

1R AND 1AC TUBE TEST SETS

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| (D) Grid Current Measurements . . . . .  | 6           | <u>1. GENERAL</u>   |             |
| (E) Space Current Measurements . . . . .   | 6           | 1.01 This section contains the description<br>and methods of operation of the 1R<br>(J64001R) Tube Test Set and the 1AC<br>(J64001AC) Tube Test Set. Both are portable<br>devices which are used for testing the tubes<br>of the J and K carrier telephone systems, C5<br>and L carrier terminals, and C1 repeaters,<br>while they are in service. Where proper con-<br>necting arrangements are provided, the test<br>sets also afford means for testing the same<br>tubes; viz., 310A, 311A, 328A, and 329A, when<br>associated with other types of equipment.<br>The 1AC Tube Test Set incorporates all the<br>functions of the 1R Tube Test Set, but in ad-<br>dition contains a vacuum tube voltmeter cir-<br>cuit which is used to test the control tubes<br>of type K deviation regulators. The 1AC Tube<br>Test Set will be used primarily in those sta-<br>tions in which deviation regulators are in-<br>stalled. |             |
| (F) Cathode Activity Tests . . . . .   | 6           | 1.02 This issue replaces Issue 1 of April,<br>1938 and includes information on the<br>1AC Tube Test Set. The information on the 1R<br>Tube Test Set is also revised and brought up<br>to date.  |             |
| (G) Connecting Cords . . . . .   | 7           | 1.03 Current measurement is one means of<br>rapidly checking certain aspects of the<br>performance of a tube. The 1R and 1AC Tube<br>Test Sets include means for measuring heater,<br>grid and space currents and for making cath-<br>ode activity tests. Assuming no change in<br>the various tube voltages, space current will<br>usually change with tube age and the direc-<br>tion of this shift may vary, depending upon<br>the type and construction of tube and the   |             |
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circuit in which it is employed. The tubes employed in these carrier systems usually will show a gradual systematic reduction of space current with time. When using the Tube Test Sets the millivolt drop across a resistance in the cathode circuit of a tube is measured rather than the actual space current.

1.04 Grid current does not flow in a tube as usually employed, except under conditions of overload or special operating conditions such as those encountered in oscillator tubes or in the carrier generator circuit. A slight amount of grid current may flow in an amplifier tube having a low grid impedance without seriously affecting its operation. However, the existence of any appreciable grid current under ordinary conditions is probably an indication of unsatisfactory circuit or tube operation.

1.05 Cathode activity is measured by observing the per cent change in space current which takes place with a given change in heater current. The magnitude of this change will usually give an approximate indication of the remaining useful life of a tube. The circuits of the type K deviation regulators are such that the space current of a control tube is maintained at a constant value for a wide variation in the activity of its cathode. However, the condition of the activity of the cathode is indicated by the d-c voltage applied to the grid circuit. Thus, the cathode activity of a control tube is measured with the LAC Tube Test Set by observing the per cent change in applied grid voltage which takes place with a given change in heater current.

1.06 A cord and plug are permanently connected to the heater current measuring circuit for connecting this circuit to the equipment under test. Connections to the grid and space current measuring circuits are made by means of additional cords, the particular cord to be employed depending upon the type of equipment to be tested. The power for operating the vacuum tube of the LAC Tube Test Set is obtained by a P3Y cord which connects the LAC Tube Test Set to the battery supply jack provided in the regulator bays.

1.07 The IR Set and the LAC Set, in performing the equivalent functions of the IR Set, are entirely self-contained with the exception of the cords used to pick up the grid and plate circuits of the equipment containing the tubes to be tested. The power connection made with the P3Y cord described in Paragraph 1.06 is required for the LAC Set when measurements on pilot channel control tubes are made. Both sets are mounted in portable cases having a carrying handle. A face view of the equipment is given in Figs. 1A and 1B. The IR and LAC Sets are provided with a cover for protecting the meters when not in use.

## 2. DESCRIPTION OF CIRCUITS AND FUNCTIONS COMMON TO IR AND LAC TUBE TEST SETS

### (A) Meters

2.01 The test set includes two Weston Model 643 type meters which are accurate to within 1 per cent of the full scale deflection. They are calibrated for use in a horizontal position. One meter, KS-7898, is associated with the heater (filament) current measuring circuit and the other, KS-7899, with the grid and space current measuring circuits. The former is designated FILAMENT CURRENT and has two scales, one of which is graduated to read currents from .50 to 1.0 ampere and the other to read from .25 to .50 ampere. A key is included for switching from one scale to the other. This meter is a suppressed zero type so no change should be made in the setting of the pointer adjusting screw until the meter is checked by means of a series calibrating meter.

2.02 The other meter, which is designated SPACE-GRID, has a normal resistance of 2000 ohms and requires 30 microamperes for full scale deflection. Arrangements are provided for switching a 23,000-ohm resistance into the circuit, thus permitting the meter to be used not only as a microammeter but a millivoltmeter as well. Three scales are provided as follows: One graduated to read microamperes between 0 and 5 on the left-hand side of the scale; a second to read millivolts from 0 to 750; and a third to read per cent activity between 0 and 50 per cent, the 0 point being located at the extreme right-hand end of the scale and the 50 per cent point at mid-scale. The meter is protected by means of an external 200-ohm shunt which can be removed from across the meter by means of a non-locking key. Another key is employed to switch the meter from the microampere to the millivolt measuring condition. A third key reverses the flow of current through the meter.

### (B) Functions of the Heater Current Measuring Circuit

2.03 The heater (or filament) current measuring circuit which is common to both the IR and LAC Tube Test Sets is shown in Fig. 2. It consists of an M3AL cord equipped with a 304A plug for making connection to the equipment under test, two 36-ohm wire rheostats arranged to operate together, two keys, and a Weston milliammeter as described above. The keys are designated METER SCALE and CURRENT and are also marked 1 and 2, respectively.

