

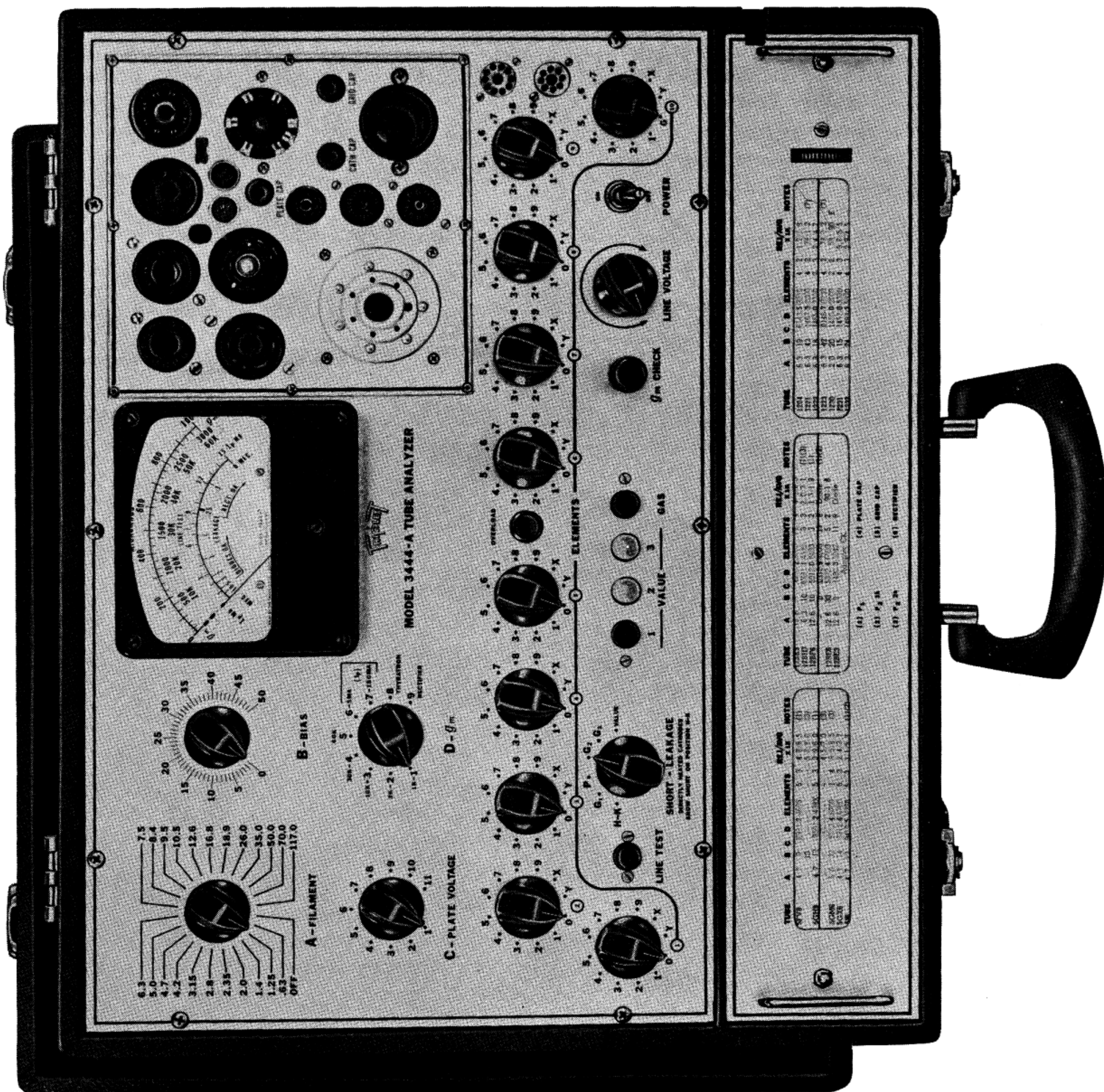
INSTRUCTION MANUAL
MODEL 3444-A TYPE 1
TUBE ANALYZER

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THE TRIPLETT ELECTRICAL INSTRUMENT CO.

Bluffton Ohio



MODEL 3444-A (TYPE I)

TECHNICAL DATA

MODEL 3444-A TYPE I

Gm SIGNAL POTENTIALS AND RANGES

FIVE direct reading Gm ranges

1. 1,000 micromhos
2. 3,000 micromhos
3. 10,000 micromhos
4. 30,000 micromhos
5. 60,000 micromhos

FIVE signal potentials @ 5 KHz

1. 1000 millivolts
2. 333 millivolts
3. 100 millivolts
4. 33 millivolts
5. 16 millivolts

SHORT TEST

Filtered DC, 85 Volts. In accordance with EIA G-8 Committee recommendations.

LEAKAGE

0 to 20 megohms at 85 volts (measurements made directly on the meter.)

PLATE POTENTIALS AND CURRENT RANGES

Four DC plate potentials.

- 12 volts
- 30 volts
- 100 volts
- 250 volts

Two DC plate current ranges (can be used for plate current cut-off measurements and grid current readings to determine cut-off point of tube.)

- 15 ma } full scale
- 150 ma }

BIAS

Two DC bias ranges (on 50 division scale so that actual bias voltages can be read directly.)

- 0 to 5 volts
- 0 to 50 volts

SCREEN POTENTIALS

Five DC screen potentials

- 12 volts
- 30 volts
- 45 volts
- 100 volts
- 250 volts

FILAMENT VOLTAGES

Twenty-three AC voltages, closely regulated:

- .63, 1.25, 1.4, 2.0, 2.35, 2.8, 3.15, 4.2, 4.7, 5.0, 6.3, 7.5, 8.4, 9.5, 10.5, 12.6, 16.8, 18.9, 26.0, 35.0, 50.0, 70.0, 117.0.

Gm CIRCUIT CHECK

Self checking Gm circuit with 5 KHz solid state signal source and solid state microammeter.

GRID CURRENT

Grid current test under operating conditions.

PLATE CUT-OFF

Cut-off measurement on voltage amplifiers.

RECTIFIER TEST

Test for rectifiers is made under load.

DUAL PURPOSE TUBES

Single element switching set up for dual purpose tubes.

THYRATRON TEST

Firing voltage, grid current and cut-off measurements in thyratrons.

SOLID STATE MICROAMMETER

Sensitivity 33 mv full scale.
Current degenerated and highly stable.

SOLID STATE SIGNAL OSCILLATOR

Output 1.4 volts, 5 KHz.
FET-RC oscillator circuit.

REGULATED SUPPLY

Oscillator and microammeter are powered by zener controlled supply for stability.

METER (Suspension)

Rugged 50 microammeter, illuminated, with 4" scale length and knife edge pointer.

TUBE CHART

Roll chart illuminated and removable.

SOCKETS (On removable panel)

Compactron; 9 pin novar; Octal; Loctal; 8 pin subminiature; 7 pin subminiature; 4-5-6 pin combination; 7 pin and pilot light socket; 5 pin nuvistor; 7 pin nuvistor; acorn; 7 pin miniature; 7 pin septar; 9 and 10 pin miniature; 10 pin decal; plate, grid and cathode jacks.

NOTE — Small protrusion at one end of 7 pin subminiature socket indicates No. 1 pin.

PIN STRAIGHTENER DIES

7 pin and 9 pin straightener dies on panel.

CASE

Wood, gray leatherette covered, 15-3/16" x 18-3/16" x 7 3/4".

OVERLOAD INPUT

Red bulb lights with excessive overload.

FUSE

3 amp, 250 volt, type 3AG in roll chart compartment.

WEIGHT

25 pounds.

POWER

117 AC volts, 50-60 Hz.

ACCESSORIES

One black grid cap or cathode cap lead, one red plate cap lead.

THEORY OF OPERATION

This Tube-Analyzer has been designed to provide a portable vacuum tube measuring device that will test and measure tubes under applied potentials and signal amplitudes similar or identical to those in standard laboratory G_m testers or the General Radio Bridge. Full wave filtered dc plate and screen potentials are selected from divider circuits in steps to fit the book values for these potentials listed by the tube manufacturers. The bias control is calibrated in volts, two ranges, zero to 5 and zero to 50, and can be read directly in volts from the dial. Plate current ranges of 15 and 150 milliamperes are available, and mutual conductance is measured in a self checking circuit on 5 independent ranges.

MUTUAL CONDUCTANCE CIRCUIT

Steady state (non pulsating) dc voltages are applied to all elements of amplifier tubes except the heater. These potentials are selected to fit published book values for each tube under test, within the potential limits of 250 volts for plate and screen, and 50 volts for control grid. Heater voltage is available in 23 steps from .63 to 117 volts from a tapped transformer. The source of the grid signal is a 5000 cycle sine wave oscillator. This operates in conjunction with a solid state microammeter to read micromhos. Both the oscillator and electronic microammeter receive power from a regulated power supply. Solid state rectifiers are used in all circuits for long life and best regulation. All circuits are adequately by-passed for minimum circuit impedance at 5 KHz.

