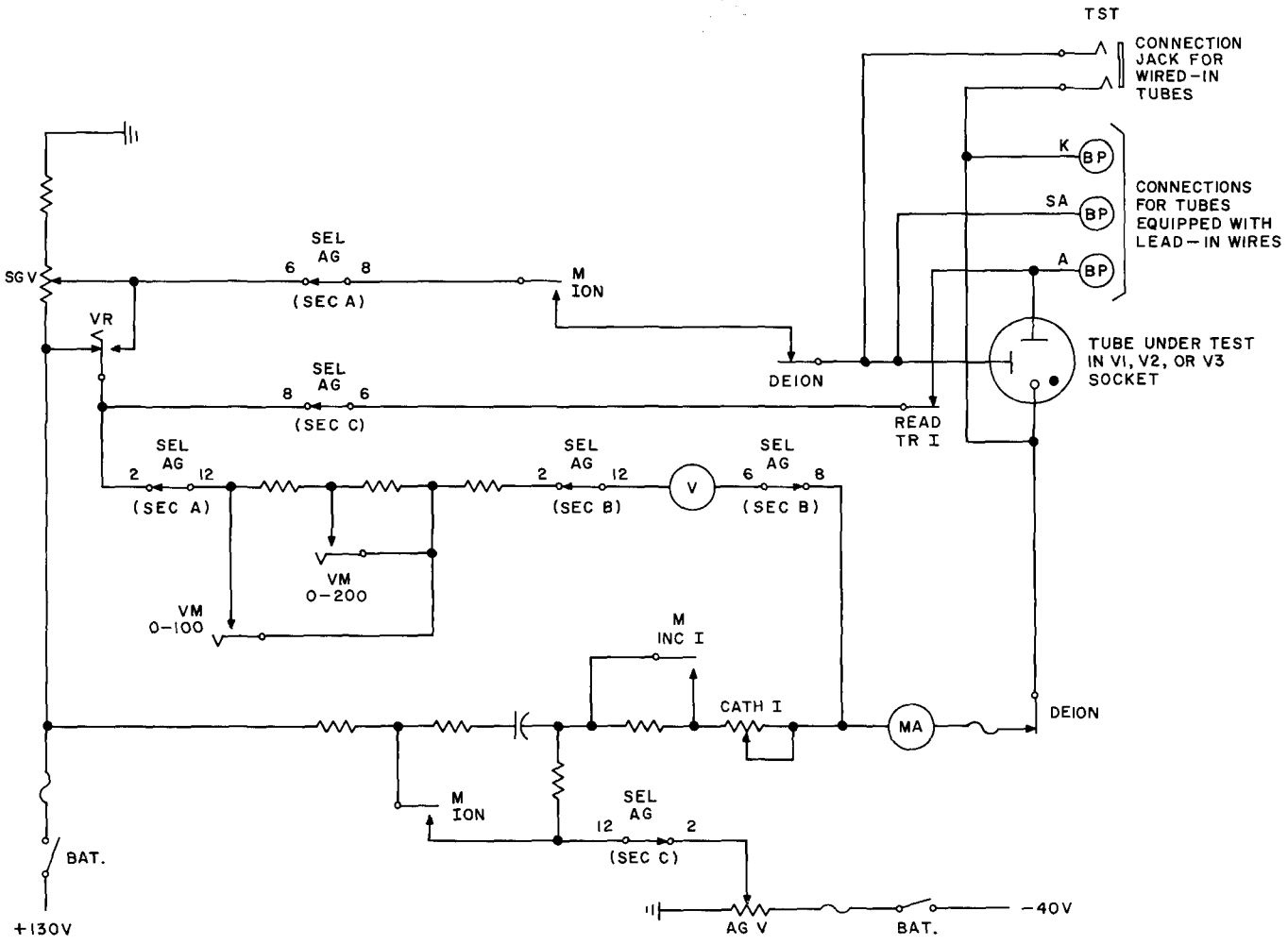

Fig. 3—Anode Gap Tests—Three-Element Tubes

momentary voltage from the discharge of a capacitor to be applied in series with the breakdown voltage to assist in ionizing the tube. The voltmeter reading with the DEION key held operated corresponds to the breakdown voltage of the tube.

4.20 The AG V potentiometer is then restored to the MIN position and the DEION key is momentarily operated causing the tube to deionize.