2.04 The key functions are as follows:

| <u>Key</u> | <u>Position</u> | <u>Function</u>   |
|------------|-----------------|---|
| 1          | HIGH            | FILAMENT CURRENT meter indicates current on .5 to 1.0 ampere scale. |

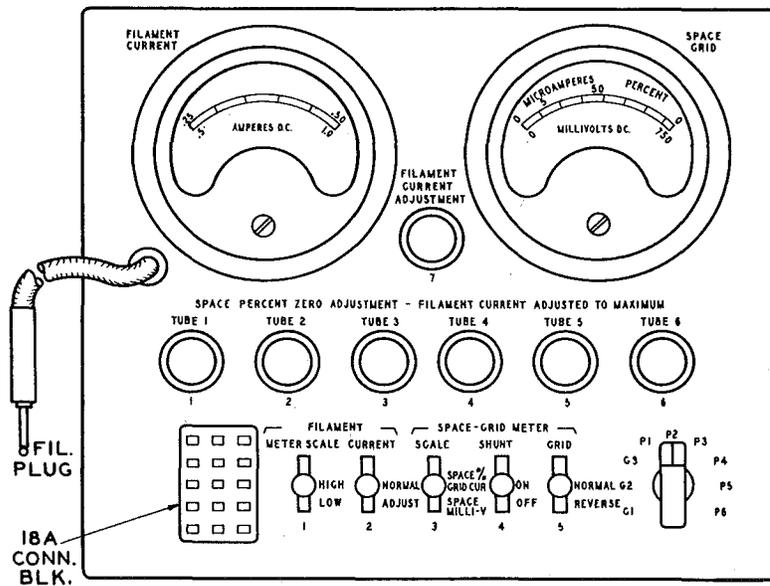


Fig. 1A - Face View of 1R Tube Test Set Equipment

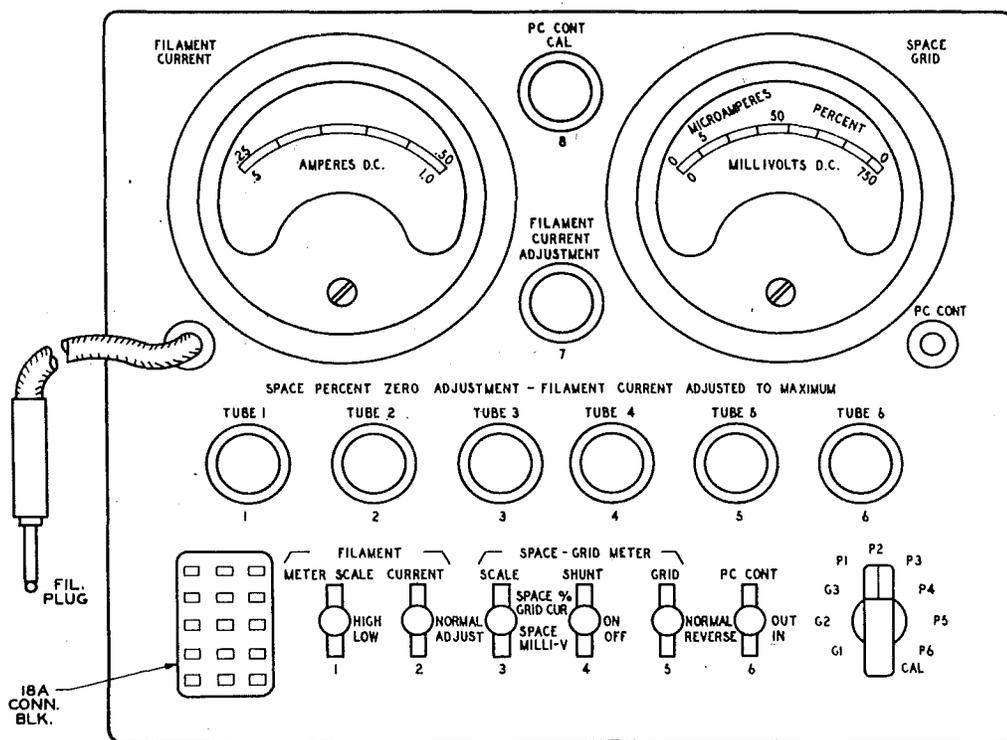


Fig. 1B - Face View of 1AC Tube Test Set Equipment

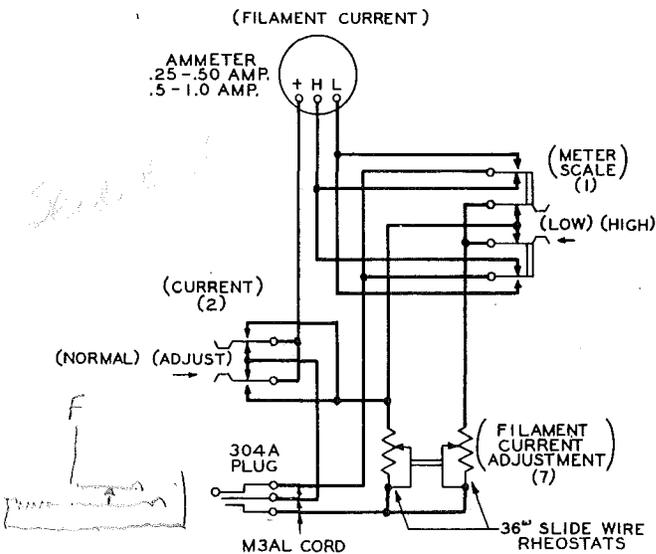


Fig. 2 - Heater Current Measuring Circuit

| Key | Position | Function   |
|-----|----------|--|
| 1   | LOW      | FILAMENT CURRENT meter indicates current on .25 to .50 ampere scale.   |
| 2   | NORMAL   | FILAMENT CURRENT meter is connected directly in series with the heater circuit under test and indicates normal current.  |
| 2   | ADJUST   | FILAMENT CURRENT meter and a rheostat are connected in series with heater circuit under test. The rheostat is switched into the circuit in place of the heater current adjusting resistances or ballast lamps. This is a double rheostat. One winding is used for the LOW scale position and the two windings in parallel are used for the HIGH scale position of key 1. |

### (C) Functions of Circuit for Measuring Grid Current, Space Current, and Cathode Activity

2.05 The following circuit descriptions, Paragraphs 2.05 to 2.17 inclusive, apply to the 1R Tube Test Set and also apply to the 1AC Tube Test Set when the PC CONT key is in the OUT position, which is the condition under which the functions of the 1AC Tube Test Set are identical to those of the 1R Tube Test Set. The circuits which are shown schematically in Figs. 3A and 3B are arranged to measure individually the grid currents of three tubes and the space currents and activities of six tubes. Measurements are made by connecting the meter across resistances in the grid and cathode circuits

of the tubes to be tested. Consequently, these are voltages rather than current measurements, although the actual currents can be calculated from the meter readings, inasmuch as the values of the resistances across which the measurements are made are known. Ordinarily, however, tube limits will be set up on the basis of actual meter readings so that conversion to currents will not be necessary.