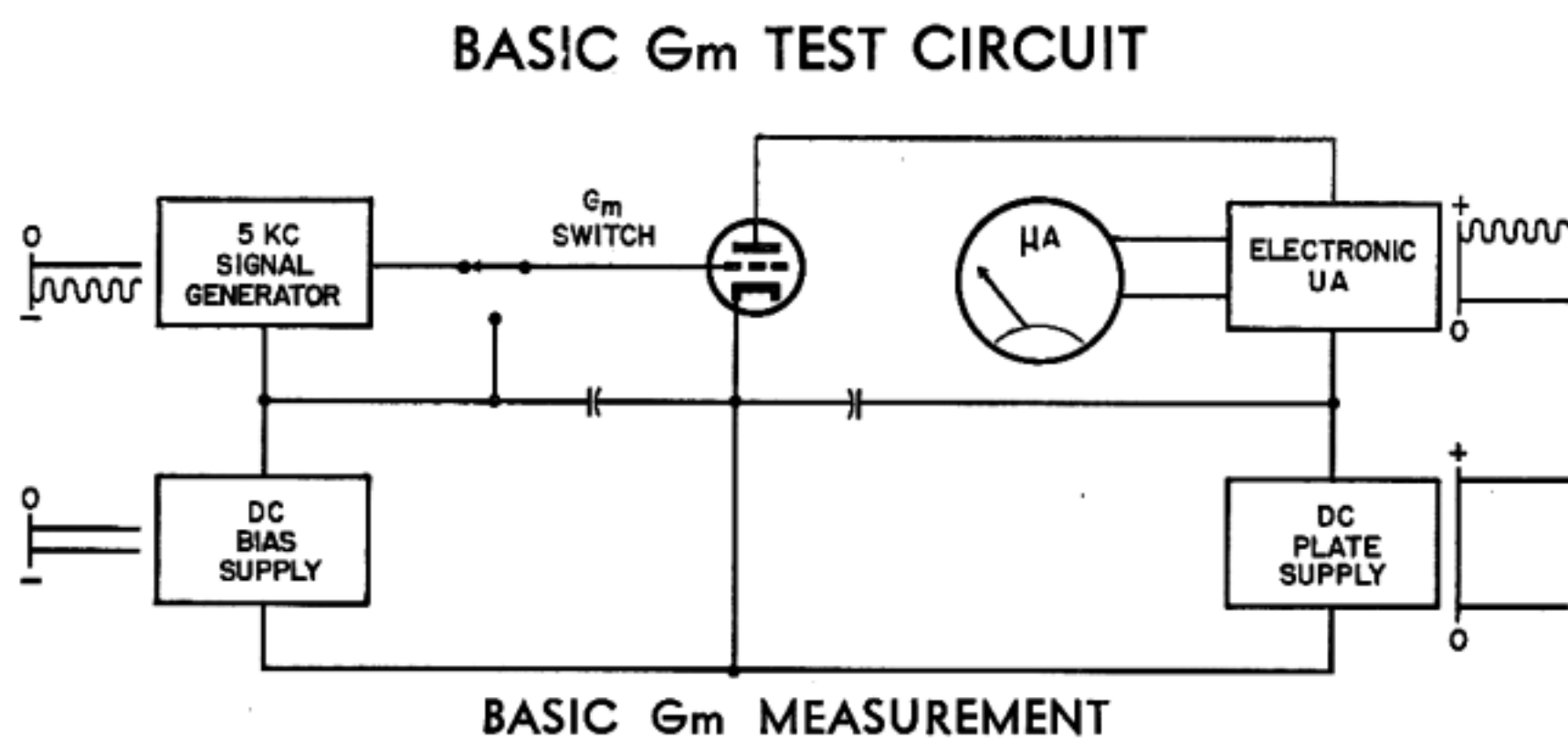


Fig. 1

When the G_m test switch is closed, the 5 KHz signal is applied to the control grid of the tube under test, and this produces a 5 KHz plate current component in the plate circuit. Before this component is measured, it must be separated from the DC plate current and 120 cycle supply ripple. This is done by means of a band-pass amplifier whereby only the 5 KHz current reaches the meter. This current is in microamperes per volt of input signal and is therefore in micromhos of transconductance at the applied set of plate, screen and grid potentials. As shown in the diagram the microammeter may also be switched in the signal circuit to measure the signal current flowing thru a precision resistance divider. It may be shown mathematically that by cross checking the output current against this input current a very high order of G_m accuracy can be obtained.

LEAKAGE TEST CIRCUIT

The leakage test circuit is controlled by a SHORT-LEAKAGE SWITCH, which in its five designated positions disconnects all of the tube elements from the other testing circuits and connects them into the leakage testing circuit

(see Fig. 2). In each designated position a specific tube element is isolated and connected into a series circuit consisting of the isolated element, an 85 VDC source, a current limiting resistor, a microammeter and the other elements of the tube. The meter deflection in each position is determined by the insulation resistance existing between the isolated element and the other elements of the tube. Since this deflection is inversely proportional to the leakage resistance, a full-scale deflection indicates a low resistance short. The LEAKAGE scale of the meter is calibrated for a resistance range of zero to 20 megohms.

SHORT TEST CIRCUIT

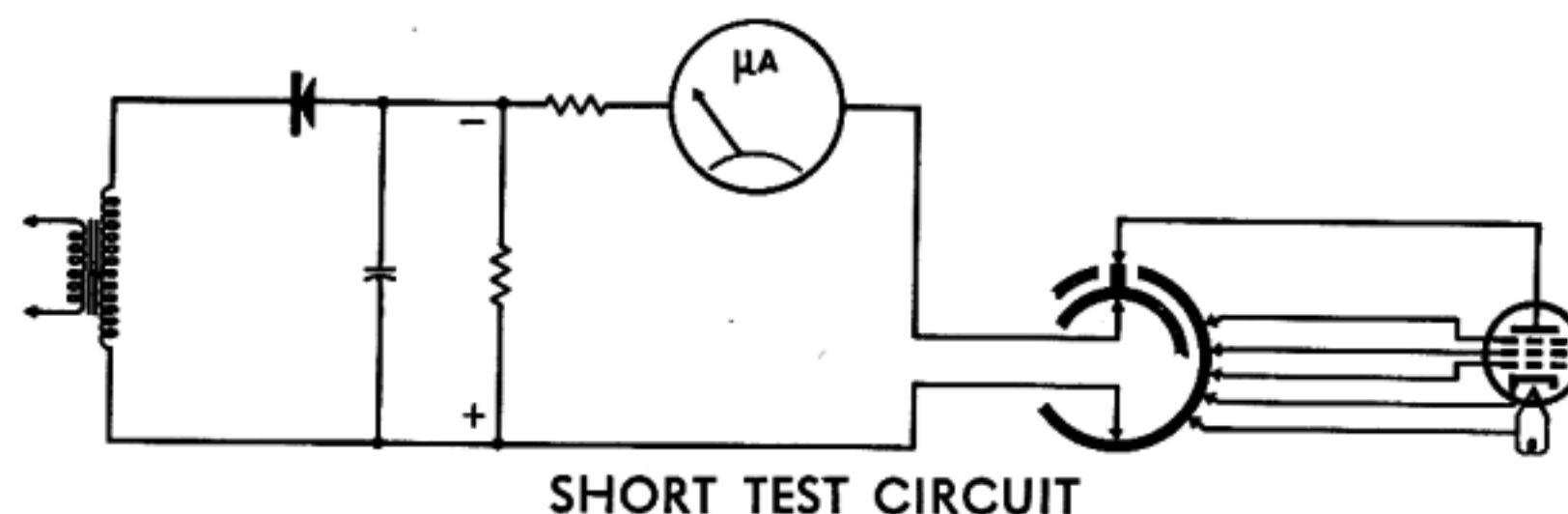


Fig. 2

Using the meter to measure insulation resistance provides a more accurate indication of tube condition, and is particularly useful for selecting tubes that have a high heater-cathode leakage resistance for critical applications. Tubes that have a heater-cathode leakage resistance of less than 250,000 ohms may still function satisfactorily in many circuits. However, leakage resistances as high as several megohms, not detected by the conventional neon bulb short test circuit, may prevent a tube from functioning properly in some applications.

CATHODE EMISSION TEST CIRCUIT

The useful life of a diode or rectifier type tube ends when its ability to emit electrons falls below some level, the exact value of which may differ for each type. In Fig. 3 a dc milliammeter is connected in series with the plate of the tube under test. The meter is protected by a shunt resistor and the tube is protected by a load resistor.