4.21 In order to improve the accuracy of the reading, it is desirable to repeat the test described in 4.19 and 4.20 five or six times and take the average of all the voltmeter readings except the first. (See Note in 4.07).

Breakdown Voltage Tests—Two-Element Tubes Ionizing at Less Than 135 Volts

4.22 The circuit arrangement for applying the breakdown test voltage when testing two-element tubes ionizing at less than 135 volts is shown in Fig. 4. This arrangement is similar to the test described in 4.18 through 4.21 except that the VR key is operated and the voltage applied across the control gap of the tube under test is controlled by the SG V potentiometer, thereby making it possible to use a lower test breakdown voltage as required by the characteristics of these tubes.

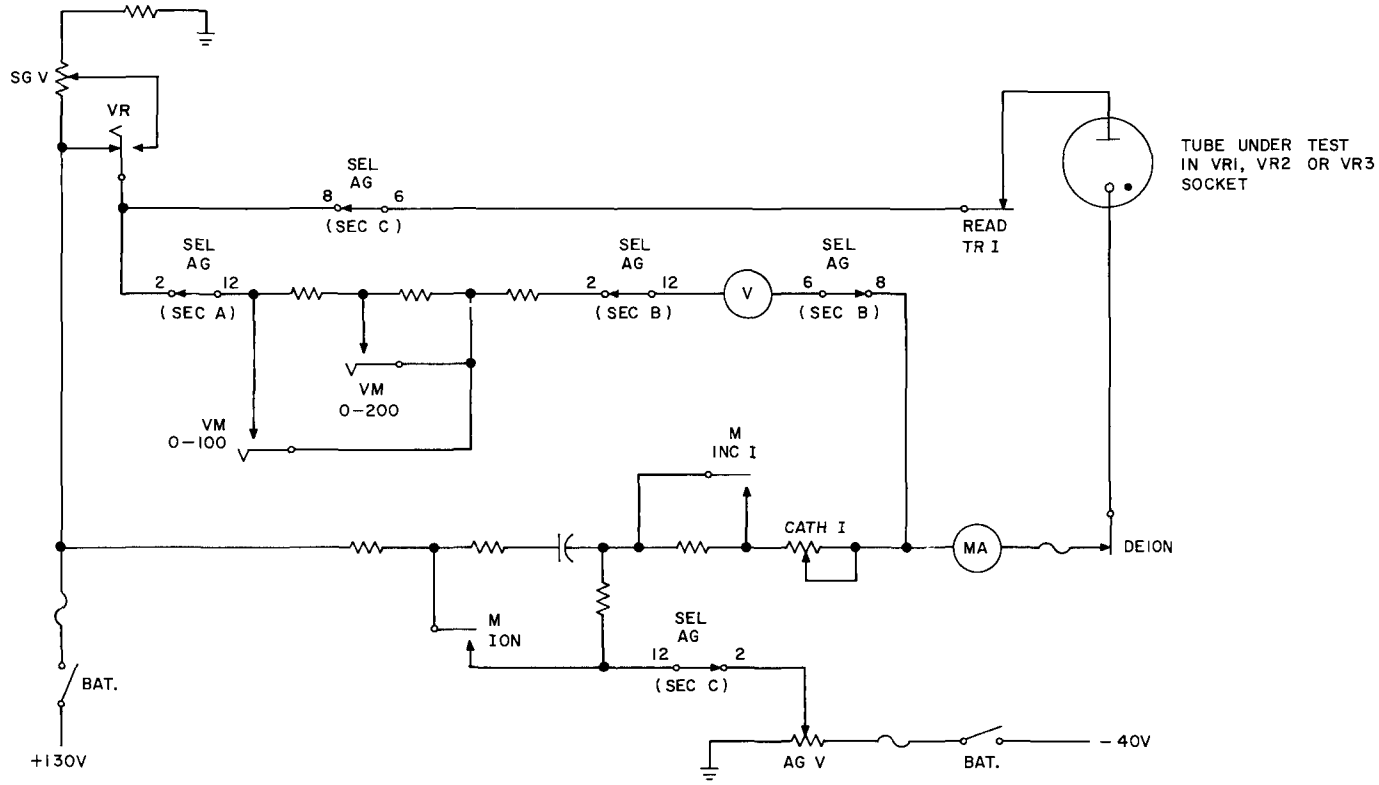

Fig. 4—Anode Gap Tests—Two-Element Tubes

Voltage Drop—All Voltage Regulator Two-Element Tubes

4.23 The circuit arrangement for checking the voltage drop to determine the voltage regulating characteristics of two-element tubes is shown in Fig. 4.