2.06 The testing circuit includes the microammeter described above, six variable resistances, three keys, and a rotary switch for selecting the tube to be tested. When this switch is in position G1, G2, or G3 the circuit is arranged for measuring grid currents, and when in positions P1 to P6 is arranged for measuring space currents and per cent activity. Each of the six circuits for measuring space current contains a 1,000-ohm resistance and a 38,000-ohm rheostat. These are, however, short-circuited by means of key 3 during a measurement of space current and are employed only when making cathode activity measurements.

2.07 The designations on the rotary switch, G1 to G3 and P1 to P6, correspond to the tube numbers in the circuits under test. For example, the switch would be set on G1 to measure the grid current of the first tube (1) of an amplifier and on P3 to measure the space current of the third tube (3).

2.08 The functions of keys 3, 4, and 5 are listed in the following table:

| Key | Position         | Function   |
|-----|------------------|--|
| 3   | SPACE %-GRID CUR | For grid measurements the 23,000-ohm millivoltmeter resistance is short-circuited and for space per cent measurements it is replaced by a SPACE PER CENT ZERO ADJUSTMENT rheostat. |
| 3   | SPACE MILLI-V    | The SPACE PER CENT ZERO ADJUSTMENT rheostats are short-circuited so that the SPACE - GRID meter functions as a 25,000-ohm millivoltmeter for measuring space currents.             |
| 4   | ON               | In this position a 200-ohm protective shunt resistance is connected across the SPACE - GRID meter. This provides protection for the meter.   |