BASIC EMISSION CIRCUIT

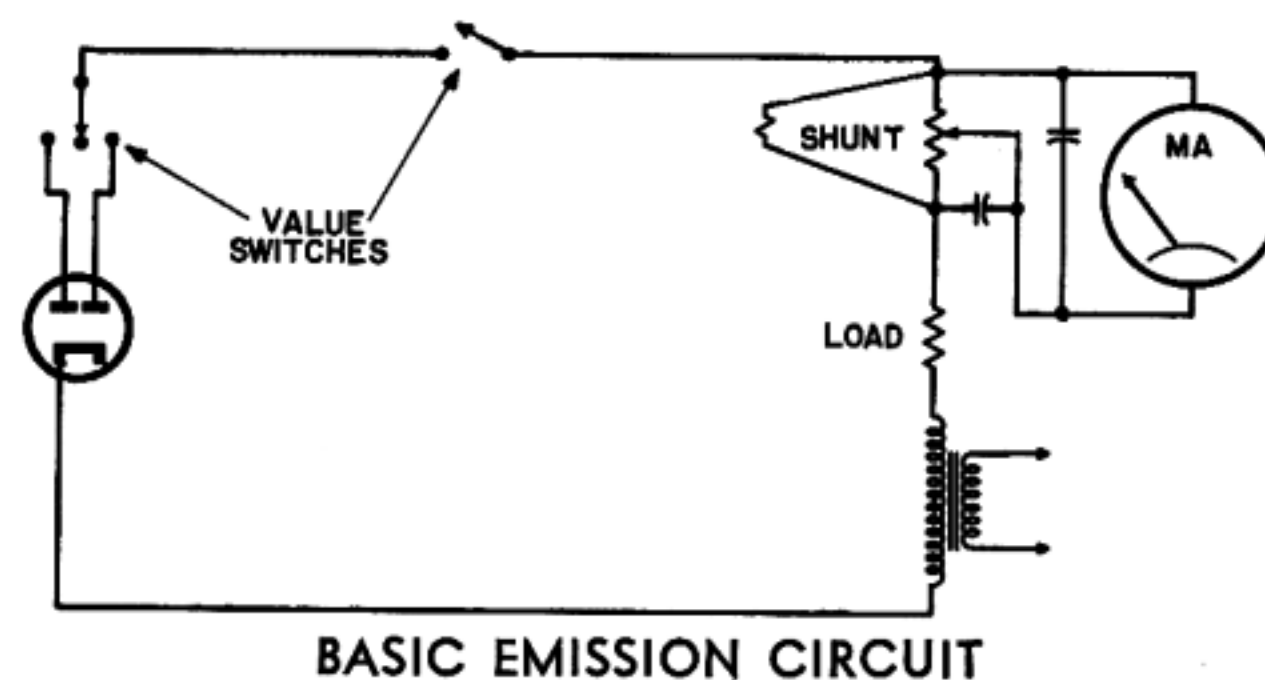


Fig. 3

With the D- G_m RANGE switch in the RECTIFIER position, the quantity of electrons reaching the plate from the cathode is measured by the milliammeter in the plate circuit. Since rectifier and diode type tubes are rated in terms of emissive capacity, the loss of this capacity will be noted by failure of the meter pointer to reach the lo-limit value.

PLATE CURRENT MEASUREMENT

Plate current is measured on either one of two ranges as shown in Fig. 4. The meter reads, directly in dc milliamperes, the plate current drawn by the tube at the grid voltage shown on the B-BIAS dial and the plate and screen voltages listed for the various positions of the C-PLATE VOLTAGE switch.

PLATE CURRENT MEASUREMENT

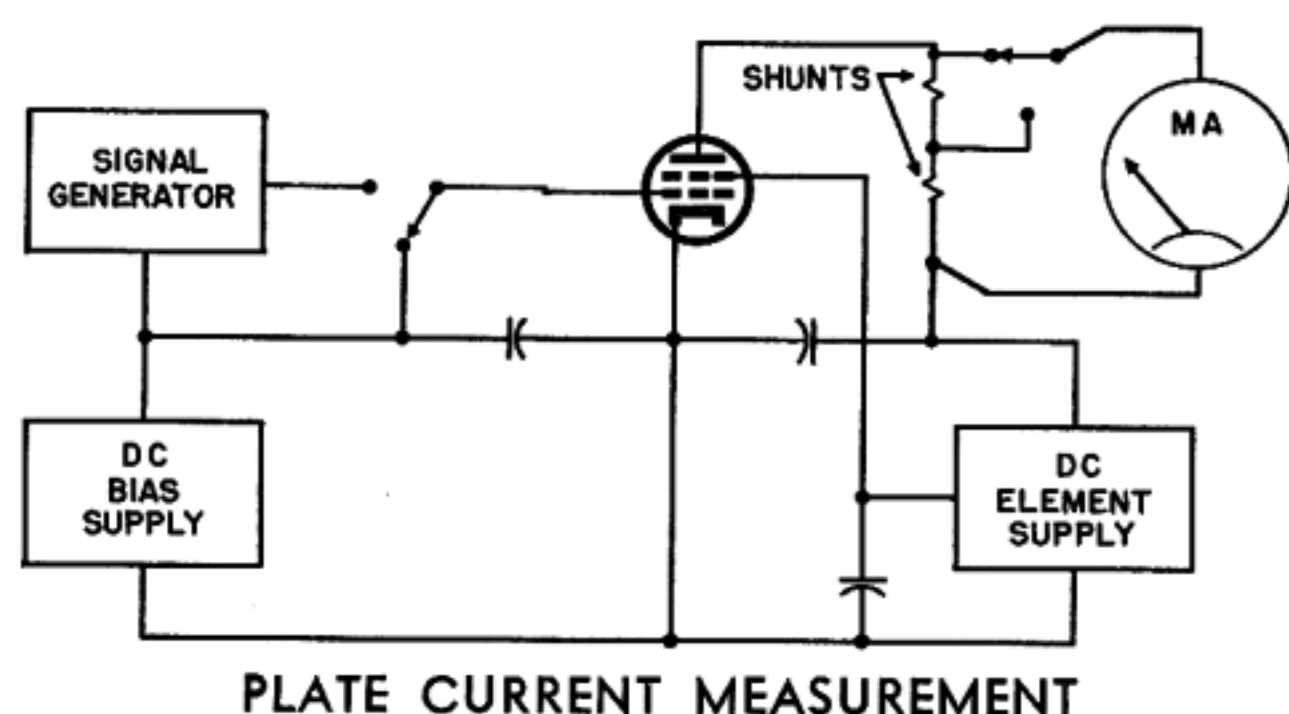


Fig. 4

CUT OFF CHARACTERISTIC

On many tubes it is important to know the dc grid voltage required to "cut-off" or cause the plate current to be reduced to zero. This value can be determined, using the Plate Current circuit, by rotating the B-BIAS or bias control in a negatively increasing direction until the meter just reaches the zero line. The cut-off bias may then be read directly from the B-BIAS dial in volts. This is a particularly important measurement on dual triodes where balanced cut-off as well as normal characteristics are required, such as in computer flip-flop circuits, integrator and memory circuits.

THYRATRON TEST CIRCUIT

In Fig. 5 a dc milliammeter is connected in series with the anode of the tube under test. AC voltage is applied to the plate of the tube by the element transformer, and the heater is energized by the filament transformer. When the dc bias is increased in a negative sense, a point will be reached where the tube will no longer conduct. This point is referred to as cut-off, and is indicated on the meter by a sudden deflection to zero. In operation, the B-BIAS control, is gradually increased between the limits specified in the REJ/AVG column of the tube data chart.

THYRATRON TEST CIRCUIT

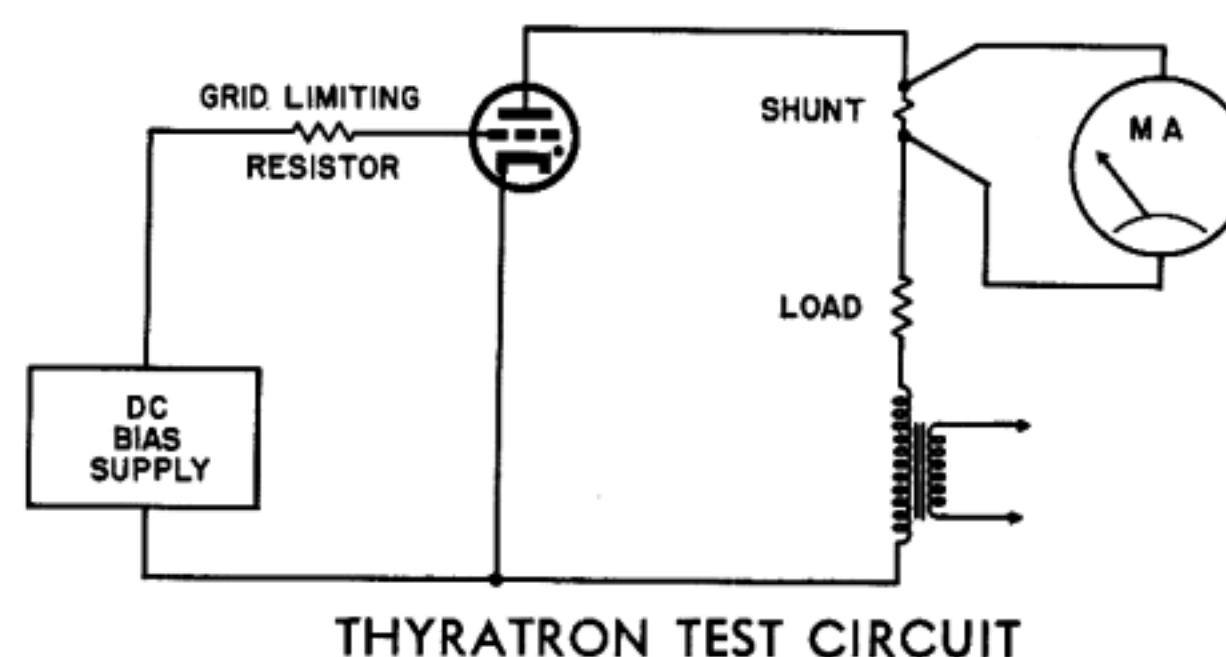


Fig. 5

Any thyatron which fails to cut-off within these limits does not have normal characteristics.