4.24 When the SEL switch is operated to AG, the AG V potentiometer controls the voltage which is applied across the control gap of the tube under test. If the tube does not ionize at the MAX position of the AG V potentiometer, the M key is momentarily operated to ION to assist in causing the tube to ionize.

4.25 The AG V potentiometer controls the amount of current flowing in the tube.

4.26 Voltmeter readings may be noted at two or more specified current values. The difference in the successive voltmeter readings gives the voltage regulation characteristics of the tube.

Transfer Current Measurements—Three-Element Tubes

4.27 The circuit arrangement for measuring the transfer current required in the starter gap to produce anode gap ionization is shown in Fig. 5.

4.28 When the SEL switch is operated to TR I, with the COARSE and FINE TR I potentiometers operated to MIN, the starter gap voltage is controlled by the SG V potentiometer.

4.29 The starter gap voltage is gradually increased by turning the SG V potentiometer toward the MAX position until the tube ionizes as indicated by the sudden increase in the current flow on the voltmeter (the voltmeter functions as a microammeter in this test). The SG V and TRI controls are adjusted until the reading on the voltmeter is stable. The COARSE and FINE TR I potentiometers are turned slowly toward the MAX position until transfer from the starter gap to the anode gap occurs, which is indicated by a sudden increase in the current flow in the milliammeter. The READ TR I key is momentarily operated in order to deionize the anode gap and then the reading on the voltmeter is the transfer current.