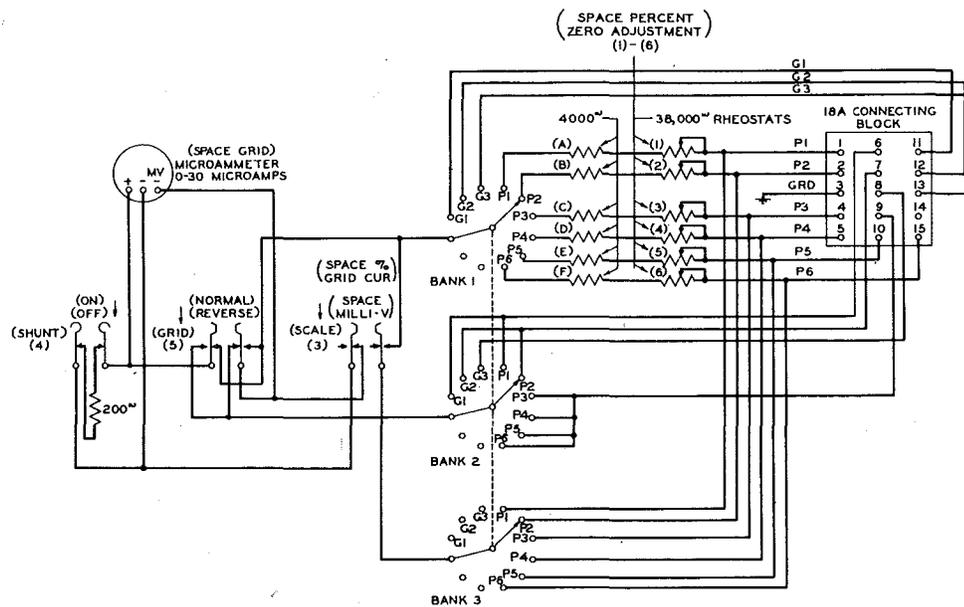


Fig. 3A - 1R Tube Test Set Circuit for Testing Grid and Plate Currents

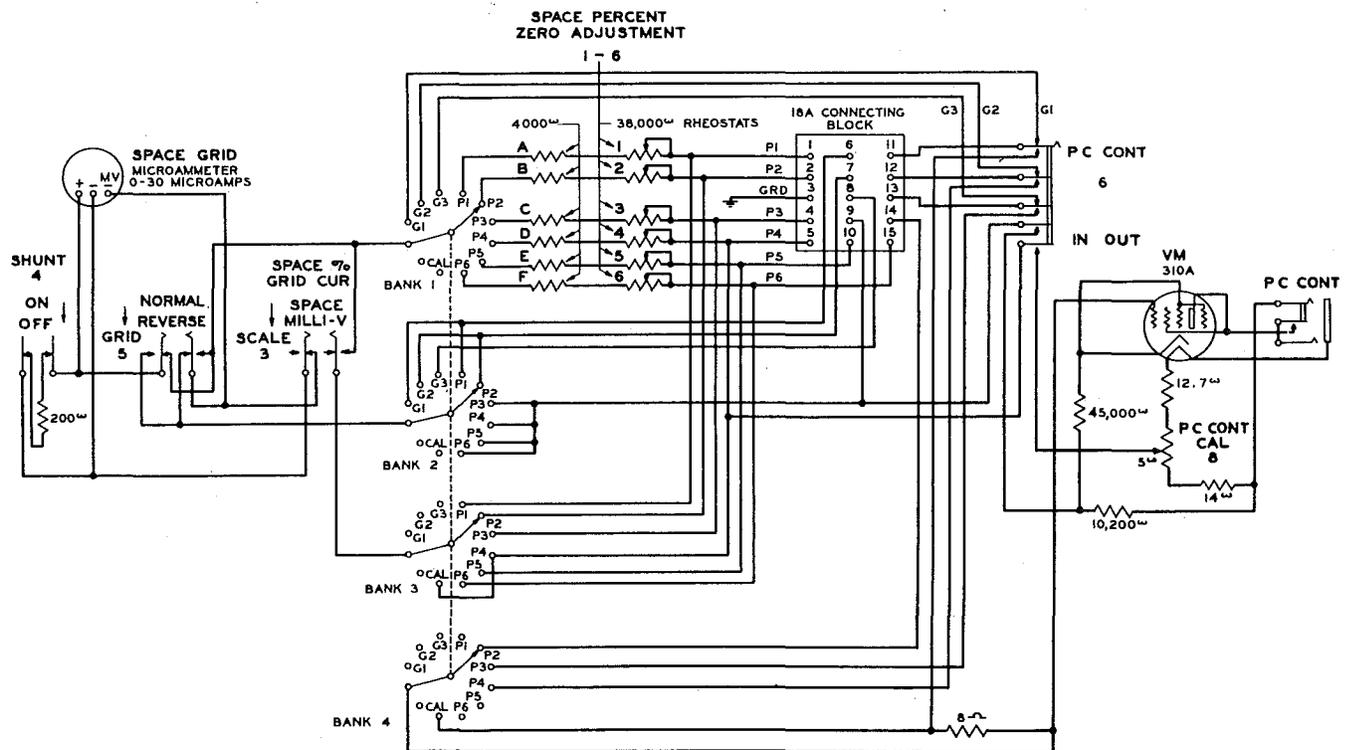


Fig. 3B - 1AC Tube Test Set Circuit for Testing Grid and Plate Currents and the D-C Grid Voltage of Type K1 Carrier Pilot Channel Control Tubes

| Key | Position | Function  |
|-----|----------|---|
| 4   | OFF      | The 200-ohm protective shunt is removed, thus permitting direct readings of grid and space current and per cent activity. |
| 5   | NORMAL   | Connections to meter from test circuit are normal.  |
| 5   | REVERSE  | Connections to meter from test circuit are reversed. Used mainly for measuring grid currents.                             |

#### (D) Grid Current Measurements

2.09 As previously explained, grid currents are measured by connecting the meter across a resistance in the grid circuit of the tube to be tested. The current readings thus obtained are not actual grid currents. However, the readings are directly proportional to the true grid currents so that they can be used for assigning limiting values. The measuring circuit is shown schematically in Fig. 4. The connection from the equipment containing the tube under test to the 18A Connecting Block in the test set is made by means of a cord as described in Paragraph 2.17.

2.10 The circuit is set up by operating the rotary switch to G1, G2, or G3 and having keys 3, 4, and 5 in their normal position. The SPACE-GRID meter is thus connected directly across the resistance in the grid circuit. If the initial reading is 3 microamperes or less on the 0-5 microampere scale, after operating the GRID key to both positions for checking the direction of the current, key 4 can safely be operated to the OFF position, thus removing the 200-ohm shunt resistance which provides protection for the meter. This key is non-locking. When operated, a full scale meter deflection is obtained for a meter current of 30 microamperes. Only the first 5 microamperes are marked on the scale.

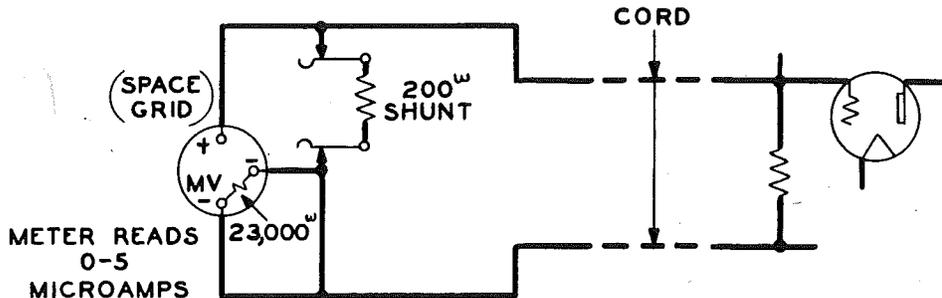


Fig. 4 - Grid Current Measuring Circuit

2.11 Not all of the equipment which uses the 1R Set for testing tubes is arranged for measuring grid currents. The maintenance instructions for a particular circuit or carrier system will state the requirements for each case. The test set is arranged for measuring the grid current of circuits normally having extremely small or zero grid current. However, with special wiring on the circuit under test, very large grid currents can be measured by utilizing the space current measuring circuit of the test set. It may be necessary to operate key 5 to REVERSE for this test.

#### (E) Space Current Measurements

2.12 The space current of a tube under test is obtained by a measurement of the millivolt drop across a resistance in the cathode circuit. The measuring circuit is shown schematically in Fig. 5. Connection from the test set to the equipment is made by a cord as described in Paragraph 2.17 and the rotary switch is set to P1 to P6, depending on which tube is to be tested.

2.13 If the initial meter reading with key 4 in the ON position does not exceed 10 per cent of full scale (75 millivolts), key 4 can safely be operated to the OFF position, thereby removing the protective resistance and permitting a more accurate reading. Under this condition, the space current in milliamperes will be equal to the reading in millivolts divided by the value of the resistance in the plate circuit of the tube under test. As previously explained, however, this will not normally be necessary, inasmuch as tube rejection limits are set up on a meter reading basis.

#### (F) Cathode Activity Tests

2.14 The circuit for making activity tests is illustrated schematically in Fig. 6. For this measurement, the 23,000-ohm series resistance of the millivoltmeter is replaced by a 4,000-ohm resistance and a 38,000-ohm rheostat. Separate rheostats, designated SPACE PER CENT ZERO ADJUSTMENT, are provided