VOLTAGE REGULATOR TEST CIRCUIT

Voltage regulators are checked with a DC potential applied to the anode and a super-imposed AC potential. The peak voltage is increased in steps until the minimum firing or ionizing voltage specified by the tube manufacturer is exceeded. The tube should fire or start to regulate within the limits specified in the roll chart if it is operating correctly. (See Fig. 6)

VOLTAGE REGULATOR TEST CIRCUIT

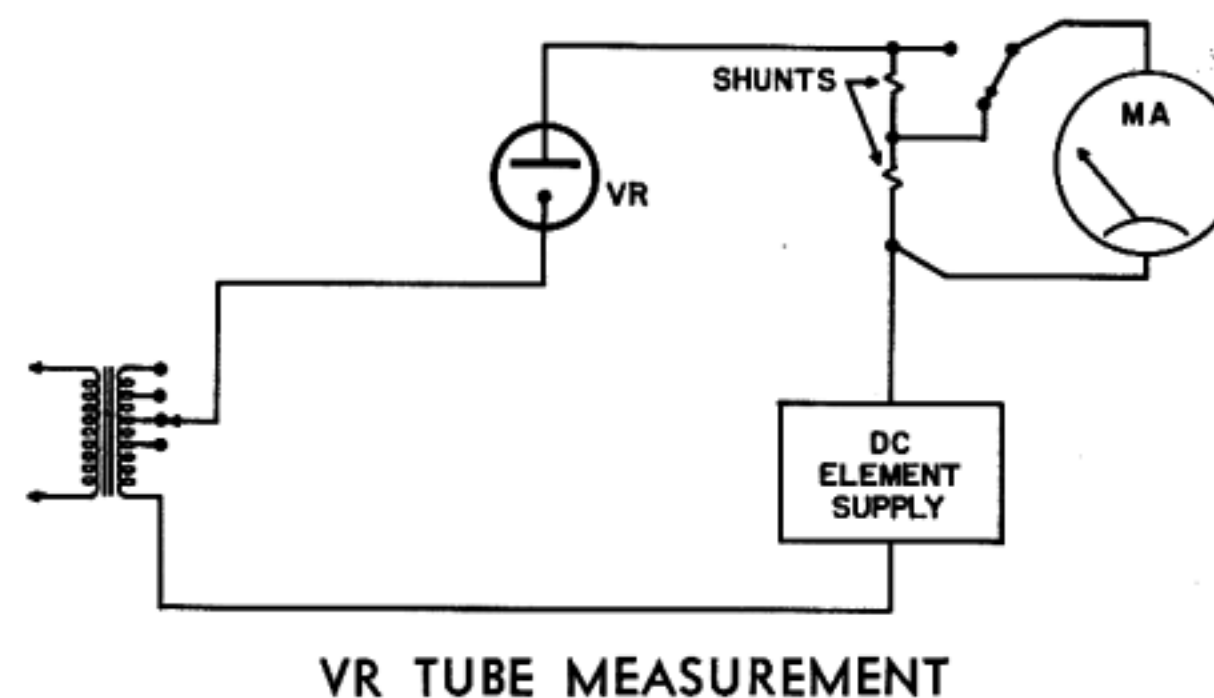


Fig. 6

CATHODE RAY TUNING INDICATOR TEST CIRCUIT

Fig. 7 shows the basic tuning indicator circuit. The 1 meg resistor is used to drop the plate voltage so that the voltage directly at the plate will vary widely with grid bias and thus control the target shadow. The bias is then varied to control the shadow as noted on the roll chart.

CATHODE RAY TUNING INDICATOR TEST CIRCUIT

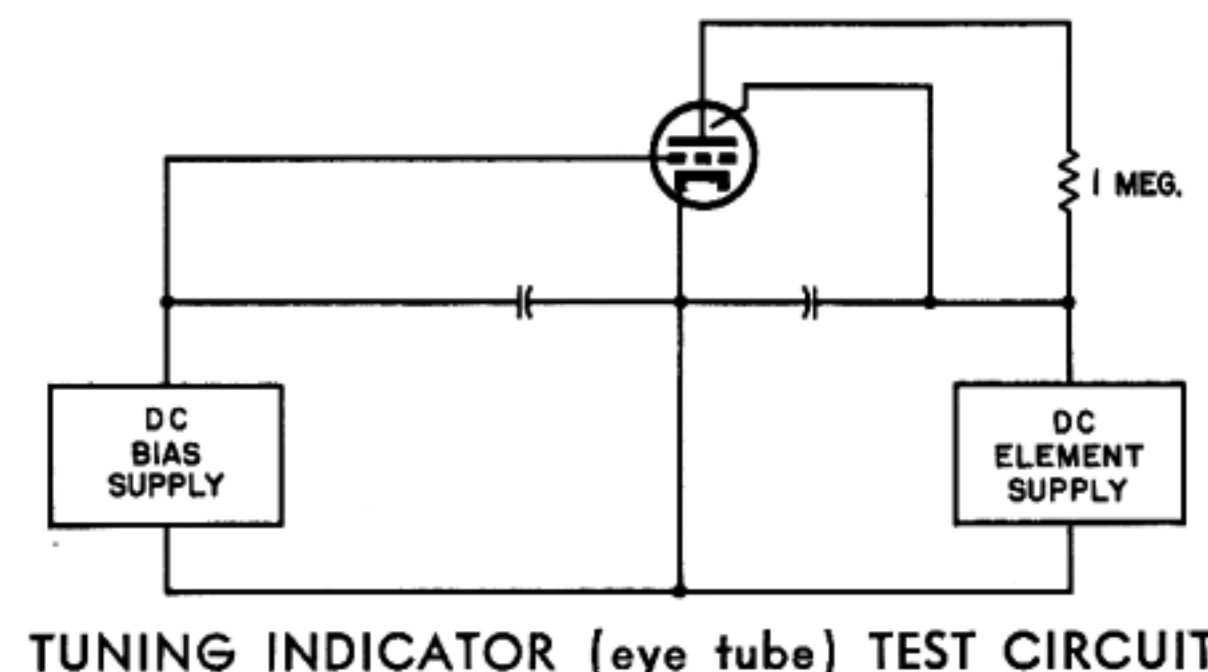


Fig. 7

INSTALLATION AND INITIAL ADJUSTMENT

The Model 3444-A as received from the factory is ready for immediate use. Place the Tube-Analyzer on a solid bench or table within 6 feet of a 105-127 volt 50-60 cycle outlet.

Open the cover, take the line cord out of the accessory compartment and plug it into the AC line.

Set LINE VOLTAGE to its maximum counter-clockwise position.

Snap the ON-OFF switch to the ON position.

Set the SHORT-LEAKAGE switch to the VALUE position.

Press the LINE TEST switch and check to see that the instrument pointer can be set to the LINE TEST position by adjusting the LINE VOLTAGE control. The Tube Analyzer is now ready for operation.

To the right of the PUSH-BUTTON switches is located the Gm CHECK control. This is a combination push-button and variable potentiometer to check and adjust, if necessary, the 5 KHz signal voltage.

This check is made by first rotating and slightly pushing the Gm CHECK control until it engages the slot in the potentiometer, then with the VALUE (I) depressed, the control is adjusted until the meter reads full scale.

This check need only be made at periodic intervals to compensate for environmental changes.

To make the above check the SHORT-LEAKAGE switch must be in the value position and the D-Gm RANGE switch must be in positions 1, 2, 3, 4 or 5.

The regulated voltage supplied to the oscillator and microammeter makes it possible to check the output of the 5 KHz oscillator without removing tubes being tested from the analyzer.

On the tube socket panel, the GRID CAP, CATH. CAP and PLATE CAP jacks for top cap connection leads are located. These are used with the red and black leads found in the accessory compartment. Where it is necessary to test tubes having top cap connectors, one or both of these leads may be used. When not in use, these leads should be kept in the accessory compartment to avoid damage and to keep them out of the way of the various controls. Below the meter and between No. 5 and No. 6 element switches is the OVER-LOAD warning light which will light when an excessive load is placed on the tester. When this lamp glows at any time, the Tube-Analyzer should be turned off. All controls should then be carefully checked, and if no errors are found, the tube should be examined carefully for an intermittent short.