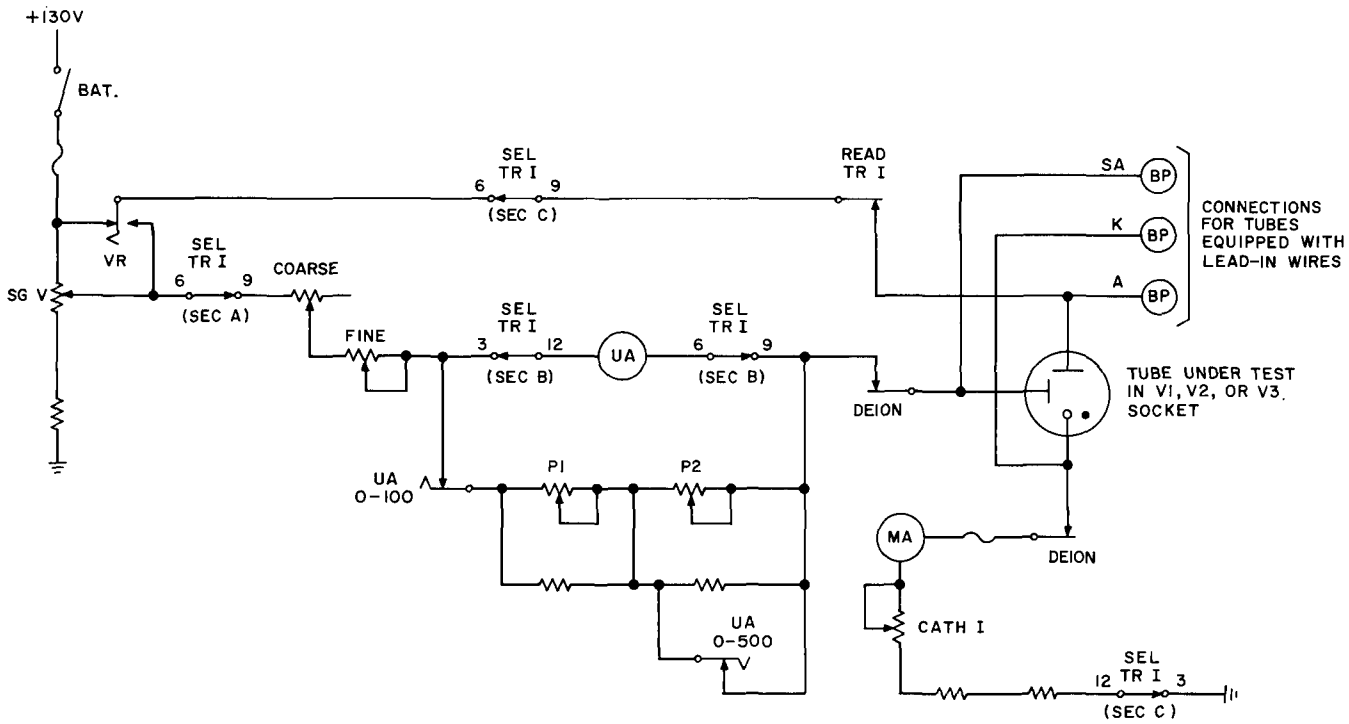

Fig. 5—Transfer Current Test

4.30 Transfer current measurements of wired-in tubes may be made similar to 4.27 through 4.29 except that the transfer current will be the maximum reading obtained on the voltmeter ***immediately before*** transfer occurs. It is not possible to deionize the anode gap by operating the READ TR I key.

4.31 Tests may be repeated by returning all the potentiometer to MIN and momentarily operating the DEION key.

Test Voltage for External Circuit Testing

4.32 The circuit arrangement to supply an external test voltage read to calibrate the 60 or 120 IPM interrupter circuit used in some No. 5 Crossbar offices is shown in Fig. 6.

4.33 When the SEL switch is operated to TST E, the SG V potentiometer controls the test voltage as indicated on the voltmeter. The connection to the external circuit is from terminal SA on the test set.

5. MAINTENANCE

5.01 Removing the four corner screws in the top of the test set and lifting the top from the casing makes the apparatus readily accessible. The keys, jacks, and meters should be adjusted to meet the requirements given in the Bell System Practices sections applying to the particular piece of apparatus. In case the voltmeter or milliammeter becomes defective, it should be removed from the set and returned through the usual channels for repair.

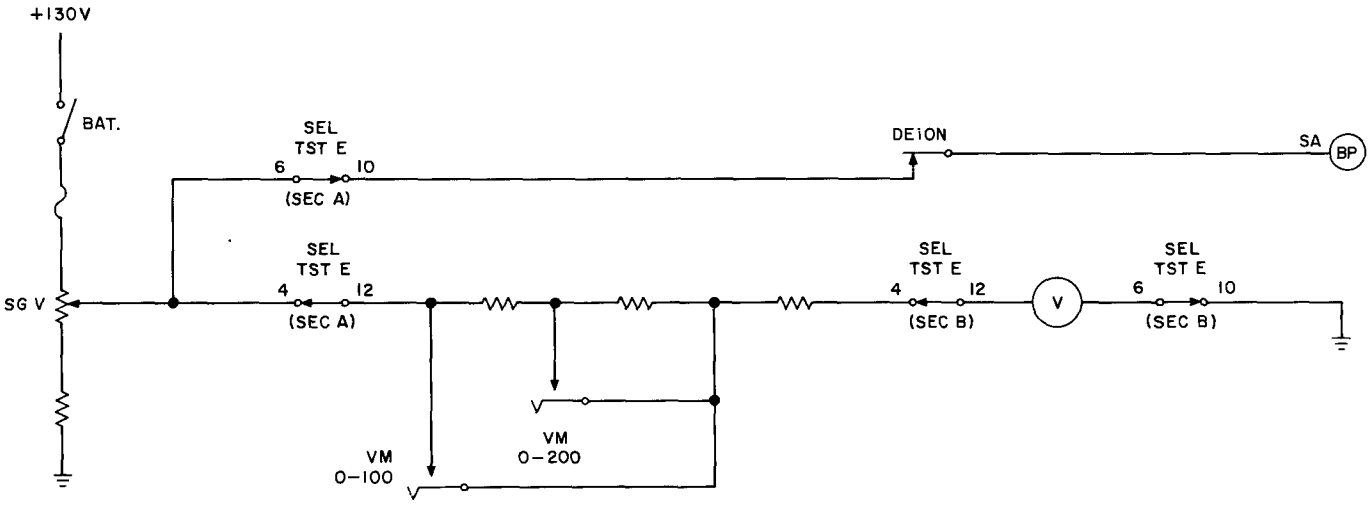

Fig. 6—Test Voltage for External Circuit Tests