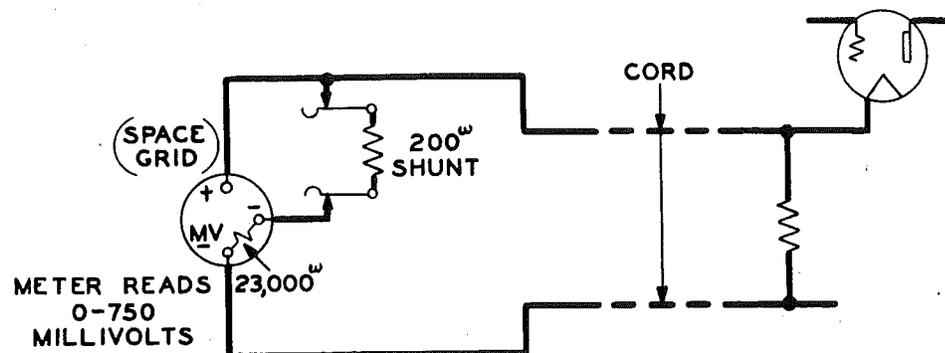


Fig. 5 - Space Current Measuring Circuit

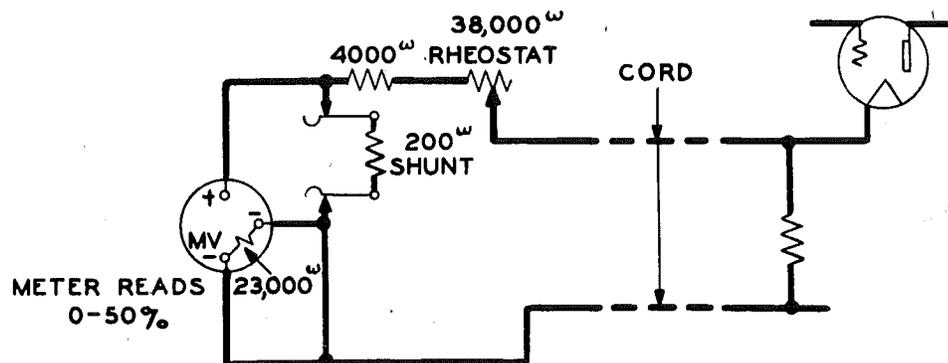


Fig. 6 - Cathode Activity Test Circuit

for each of the six activity measuring circuits. The rotary switch is set to any one of the P1 to P6 positions, depending on which tube is to be tested.

2.15 The heater current measuring circuit is also employed when making this test, and the change in space current for a given heater current change is measured on the per cent scale. Under the normal current condition for a particular tube circuit, the SPACE-GRID meter is made to read zero on the per cent scale by adjusting the 38,000-ohm rheostat. The heater current is then reduced by a specified amount and the percentage change in space current observed after sufficient time has elapsed for the space current to stabilize. The heater current and space per cent readings should be observed and data taken only after they have remained steady for a period of about one minute.

2.16 When cathode activity tests are made on oscillator tubes such as those employed in C5 terminals the testing principle is somewhat different from that just described although the testing method is identical. The performance of tubes of this type can be determined better by grid current rather than space current measurements. For this reason

activity tests are made by observing the percentage change in grid current due to a specified change in heater current as noted in Paragraph 2.11.

#### (G) Connecting Cords

2.17 Several shielded cords have been designed for connecting the 1R and 1AC Tube Test Sets to the various types of equipment with which they are designed to operate. These cords are 6 feet long and are coded and used as listed in the following table.

| Cord Code | Plug Codes                   | Arranged for Testing      | Used With  |
|-----------|------------------------------|---------------------------|--|
| M1T       | 306A and 307A                | Space Currents of 2 Tubes | Types J and K Carrier, Certain Type C Carrier Circuits and Volcas Circuits |
| M11C      | 307A and Yaxley 625 Pin Plug | Space Currents of 6 Tubes | Type J Carrier   |

| <u>Cord Code</u> | <u>Plug Codes</u>            | <u>Arranged for Testing</u>        | <u>Used With</u>      |
|------------------|------------------------------|------------------------------------|-----------------------|
| M12B             | 307A and Yaxley 625 Pin Plug | Grid and Space Currents of 3 Tubes | Type K Carrier        |
| M15A             | 307A (both ends)             | Space Currents of 4 Tubes          | 14C Program Amplifier |
| P3W              | 309 and 307A                 | Space Currents of 2 Tubes          | V-1 Repeater          |

### 3. DESCRIPTION OF CIRCUITS AND FUNCTIONS PARTICULAR TO THE IAC TUBE TEST SET

#### (A) Circuit Functions in Measuring Applied Grid Voltage and Cathode Activity of K1 Pilot Channel Control Tubes

3.01 This circuit is shown schematically in Fig. 3B. Power is supplied to the VM tube by the use of a P3Y cord, which makes the connections from the PC CONT jack on the IAC Set to the TTS battery supply jacks provided in the regulator bays. The pilot channel control circuit is connected to the IAC Set by an M8E cord with 307A and 625 Yaxley pin plugs. When this connection is made terminals 7 and 9 of the 18A connecting block are interconnected and terminals 2, 4, and 5 of the 18A connecting block are connected together. The circuit arrangements are such that the grid circuits of the control tubes are connected between terminals 11 and 12, 13, or 14 of the 18A connecting block. Thus when the PC CONT key is operated to the IN position, the switch to positions P2, P3, or P4, and key 3 is operated to SPACE MILLI-V, the IAC Tube Test Set is set up for measuring the d-c voltages applied to the grids of these control tubes. When key 3 is operated to SPACE PER CENT the IAC Set is set up to measure the percentage change in the grid voltage when making an activity test. A simplified schematic of these circuit arrangements is shown in Fig. 7.

#### (B) Calibration

3.02 To calibrate the voltmeter circuit, the switch of the IAC set is turned to the CAL position, which causes the input to the grid of the VM tube to be shorted. The PC CONT CAL dial is then adjusted until a zero millivolt reading is obtained on the SPACE-GRID meter with key 3 operated to Space Milli-V and the shunt key in the OFF position. In this condition, the terminals of the meter are connected to equal potential points in the heater and cathode circuits.

#### (C) Voltage Measurements on Control Tubes

3.03 When the switch is turned to position P2, P3, or P4, the d-c voltage at the grid of the respective control tubes is applied to the 8-megohm input circuit of the VM tube through a 2-megohm series resistance in the control circuit. The polarity is such that the grid is at a negative potential. This negative potential reduces the cathode current of the VM tube and upsets the balance obtained in the calibration. The resulting difference in potential between the terminals of the meter is indicated on the millivolt scale when the shunt key is in the OFF position.

3.04 Because of the 2-megohm series resistance in the control tube circuit, only .8 of the actual grid voltage is applied to the grid circuit of the VM tube. However, the constants of the IAC set are so arranged that the millivolt reading multiplied by a factor of 10 indicates the actual voltage on the grid of the control tube.

#### (D) Cathode Activity Measurements of Control Tubes

3.05 The cathode activity of a control tube is measured by observing the percentage change in grid voltage when the heater current is changed a specified amount. This circuit is also illustrated in Fig. 7.