THE CONTROLS

The A-FILAMENT switch is mounted in the top left corner and is clearly marked on the panel. In the tube data chart, under the column marked A, the correct setting is shown for each type of tube. Failure to make this adjustment correctly may result in burning out the filament of the tube under test.

To the left of the meter is mounted the control for the grid bias, B-BIAS. When testing amplifier tubes this control should be set for the correct bias condition specified on the tube data roll chart under the column marked B. This control is calibrated directly in volts, either 5 volts full scale or 50 volts full scale dependent upon the position of the C-PLATE VOLTAGE switch.

Located directly below the A-FILAMENT switch is the C-PLATE VOLTAGE switch which selects the plate and screen voltages for the tube under test, and also controls the range of the B-Bias control. Potentials ranging from 250 volts DC to 12 volts DC are available for amplifier tubes while AC voltages from approximately 300 volts to 15 volts are available for rectifier and diode types.

C-Plate Voltage Position	DCV Plate	DCV Screen	Bias Range (DCV)
1	250	250	0-5
2	250	250	0-50
3	250	100	0-50
4	250	100	0-5
5	100	100	0-5
6	100	100	0-50
7	100	45	0-50
8	100	45	0-5
9	30	30	0-5
10	30	12	0-5
11	12	12	0-5

Directly below the B-BIAS control is located the D-Gm RANGE switch.

The D-Gm RANGE switch has several functions. On positions 1-5 it selects full scale mutual conductance ranges from 1,000 through 60,000 micromhos. On amplifier types this switch must always be indexed to one of these ranges for a transconductance measurement. On the next two positions, No. 6 and No. 7, this switch provides full scale DC plate current, (Ip) readings of 15 and 150 milliamperes full scale respectively. These ranges are used for studying the plate current, grid current and cut-off characteristics of amplifier types. The eighth position is used for Thyratrons where a DC bias is applied to the control grid and an AC plate or anode potential used. Cut-off and control characteristics of these tubes are measured in this position. The ninth position is used for emission tests on rectifiers and diodes.

The ten element switches are located below the meter and across the panel from the lower left corner to the lower right corner. They are used to connect the tube base pins to the testing circuit. To set these switches correctly consult the roll chart under the column marked ELEMENTS. For example, numbers 03512-50040 will appear on the chart for the tube type 6S4. Working from left to right set the switches as indicated.

Located to the left of the PUSH-BUTTON VALUE switches is the SHORT-LEAKAGE switch, which when in the short test positions, disconnects all of the tube electrodes from the other tube testing circuits, and connects them into the leakage test circuit. By slightly tapping the tube under test at each of the five positions on this switch, leakage between the tube elements will be indicated by a deflection of the meter. If a filament type tube or a tube with internal heater-cathode connection is being tested, the meter should read full scale when the switch is in the H-K position. This is noted on the panel under the SHORT-LEAKAGE switch—"Directly Heated Cathodes Show Short on Position H-K".

Switch Position	Leakage between
H-K	Heater to Cathode
G ₁	Control Grid and other tube elements
P	Plate and other tube elements
G ₂	Screen Grid and other tube elements
G ₃	Suppressor Grid and other tube elements
VALUE	Used for all other tests

Located in the center and at the bottom of the panel are the VALUE switches (1) (2) (3) and GAS push-button switches. Switch (1) when depressed activates the power supplies and measuring circuits necessary to check the tube,

or in the case of multi-section tubes, one section of the tube. Switch (2) when depressed disconnects P₁ and G₁ and connects P₂ and G₂ when testing multi-section tubes with common cathodes. (Note) Switch (1) must also be depressed when using switch (2). Switch (3) when depressed disconnects P₁, G₁ and K₁ and connects P₂, G₂ and K₂ when testing multi-section tubes with separate cathodes. (Note) Switch (1) must also be depressed when using switch (3).

The GAS switch is used in conjunction with the VALUE switches to check for grid current. (Note) When performing the gas test the D-Gm switch should be in positions 6 or 7.

To the right of the VALUE switches is the Gm CHECK control. The function and adjustment of this control is covered under "Installation and Initial Adjustment".

Between the Gm CHECK and the POWER switch is the LINE VOLTAGE control. Compensations for line voltage variations is accomplished by depressing the LINE TEST button, located between ELEMENT switch No. 1 and the SHORT-LEAKAGE control, and rotating the LINE VOLTAGE control till the meter pointer coincides with the line test mark on the meter. (NOTE) The SHORT-LEAKAGE switch must be in the VALUE position when adjusting the LINE VOLTAGE control.

STEP BY STEP OPERATING INSTRUCTIONS

TESTING AMPLIFIER TUBES

1. Set the LINE VOLTAGE control to the minimum voltage (extreme counter-clockwise position).

2. Plug the LINE CORD into a 105-127 volt, 50-60 cycle supply.

3. Set the SHORT-LEAKAGE switch to its VALUE position.

4. Locate the tube type number on the tube roll chart, and set the A-FILAMENT switch as specified in the A column.

5. Set the grid bias control B-BIAS as specified in the B column of the tube chart.

6. Set the ten ELEMENTS to their correct positions as specified in the ELEMENTS column of the tube roll chart.

7. Apply power by snapping the ON-OFF toggle switch to the ON position.

8. Plug the tube to be tested into the proper socket.

9. Rotate the C-PLATE VOLTAGE switch to the position specified in the C column of the tube roll chart.

10. Set the D-Gm RANGE switch to the position specified in the D column of the tube roll chart.

11. Press the LINE-TEST switch and turn the LINE VOLTAGE knob to set the instrument pointer exactly over the red LINE-TEST mark on the scale.

12. Check for a leakage indication with the SHORT-LEAKAGE switch in the H-K position. If a filament type tube is being tested, the meter will indicate approximately full scale deflection when the switch is in this position (no indication indicates open filament). Tap the tube lightly and observe momentary or sustained meter deflection changes.

13. Rotate the SHORT-LEAKAGE switch through the five leakage positions. While the switch is in each of these positions, tap the tube lightly and note any momentary or sustained meter deflection changes. On the H-K position the heater is isolated from the cathode, and all cathode to heater leakage resistance or intermittent shorts are measured in this position. On the G₁ position the Control Grid is isolated; on the P position the Plate is isolated; on the G₂ position the Screen Grid is isolated; and on the G₃ position the Suppressor Grid is isolated. If a multi-section tube is being checked, this procedure must be repeated for each section of the tube.

Refer to the NOTES column on the roll chart. This will usually indicate (1), (1&2) or (1&3) showing the tube has two sections to be tested. Depress the (2) or (3) switch, whichever is indicated in the NOTES column and repeat the short test procedure checking positions H-K thru G_3 on the leakage switch for second section shorts. (Note) DO NOT depress switch (1) when performing short or leakage tests.

The abbreviations for the roll chart notes are:

- (1) P_1
- (2) P_2 1K (one cathode)
- (3) P_2 2K (two cathodes)
- (4) Plate Cap
- (5) Grid Cap
- (6) Rectifier

F Indicates filament type tube (will show short on H-K position).

14. Set the SHORT-LEAKAGE switch to the VALUE position.

15. Depress the VALUE (1) switch. Read the mutual conductance of the tube on the range corresponding to the position of the D-Gm RANGE switch. On position 1 the meter reads directly in micromhos on the top or 1000 arc. On position 2 of this switch, the meter reads directly on the 2nd., or 3000 arc. On position 3, use the top, or 1000 arc, and add a zero, or multiply by ten for 10,000 micromhos full scale. On the 4th switch position, use the 2nd., or 3000 arc, and add a zero, or multiply by ten for 30,000 micromhos full scale. On the 5th position read directly off the 60 K scale.

Compare the reading with the figure listed in the roll chart or instruction book in the column headed REJ/AVG. The first figure X 1000 is the customary reject value in micromhos based on 65% of the average or published value for new voltage amplifiers and general purpose types, and about 50% of the average or "bogie" value for power amplifier and converter types. The second figure is the average or "bogie" value for that type tube.

EXAMPLE:

Tube	A	B	C	D	Elements	REJ/AVG X 1K	Notes
6L6 ..	6.3	21	2	3	01465-02300	2.4/4.7	(1)

The reject value for a 6L6 is 2400 micromhos and the "bogie" value is 4700 micromhos.

16. If the tube has two plates, is a dual triode or has two sections more or less similar, the (1) and (1&2) notation will appear in the NOTES column. Refer to step number 13 where the short testing procedure is given for double section tubes, and be sure this procedure is followed before continuing with the Mutual Conductance measurement of the second section. If the tube has two separate cathodes such as is usually encountered in dual triodes, depress the (3) switch to the P_2 2K position and also depress the (1) switch. The instrument will then read the G_m of the second section. Where the two sections or plates of the tube share a common cathode, as shown in the NOTES column of the roll chart, use the P_2 1K position.

17. Tubes with unlike sections such as triode-heptodes, triode-pentodes and multi-diode-triodes are handled in one of two ways. Where it is practical, one setting of the ELEMENT switches programs the testing procedure for both sections. Here, different settings of B, C and/or D switches may be required for each section. Test the first section just as a single tube would be handled. Then make the settings for the B, C and/or D controls as required on the roll chart for the second position. Depress the (2) or (3) switch as indicated on the roll chart and depress the (1) switch to read the meter.

EXAMPLE:

Tube	A	B	C	D	Elements	REJ/AVG X 1K	Notes
6T8 ..	6.3	29	1	2	09812-03540	.79/1.2	(1)
	-	0	11	9	- - -	Diode	(1&3)
	-	-	-	-	40012-93000	Diode	(1)(1&2)

Where dashes (-) appear in the roll chart, the same setting of the controls is made as in the preceding test. The first test is made as in steps (1)-(15). The second test is made by changing B-BIAS, C-PLATE VOLTAGE and D-Gm RANGE switches only as noted, then note (1&3) on roll chart indicates to depress (3) in P_2 2K position while holding the (1) button in the depressed position and read the meter for good DIODE indication (should read above DIODE OK point on the scale.) The same procedure applies for the third test i. e. change ELEMENT switches only as noted on the chart leaving A, B, C, and D controls the same as the preceding (second) test, then note (1)(1&2) on roll chart indicates to use both P_1 and P_2 1K so that two tests are made with one setting, both tests should indicate above DIODE OK point on the scale (the note DIODE under REJ/AVG column refers to this scale).

18. Some tubes with unlike sections may require two settings of the ELEMENT switches. In such cases each section should be treated as a separate tube. Make the first test as in steps (1)-(17). Make the new settings of the ELEMENT switches and then proceed with the second test as in steps (1)-(17).

GAS TEST

1. Where Gas or Grid Current readings are of interest, this test may follow the Mutual Conductance reading.

2. Switch the D-Gm RANGE control to position 7 with all other controls and switches remaining in the position listed on the chart for G_m readings.

3. Depress the indicated value switches and note the reading on the 3rd., arc from the top. This reads directly in milliamperes, zero to 150 ma. If the tube draws less than 15 ma., switch to position 15, but always try the 150 ma. range first to avoid any overload of the meter.

4. Check the plate current reading in ma., and then depress the VALUE (1) and the GAS buttons and again note the reading. The difference in milliamperes is caused by gas or grid current flowing thru a one megohm resistor introduced in the grid circuit. Grid or Gas Current varies widely for different tube designs, but on power amplifiers 2 micro-

amperes is often permissible. This is equivalent to 2 volt change in grid bias when the VALUE switch is shifted to the GAS position, caused by 2 microamperes multiplied by one (1) megohm. For a tube in the 2000 Gm region this would be about 4 ma. change in plate current for 2 microamperes of grid current; for a tube in the 5000 Gm region the change in plate current would be about 10 ma. for 2 microamperes of grid current.

5. The exact grid current can be determined by noting the grid current change as described above, returning the VALUE switch to the VALUE position, and by careful rotation of the B-BIAS control, find out how many volts of bias change cause the same change in plate current. Since the B-BIAS control reads directly in volts, either 0-50 or 0-5 volts, this bias change can be read directly. Multiply the figure in volts by 10^{-6} to determine exact grid current. There is no signal applied to the tube on positions 5 thru 8 of switch D, so this Gas or Grid Current is the true value taken under operating conditions.

6. To determine the bias range of the B control, note the position to which the C switch is indexed, and refer to the following table or the one on page 6.

C-PLATE-VOLTAGE Switch Position	0-5 DCV Bias	0-50 DCV Bias
1	X	
2		X
3		X
4	X	
5	X	
6		X
7		X
8	X	
9	X	
10	X	
11	X	

CUT OFF CHARACTERISTIC

1. On many applications of vacuum tubes, it is desirable to know the grid voltage necessary to reduce the plate current to zero, or "cut-off" the tube. This measurement can easily be made on the Ip or plate current positions of the D-Gm RANGE switch.

2. Use the roll chart settings for mutual conductance.

3. Switch the D-Gm RANGE to position 7.

4. Depress the VALUE (1) switch. The meter will read plate current on the 150 ma. range.

5. Rotate the B-BIAS control to increasing or higher bias voltage. The meter will indicate lower and lower plate current. Continue until the pointer just reaches zero.

6. Read the B-BIAS dial. Refer to the table above noting the C-PLATE VOLTAGE switch position and Bias range. This dial reads 0-5 or 0-50 approximate volts Bias depending on the position of the C-PLATE VOLTAGE switch. Read the cut-off bias in volts.

7. On dual triodes, this test is particularly important to determine balanced cut-off. Return B-BIAS control to its original position.

8. Repeat steps 1 thru 7 for 2nd section.

TESTING RECTIFIER AND DIODE TYPES

1. All rectifiers and diodes are checked with the D-Gm RANGE switch in position 9 marked RECTIFIER.

2. In this position, the B-BIAS control is changed to a meter sensitivity or variable shunt to provide means for reading emission current over a wide range. It must be set correctly for each tube type.

3. Rotate the TEN ELEMENT switches to the correct positions.

4. Set A-FILAMENT and B-BIAS controls.

5. Plug tube in the correct socket.

6. Set C-PLATE VOLTAGE and D-Gm RANGE controls.

7. Set SHORT-LEAKAGE switch to VALUE position.

8. Press LINE-TEST button and adjust LINE VOLTAGE.

9. Check for shorts and leakage.

10. Depress VALUE (1) switch and read condition of Rectifier or Diode compared to the DIODE OK or RECT. OK arrows on the meter scale.

11. Repeat for dual tubes using the correct value switches as indicated on the roll chart.

TESTING THYRATONS

1. All thyatron tubes are tested with the D-Gm RANGE switch in position 8 marked THYRATRON. Here DC bias is applied to the control electrode, and AC potential at the power line frequency is applied thru a current limiting resistor to the anode. The most important measurements on thyatrons are control grid firing voltage, cut-off or extinction voltage and grid current.

2. Set A-FILAMENT and B-BIAS controls.

3. Index the TEN ELEMENT switches.

4. Plug tube in correct socket.

5. Set C-PLATE VOLTAGE and D-Gm RANGE controls.

6. Set SHORT-LEAKAGE switch to VALUE position.

7. Press LINE TEST button and adjust LINE VOLTAGE.

8. Check for shorts and leakage.

9. Depress No. (1) VALUE switch and hold.

10. Slowly rotate the B-BIAS dial to reduce the control grid bias until the instrument pointer suddenly deflects up-scale. Note the reading on the bias control.

11. From this position still depressing the VALUE switch, rotate the bias dial to increase the bias or negative control electrode voltage, and note the cut-off or extinction potential where the instrument pointer deflects to zero. The difference between these two bias dial readings is the firing range and should be within the limits shown in the chart. These readings may be converted to volts by referring to paragraph 6 under GAS TEST.

EXAMPLE:

Tube	A	B	C	D	Elements	REJ/AVG	Notes
2D21	6.3	40	1	8	53127-47000	*Thyratron	(1)
(* Fires from 40-10, cuts off from 10-40)							

Set up as indicated and while holding the VALUE switch down the tube should fire when rotating the B-BIAS control from 40 to 10 and should cut-off when B-BIAS is rotated from 10 to 40.

12. The tube may also be tested for grid current by repeating step 10. Note the exact value by checking the firing voltage two or three times.

13. Cut-off the tube.

14. Depress the VALUE (I) and GAS switches.

15. Slowly check the firing voltage. For most thyratrons, the low or 5 volt bias range is used on the B dial. Also the grid current limit usually published is not over 2 microamperes. This would be equivalent to 2 ua X 1 megohm or 2 volts. This is 20 divisions on the B-BIAS dial on the 5 volt range. Therefore if the tube has less than 2 ua grid current, the firing reading of the B-BIAS dial in the GAS position should not differ more than 20 divisions from the firing reading in the VALUE (I) position.

16. The anode current reading or magnitude of meter deflection should be over 9 on the Ip arc or above the Rectifier rejection limit unless otherwise noted.

TESTING VOLTAGE REGULATOR (VR) TUBES

1. Set the A-FILAMENT and B-BIAS controls.

2. Set the ELEMENT switches.

3. Set the C-PLATE VOLTAGE and D-Gm RANGE switches.

4. Plug the tube into the correct socket.

5. Rotate the A-FILAMENT switch to the position as noted on chart. Tube should fire when switch is at this position.

6. Read meter, it should read in RECT. OK section, unless otherwise noted on the roll chart.

EXAMPLE:

Tube	A	B	C	D	Elements	REJ/AVG	Notes
0C3	1.4	0	5	7	02004-00000	X 1K	(I)

(* No leakage test. Increase A to 16.8, firing is indicated by upscale deflection.)