3.06 For this measurement, the 23,000-ohm series resistance of the millivoltmeter is replaced by a 4000-ohm resistance and a 38,000-ohm rheostat.

3.07 Under the normal heater current for a particular tube circuit, the SPACE-GRID meter is made to read zero on the per cent scale by adjusting the 38,000-ohm rheostat. The heater current is then reduced by a specified amount and the percentage change in grid voltage observed after sufficient time has elapsed for the tubes to stabilize. The heater current and per cent readings should be observed and data taken only after they have remained steady for a period of about one minute.

#### (E) Connecting Cords

3.08 Cords have been designed for connecting the IAC Test Set to the equipment with which it is designed to operate. These cords are 6 feet long and are coded and used as listed in the following table.

| <u>Cord Code</u> | <u>Plug Codes</u>            | <u>Arranged for Testing</u>                                  | <u>Used With</u>                      |
|------------------|------------------------------|--|---------------------------------------|
| M8E              | 307A and Yaxley 625 Pin Plug | Space Current of Tubel and Grid Voltage of Tubes 2, 3, and 4 | Type K Pilot Channel Control Circuits |

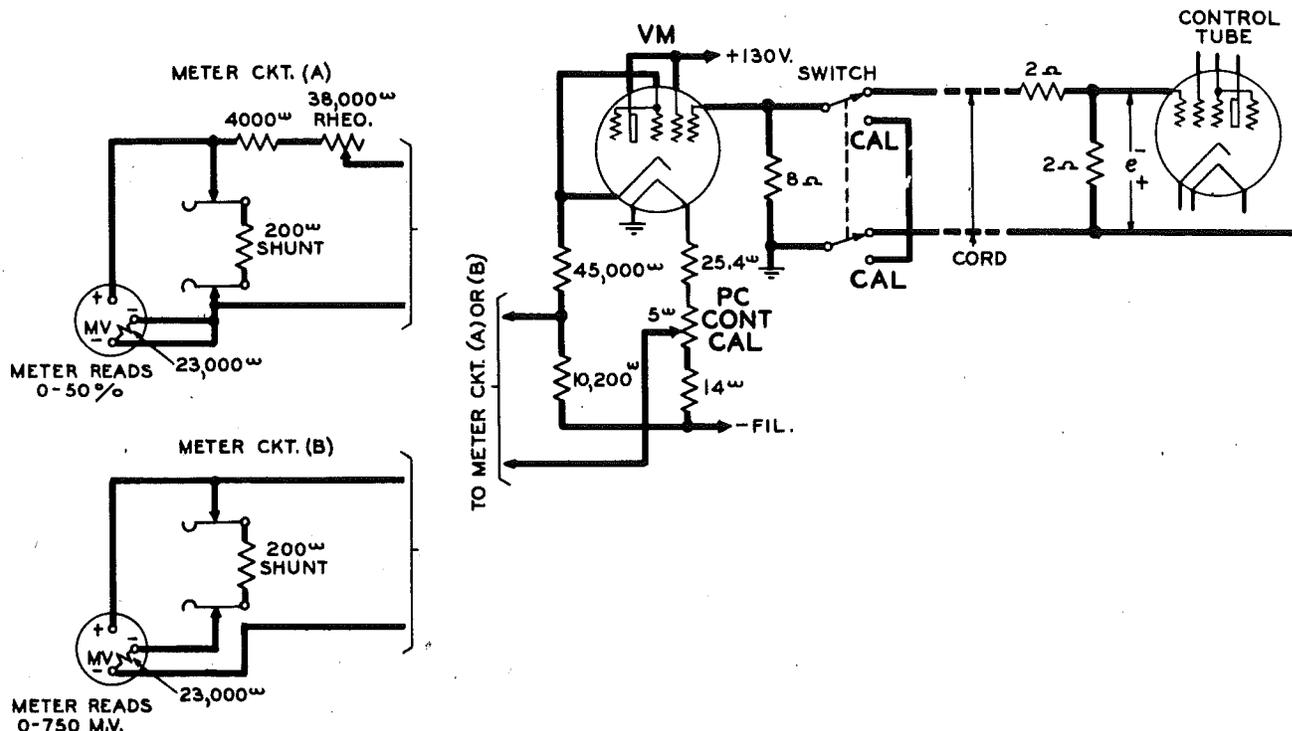


Fig. 7 - Cathode Activity and Grid Voltage Measuring Circuits of the IAC Tube Test Set for Measuring Pilot Channel Control Tubes

| Cord Code | Plug Codes   | Arranged for Testing                            | Used With                             |
|-----------|--------------|---|---------------------------------------|
| P3Y       | 306A and 310 | Connecting Power for the VM Tube of the IAC Set | Type K Pilot Channel Control Circuits |

3 microamperes and in the case of activity and space current measurements the limiting value is 75 millivolts.

4.04 In case tubes have been replaced or the heater current turned off make sure that the tubes have heated up before making any measurements.

#### 4. OPERATING PROCEDURE COMMON TO LR AND IAC TUBE TEST SETS

4.01 This part gives detailed procedures for making heater, grid and space current measurements and for cathode activity tests.

Note: For making these tests, Paragraphs 4.01 to 4.11 inclusive, with the IAC Tube Test Set the PC CONT key must be in the OUT position.

4.02 When making heater (filament) current measurements always start with the METER SCALE key in its normal (HIGH) position. If no deflection is observed on the milliammeter after inserting the plug in the FIL jack, operate the key to the LOW position.

4.03 When making any measurements using the SPACE-GRID meter its deflection should be observed before operating key 4 to the OFF position. If this deflection is less than 10 per cent of full scale the shunt may be removed. In the case of grid current measurements the 10 per cent limiting deflection is

#### (A) Measurement of Heater Current

4.05 In order to conserve filament battery it has been found desirable to operate the tubes of circuits having but one tube in series or parallel with the tubes of other circuits having one or two tubes. This means that, in some instances, the heater current for two separate panels can be controlled from the filament jack in one panel. However, the jacks for picking up the grid and cathode resistance are located in their respective panels.

4.06 The opposite situation exists on the type J carrier amplifiers. Because of the large number of tubes per panel, two type 310A and four type 311A, it has been found necessary to provide three filament jacks on each amplifier panel. The heater circuit of the two 310A tubes designated 1 and 2 can be picked up by plugging in jack A. The heater circuits of the 311A tubes 3, 4 and 5, 6 can be picked up in jacks B and C respectively. The cathode resistors for all six tubes are available for test on the one Yaxley receptacle.

## 4.07 Procedure:

- (1) With all keys in their normal positions insert the filament plug of the test set in the FIL jack of the circuit under test.
- (2) Read the normal heater current on the FILAMENT CURRENT meter, using .50 to 1.0 ampere scale.
- (3) If no reading is obtained operate key 1 to LOW and read the heater current using the .25 to .50 ampere scale.

(B) Measurement of Grid Current

## 4.08 Procedure:

- (1) With keys 2, 3, 4 and 5 in their normal positions, connect the test set to the FIL ACT TST jacks of the circuit to be tested by means of the proper cord as specified in Paragraph 2.17.
- (2) Operate the dial switch on the test set to G1, G2 or G3 depending upon the tube to be tested.
- (3) Note reading of SPACE-GRID meter on 0-5 microampere scale. If no reading is obtained, operate key 5 to REVERSE to see if current is flowing in the other direction.
- (4) If a reading of less than 3 microamperes is observed operate key 4 to OFF and again read the microampere scale of the meter. If the reading is above 5 microamperes take the reading on the millivolt scale. In several cases where readings above 5 microamperes may be expected limits in terms of millivolt scale readings have been specified.
- (5) Release key 4 to protect the meter.
- (6) Repeat steps (2) to (5) for other tubes to be tested.

(C) Measurement of Space Current

## 4.09 Procedure:

- (1) With keys 3, 4 and 5 in their normal positions connect the test set to the FIL ACT TST jack of the circuit to be tested by means of the proper type of cord as specified in Paragraph 2.17.
- (2) Operate the dial switch on the test set to one of the positions P1 to P6 depending upon the tube to be tested.
- (3) Operate key 3 to SPACE MILLI-V.

(4) If a reading of less than 75 on the 750 millivolt scale is obtained operate key 4 to the OFF position and note the meter deflection in millivolts.

(5) If the initial reading is greater than 75 millivolts the actual voltage can be determined approximately with the shunt key normal by multiplying the meter reading by 10. Thus, if a deflection of 80 is obtained the true voltage drop is 800 millivolts.

(D) Measurement of Cathode Activity

4.10 This test should not be made when the battery voltage is changing rapidly, or during or shortly after periods of power failure when abnormal voltage conditions prevail. Such conditions make it impracticable to hold the heater current at the proper value for a satisfactory test.

## 4.11 Procedure:

(1) With all keys in their normal positions insert the filament plug into the FIL jack and patch the proper connecting cord as specified in Paragraph 2.17 between the test set and the FIL ACT TST jack on the circuit to be tested.

(2) If no deflection is observed on the FILAMENT CURRENT meter operate key 1 to LOW. The reading obtained in either case is the heater current drawn by the tubes at the time of the test for the existing office voltage. Carefully observe the meter deflection.

(3) Operate the rotary switch on the test set to one of the P1 to P6 positions depending on the tube to be tested.

(4) Observe the millivolt reading on the SPACE-GRID meter. If this is greater than 75 millivolts reduce the reading by adjusting the SPACE PER CENT ZERO ADJUSTMENT rheostat corresponding in number to the setting of the rotary switch.

(5) After this adjustment, or if the initial reading is less than 75 millivolts, operate key 4 to OFF and adjust the deflection of the SPACE-GRID meter to 0 per cent by means of the SPACE PER CENT ZERO ADJUSTMENT rheostat corresponding to the tube under test.

(6) Release the SHUNT (key 4) and repeat steps (3), (4) and (5) for other tubes to be tested in the same heater circuit by setting the rotary switch to the position corresponding to the next tube to be tested.

(7) Operate key 2 to ADJUST and lower the heater current by means of the FILAMENT CURRENT ADJUSTMENT rheostat, by the appropriate amount given in the following table.

| Nominal (Rated)<br>Value of Heater<br>Current-Amperes | Decrease in Heater<br>Current-Amperes |
|---|---------------------------------------|
| 0.320   | 0.020                                 |
| 0.640   | 0.040                                 |
| 0.425   | 0.025                                 |
| 0.850   | 0.050                                 |

Since the heater current in these heater type tubes drifts back in the direction from which it was changed before becoming stable, it will be found that time can be saved during this adjustment by reducing the current initially slightly more than apparently is necessary.

(8) Set the rotary switch to the P1 to P6 position corresponding to the first tube to be tested. This should be an output tube or last amplifier tube. Operate the SHUNT key to the OFF position and observe the deflections of the two meters. While waiting for the currents to stabilize, occasionally operate the rotary switch to other tube positions and observe the per cent scale.

Caution: If the per cent reading of the SPACE-GRID meter is greater than that specified in the requirements for the tubes under test, key 2 should immediately be returned to NORMAL in order to protect the circuit. Do not continue the activity test until the defective tube has been replaced.

(9) With the FILAMENT CURRENT meter indicating the correct value, and key 4 still in the OFF position, observe the deflection of the SPACE-GRID meter after it has stabilized. This means waiting at least one minute after adjusting the heater current to its proper value. If the heater current changes during this period it should be readjusted and the space current allowed to stabilize as before.

(10) The per cent activity of the tube under test can be read directly on the PER CENT scale of the SPACE-GRID meter when the SHUNT key is operated.

(11) Operate the rotary switch to other tube positions and observe their per cent activity.

(12) Release the SHUNT key and remove the test cords.

## 5. METHOD OF OPERATION OF THE LAC TUBE TEST SET IN TESTING TUBES OF TYPE K PILOT CHANNEL CONTROL CIRCUITS

5.01 This part gives detailed procedures for making heater current, grid voltage and cathode activity tests on type K pilot channel control circuits. Pilot channel control circuits contain four tubes of which only tubes (2), (3), and (4) function as control tubes. Tube (1) is a conventional amplifier tube. In the following tests that are described the LAC Tube Test Set is so arranged that tube (1) is tested for millivolt readings and cathode activity by measuring the voltage drop due to the cathode current flowing through a resistance. Tubes (2), (3), and (4) are tested by measuring the grid voltage with the VM tube circuit of the LAC Set.