Make set up as noted and rotate A-FILAMENT control to 16.8 volts, tube should fire. The meter should now read in RECT. OK section, unless otherwise noted on the roll chart.

INSTRUCTIONS FOR SETTING TUBES UP BY THE MANUFACTURERS TUBE DATA

Prior to starting this procedure, it is recommended the pages 4 through 8 in the 3444-A Instruction Manual be carefully read until familiar with their content.

1. In order to set a tube up by the manual, it is suggested that first of all, the maximum ratings of the tube elements be observed in the data given, and that they be kept in mind as the tube is being set up.

2. For familiarization with the procedure to be used, let us take a simple triode, the 6C4, and set it up. Refer to your tube manual, and pages 6 through 10 in the 3444-A Instruction Manual. Look for "Heater Characteristics" in the tube manual. The heater voltage indicated may be set up on the 3444-A by selecting the correct indicated value of the A-FILAMENT switch, in this case setting the arrow at the 6.3 volt mark.

3. The next two element settings are related, and must thus be considered carefully before selecting their values. Refer to the C-PLATE VOLTAGE chart at the bottom of page 6 on the Instruction Manual. You will note the three columns of voltages, and that selection of the proper Screen voltage, as well as the proper Bias voltage range, is dependent upon the selection of the correct C-PLATE VOLTAGE

TESTING CATHODE RAY TUNING INDICATORS

1. Set the A-FILAMENT and B-BIAS controls.

2. Set the ELEMENT switches.

3. Set the C-PLATE VOLTAGE and D-Gm RANGE switches.

4. Plug the tube into correct socket.

5. Move B-BIAS control for 90° and for shadow closed as indicated on chart.

EXAMPLE:

Tube	A	B	C	D	Elements	REJ/AVG	Notes
2E5	2.8	0	3	6	1Y543-20000		(I)

B=0, 90 Degrees; B=11, Shadow Closed

Set up in normal manner following roll chart. With Bias (B) at "0" shadow will be open or 90 degrees, with (B) at 11 shadow should close.

TESTING CATHODE RAY PICTURE TUBES

Cathode Ray Picture tubes can be tested with the TRIPLETT BV Adapter for duo-decal base picture tubes and Triplett CD & CE with BV Adapter for 110° picture tubes. These adapters are supplied on special order.

FILAMENT CONTINUITY TEST:

1. Plug a set of test leads into the Plate and Grid Cap Jacks.

2. Switch the Shorts-Leakage Switch to either P or G position.

3. Locate the tube type number on the tube Roll Chart and determine from the ELEMENT Setting which pins are connected to the filament of the tube.

(NOTE: Each switch position and its function is listed under LINE TEST CALIBRATION in the MAINTENANCE section of the Instruction Book.)

4. Clip one of the test leads to one of the filament pins. The meter will deflect to full scale when the other lead is connected to the second filament pin. If it does not the filament of the tube is open.

position. In the data for the 6C4 tube, refer to the "Typical Operation Characteristics." You may select either set of values given for Class A Amplifier. We will set the tube up using the 250 volt plate potential. Note also, the bias or control grid voltage specification, in this case — 8.5 volts. Now refer to the C-PLATE VOLTAGE chart on page 6 and note that positions #1, 2, 3 and 4 all will apply 250 volts plate potential, so obviously one of these four positions will be used for this tube. Next, observe that there is no screen grid on the 6C4, thus eliminating the Screen voltage as a factor of selecting the correct C-PLATE VOLTAGE position. You will next observe that there are two Bias voltage ranges available, 0-5 and 0-50 volts. Since we need — 8.5 volts bias, we must select the C-PLATE VOLTAGE position which will place the 0-50 bias voltage on the grid of the tube, and at the same time 250 volts on the plate.

The C-PLATE VOLTAGE switch must thus be on either position #2 or #3. Rotate to one of these positions.

4. Since the proper Bias range has been selected by the correct selection of the plate voltage switch, it is now necessary to adjust the B-BIAS control to the correct value. In the data, for the 250 volt plate operation a — 8.5 volt bias is needed. Set the B-BIAS control on 8.5 volts.

5. To select the correct value of D-Gm RANGE switch, refer to the manufacturers data, in this case for the 250 volt class A operation, the typical transconductance is 2200 micromhos. The D-Gm RANGE switch may thus be placed in the #2 (3K) position. In most cases it is desirable to set this switch one range higher to avoid possible past full scale meter deflections.

6. Next, the setting of the ELEMENT switches. Refer to the element schematic, and observe that there are seven pins which are used in the 6C4, which means that elements one through seven will be used. You will now refer to page 12 in the 3444-A Instruction Manual, where the ELEMENT switch positions and their circuit functions are indicated. It is best to make these selections by starting with the first pin of the tube, and working on around consecutively. You will note that pin number one is connected to the plate. Now refer to page 12, and note that the plate switch position is #4. You will thus, turn ELEMENT switch 1 to position #4. Proceeding, you see that tube pin #2 has no electrical connection, thus ELEMENT switch 2 should be placed on 0. Pin #3 of the tube shows an "x", which refers to the filament. Again referring to page 12 of the Manual, you will see that ELEMENT switch positions #1 and #2 are filament positions. Unless a tube specifies that one pin is to be positive and the other negative, polarity selection of the filament connections need not be noted. We may now set ELEMENT switch 3 in position #1. Pin #4 is next; note that the filament return is at that position. You must place the other side of the filament circuit on this pin, thus if you used position #1 on ELEMENT 3, you must use position #2 on ELEMENT 4, and set switch as such. Pin #5 indicates a connection to the plate, and as referenced on page 12, ELEMENT switch 5 is also placed at the #4 position, as this tube has only one plate. Tube pin #6 is connected to the control grid of the tube (G), which function may be obtained by setting ELEMENT switch 6 in the #5 position. Pin #7 you will see is connected to the cathode, and referring to page 12 again, you see that ELEMENT switch position #3 is the cathode position. Set ELEMENT switch 7 to position #3.

7. Check through your set up again to be sure switches have been positioned correctly. Plug the tube into the socket, and proceed with the testing as indicated in the STEP BY STEP INSTRUCTIONS on page 7 of the Instruction Manual.

This set up of a simple triode is merely to illustrate the manner in which a tube may be set up from a tube manual. More complex tubes may be set up by going through the same procedure and referring to the ELEMENT switch position functions, for instance, tubes with screen grids, suppressor grids, and dual section tubes. The dual section will use the separate functions for each side, that is plate #1, control grid #1, and cathode #1, for one side; plate #2, control grid #2, and cathode #2 for the second side. Use of the VALUE (2) (3) switches will be governed by the number of plates and cathodes in a tube, as described on page 8 of the Manual.

NOTES:

(a) Many tubes may be set up on the 3444-A at exact tube manual values. For testing those which do not have the same exact voltage values, such as plate and screen voltage, always observe the maximum rating of the tube. It is best to use the next lower value of plate and screen voltages than typical operation calls for if typical operation is not the exact voltage available on the 3444-A.

A representative indication of the condition of these tubes may be obtained by setting them up and switching

the D-Gm RANGE switch to the "Plate Current" position applicable to the plate current requirements of the tube in typical operation. Next, depress VALUE (1), and adjust the B-BIAS control to the plate current value indicated as typical. Rotate the D-Gm RANGE switch back to the applicable Gm or transconductance range, depress VALUE (1), and read Gm on the tube.

(b) On tubes which require connections to external plate, grid, or cathode caps, it must be noted that the caps are connected electrically to the test circuit when the VALUE SWITCHES (2) (3) are in the up position. On dual section tubes which have caps, set up one section at a time, making two tests.

(c) Multi-section tubes with more than one screen grid or suppressor grid should as a general rule be set up separately.

(d) Compactron tubes —

The filament circuit of the tester is connected permanently to pins 1 and 12. The other pins are connected as follows:

Compactron Pins	1	2	3	4	5	6	7	8	9	10	11	12
Element Switches	Fil	1	2	3	4	5	6	7	8	9	10	Fil

CAUTION: The maximum plate current which should be used on the 3444-A is 150 milliamperes. For tubes to be set up which exceed this value, it will be necessary to set the tubes up on a different portion of the curve, at 150 milliamperes plate current or less.

RECTIFIER AND DIODES

In most cases it is best to refer the tube to the factory for set up data due to the wide variations in currents and voltages.

When this is impractical the following procedure may be followed.

The set up of rectifiers and diodes is accomplished by means of a known good tube.

1. Set A-FILAMENT according to the manual.
2. The B-BIAS CONTROL is initially set at zero.
3. Consult the tube manual for the AC voltages to be applied to the tube.
4. Set C-PLATE VOLTAGE to the position which gives the voltage closest to that determined from the manual. Positions 4, 6 and 11 are used for rectifiers and diodes. Position 4 gives approximately 195 Volts AC. Position 6 gives approximately 83 Volts AC. Position 11 gives approximately 18 Volts AC. Diodes are usually set up on position 11.
5. Set D-Gm switch to position 9 Rectifier.
6. Consult the base diagram in the manual and set the element switches accordingly. Refer to page 13 for the functions of the element switch settings.
7. Insert a good tube in the appropriate socket and after allowing sufficient time for warm up, depress VALUE (1) and rotate the B-BIAS control to give a reading of 12 on the Ip scale.