5.02 When making heater (filament current) measurements always start with the METER SCALE key in its normal (HIGH) position. If no deflection is observed on the milliammeter after inserting the plug in the FIL jack, operate the key to the LOW position.

5.03 When making any measurements using the SPACE-GRID meter its deflection should be observed before operating key 4 to the OFF position. If this deflection is less than 10 per cent of full scale the shunt may be removed. In the case of activity and grid voltage measurements the limiting value is 75 millivolts.

5.04 In case tubes have been replaced or the heater current turned off make sure that the tubes have heated up before making any measurements.

### (A) Measurement of Heater Current

5.05 Procedure:

- (1) With all keys in their normal positions insert the filament plug of the test set in the FIL jack of the circuit under test.
- (2) Read the normal heater current on the FILAMENT CURRENT meter, using .50 to 1.0 ampere scale.
- (3) If no reading is obtained operate key 1 to LOW and read the heater current using the .25 to .50 ampere scale.

### (B) Measurement of Space Current of Tube (1) and Applied Grid Voltage of Tubes (2), (3) and (4)

5.06 Procedure:

- (1) Connect power to the LAC Tube Test Set by patching from the PC CONT jack on the test set to the TTS jack on the control bay with the P3Y cord and plugs. Allow five minutes for the VM tube in the test set to stabilize.

(2) With keys 3, 4, and 5 in their normal positions and key 6 in the IN position connect the test set to the FIL ACT TST jack of the circuit to be tested by means of the proper type of cord as specified in Paragraph 3.08.

(3) Operate the switch to the CAL position.

(4) Operate key 3 to SPACE MILLI-V.

(5) Adjust the PC CONT CAL dial until a "0" millivolt reading is obtained with key 4 in the OFF position. This calibrates the test set.

(6) Operate the dial switch on the test set to one of the positions P1 to P4 depending upon the tube to be tested.

(7) If a reading of less than 75 on the 750 millivolt scale is obtained operate key 4 to the OFF position and note the meter deflection in millivolts.

(8) If the initial reading is greater than 75 millivolts the actual voltage can be determined approximately with the shunt key normal by multiplying the meter reading by 10. Thus, if a deflection of 80 is obtained the true voltage reading is 800 millivolts.

(9) As explained in Paragraph 3.04 the reading obtained in (7) or (8) must be multiplied by 10 to obtain the value of applied grid voltage to tubes (2), (3) and (4).

### (C) Measurement of Cathode Activity

5.07 This test should not be made when the battery voltage is changing rapidly, or during or shortly after periods of power failure when abnormal voltage conditions prevail. Such conditions make it impracticable to hold the heater current at the proper value for a satisfactory test.

#### 5.08 Procedure:

(1) With keys 3, 4, and 5 in their normal positions and key 6 in the IN position insert the filament plug into the FIL jack and patch the proper connecting cord as specified in Paragraph 3.08 between the test set and the FIL ACT TST jack on the circuit to be tested.

(2) If no deflection is observed on the FILAMENT CURRENT meter operate key 1 to LOW. The reading obtained in either case is the heater current drawn by the tubes at the time of the test for the existing office voltage. Carefully observe the meter deflection.

(3) Calibrate as in Paragraph 5.06, (3), (4) and (5).

(4) Operate the rotary switch on the test set to one of the P1 to P4 positions depending on the tube to be tested.

(5) Observe the millivolt reading on the SPACE-GRID meter. If this is greater than 75 millivolts reduce the reading to below 75 millivolts by adjusting the SPACE PER CENT ZERO ADJUSTMENT rheostat corresponding in number to the setting of the rotary switch.

(6) After this adjustment, or if the initial reading is less than 75 millivolts, operate key 4 to OFF and adjust the deflection of the SPACE-GRID meter to 0 per cent by means of the SPACE PER CENT ZERO ADJUSTMENT rheostat corresponding to the tube under test.

(7) Release the SHUNT (key 4) and repeat steps (4), (5) and (6) for other tubes to be tested in the same heater circuit by setting the rotary switch to the position corresponding to the next tube to be tested.

(8) Operate key 2 to ADJUST and lower the heater current by means of the FILAMENT CURRENT ADJUSTMENT rheostat by the appropriate amount given in the following table.

| Nominal (Rated)<br>Value of Heater<br>Current-Amperes | Decrease in Heater<br>Current-Amperes |
|---|---------------------------------------|
| 0.320   | 0.020                                 |
| 0.640   | 0.040                                 |
| 0.425   | 0.025                                 |
| 0.850   | 0.050                                 |

Since the heater current in these heater type tubes drifts back in the direction from which it was changed before becoming stable, it will be found that time can be saved during this adjustment by reducing the current initially slightly more than apparently is necessary.

(9) Set the rotary switch to the P1 to (P4) position corresponding to the first tube to be tested. Operate the SHUNT key to the OFF position and observe the deflections of the two meters. While waiting for the currents to stabilize, occasionally operate the rotary switch to other tube positions and observe the per cent scale.

Caution: If the per cent reading of the SPACE-GRID meter is greater than that specified in the requirements for the tubes under test, key 2 should immediately be returned to NORMAL in order to protect the circuit. Do not continue the activity test until the defective tube has been replaced.

(10) With the FILAMENT CURRENT meter indicating the correct value, and key  $k_4$  still in the OFF position, observe the deflection of the SPACE-GRID meter after it has stabilized. This means waiting at least one minute after adjusting the heater current to its proper value. If the heater current changes during this period it should be readjusted and the space current allowed to stabilize as before.

(11) The per cent activity of the tube under test can be read directly on the PER CENT scale of the SPACE-GRID meter when the SHUNT key is operated.

(12) Operate the rotary switch to other tube positions and observe their per cent activity.

(13) Release the SHUNT key and remove the test cords.

## 6. LIST OF DRAWINGS

Not attached.

| <u>Title</u>                                  | <u>Drawing</u> |
|---|----------------|
| 1R Tube Test Set -<br>Schematic               | SD-64031-01    |
| 1R Tube Test Set -<br>Assembly and Equipment  | ED-62066-01    |
| 1AC Tube Test Set -<br>Schematic              | SD-64956-01    |
| 1AC Tube Test Set -<br>Assembly and Equipment | ED-61950-01    |

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