8. The tube to be tested is inserted in the socket and the meter indication relative to the indication of the known good tube is noted. If the tube is over 25% lower than the known good tube it is usually considered questionable.

9. Diodes are set up in the same manner, the only difference being that diodes operating at lower voltages and smaller currents will register on the lower end of the Ip scale.

Due to the wide variations in voltages and currents encountered, a reading of 12 on the Ip scale may not always be possible for a good tube. In such cases the reading on the Ip scale for a good tube is noted and the tubes under test figured from that value.

THYRATRONS

As in the case of rectifier tubes the set up of thyratrons is accomplished using a known good tube.

1. Set A-FILAMENT switch according to the manual.
2. Set B-BIAS to 50 initially.
3. Set C-PLATE VOLTAGE switch according to voltages called for in tube specifications. Refer to page 6 for bias ranges at the different switch settings. Switch settings 7, 8, 9 and 10 are not used for thyatron, rectifier and diode testing. Position 1 thru 4 gives 195 VAC, position 6 gives 83 VAC and position 11 gives 18 VAC.
4. Set D-Gm switch to position 8 THYRATRON.
5. Consult base diagram for tube and set ELEMENT SWITCHES. Refer to page 13 for functions of the element switch settings.
6. Insert known good tube in socket.
7. Back off B-BIAS control until tube fires which is indicated by an upscale reading on the meter. This gives the striking point.
8. Advance the B-BIAS control until the tube cuts off. This gives the cut off point.
9. This establishes the firing and cut off points.
10. The tube to be tested is now inserted in the socket and the test repeated noting the firing and cut off points with respect to the known good tube.

VOLTAGE REGULATOR TUBES

Voltage regulator tubes are checked for ionizing voltage and are set up using a known good tube for reference.

1. Set A-FILAMENT switch to zero.
2. Set B-BIAS control to zero.
3. Set C-PLATE VOLTAGE switch so as to give a voltage below the firing point of the VR tube. Consult the tube data sheet and refer to page 6 of the manual for voltages available in the 3444-A.
4. Set D-Gm switch to position 7.
5. Consult tube manual and set element switches.
6. Insert known good tube in the socket.
7. Increase A-FILAMENT switch until tube fires. Note the filament voltage at which this occurs.
NOTE: Filament voltage is superimposed on DC Plate voltage.
8. Next return A-FILAMENT switch to zero, insert tube to be tested and repeat step 7.
9. Compare the readings to determine the merit of the tube being tested.

The above instructions and a careful study of the manual should enable the operator to set up most tubes. In the case of special tubes or if trouble is encountered the Triplet Company should be consulted for set up data.

PRECAUTIONS

AGAINST HARM TO OPERATOR, TUBE AND TUBE-ANALYZER

1. Do not plug Model 3444-A into a DC line. Be sure the power line to be used is a 105-125 volt 50-60 cycle source.
2. Do not turn on Tube-Analyzer with LINE CONTROL near its extreme clockwise position.
3. Do not insert a tube in a socket before setting the A-FILAMENT switch and the ELEMENT switches.
4. Do not change the position of the A-FILAMENT switch when any tube except a VR tube is in one of the test sockets.
5. Consult the tube data roll chart before setting the C and D controls.

6. Observe OVERLOAD light, and immediately shut off the Tube-Analyzer if it lights up.

TO AVOID FAULTY READINGS AND MISINTERPRETATIONS

1. Read the correct scale.
2. Understand the divisions on each scale.
3. Follow step-by-step instructions.
4. If the meter lamp or the roll chart lamps become excessively dim, a SHORT-LEAKAGE test should be made immediately to ascertain if the tube has developed a short, i. e., a shorted filament overloading the heater circuit without showing on the overload lamp. If so, the tube should be immediately removed from the socket to prevent damage to the tube tester.

MAINTENANCE

INPUT OVERLOAD

If the INPUT OVERLOAD lamp lights up, it indicates a short or overload condition exists somewhere in the tube analyzer, or in the tube being tested. It is in series with the primary of the power transformer, and as above, the condition causing this overload should be located before proceeding.

NOTE: Some tubes which draw a large current such as the 5U4 may cause a slight or dim glow. This is not an overload.

FUSE

If a fuse has blown, remove the roll chart so that the bayonet-type 3 amp. removable fuse may be replaced. This

fuse is located in the lower right corner inside the roll chart compartment.

Gm CHECK

To check the Gm calibration, follow procedure outlined under INSTALLATION and INITIAL ADJUSTMENT on page 6. Be sure line test adjustment is exact before touching this adjustment.

LINE TEST CALIBRATION

1. Set A-FILAMENT to 6.3 volts.
2. Set all ELEMENT switches to 0 position except Switch

1 which is to be set on position 1 and switch 2 which is to be set on position 2.

3. Set SHORT-LEAKAGE switch to VALUE position.
4. Set C-PLATE VOLTAGE switch to #1 position.
5. Set D-Cm RANGE switch to #1 position.
6. B-BIAS dial not used.
7. Turn tester ON and allow to warm up for 15 minutes.
8. Use an accurate AC voltmeter ($\pm 1/2\%$ or better) with sensitivity of at least 5,000 ohms per volt and connect across pins #1 and #2 in parallel with an 18 ohm, 5 watt load.
9. Note the meter reading while adjusting the LINE VOLTAGE control for LINE TEST.
10. If at 6.3 volts, the alignment of the LINE TEST is off, no attempt should be made to change the calibration resistor R4 unless absolute certainty of the accuracy of the voltmeter is known to be $\pm 1/2\%$ at 6.3 volts.

NOTE—Due to the importance of this adjustment it is recommended that it be made only at the factory or Field Service Station.

TO REPLACE ILLUMINATION LAMPS

Roll chart lamps may be replaced by first removing the roll chart from its compartment, then remove the lights by compressing the bracket of the socket so that it can be removed from the base plate of the roll chart assembly. Remove the defective lamp and replace with a 6.3V (GE #47 or equivalent) bayonet type lamp.

To replace the meter lamp, unscrew the four corner screws to remove the meter front. Replace the defective lamp with a 6.3V bayonet type lamp (GE #44 or equivalent.)

To replace the overload light, remove Analyzer from case by removing the 8 panel screws and the transformer support screw on the bottom of the case. The overload light is then replaced with a No. 43 or equivalent bulb.

NOTE: The ELEMENT switch numbers encircled on the panel refer to the tube socket pin numbers and the following switch positions indicate these functions:

Switch Pos.	Function
0	OFF
1	FIL (—)
2	FIL (+)
3	K ₁ (Cathode #1)
4	P ₁ (Plate #1)
5	G ₁ (Control Grid #1)
6	G ₂ (Screen Grid)
7	G ₃ (Suppressor)
8	K ₂ (Cathode #2)
9	P ₂ (Plate #2)
X	G ₁ (Control Grid #2) 2 (Second section)
Y	Plate for Eye Tubes

Compactron Socket Connections

Compactron Pins	1	2	3	4	5	6	7	8	9	10	11	12
Element Switches	Fil	1	2	3	4	5	6	7	8	9	10	Fil

Note also that the combination 4-5-6 pin socket has the following pin element numbering:

4-pin Use ELEMENT		5-pin Use ELEMENT		6-pin Use ELEMENT	
Pin #	Sw. #	Pin #	Sw. #	Pin #	Sw. #
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	6	4	5	4	4
		5	6	5	5
				6	6

TRANSFORMER LUG VOLTAGES

Lug No.	Voltage	Lug No.	Voltage
1	195	17	7.5
2	—	18	6.3
3	8.4	19	5.0
4	10.5	20	4.7
5	18.9	21	4.2
6	26.0	22	3.15
7	70.0	23	1.25
8	117.0	24	0
9	0	25	—
10	18.0	26	—
11	30.0	27	—
12	83.0	28	2.8
13	9.5	29	2.35
14	12.6	30	2.0
15	34.0	31	1.4
16	50.0	32	0.63
		33	16.8

INSTALLING NEW ROLL CHART

From time to time there will be a new roll chart to install. This will be only a few minutes work if you follow these instructions.

1. Remove the roll chart assembly from tube analyzer.
2. Remove the two screws and take off the rear panel of the roll chart assembly.
3. Roll chart to the extreme end on the top roller. Remove tape holding chart to roller. Pull out chart and remove tape from top roller.
4. Thread new chart under bottom roller up to top roller and tape chart to roller. Take special care that the chart is taped straight on the roller. Roll chart on top roller fairly loose. Now tape bottom chart to the bottom roller. If the chart has not been rolled loosely on the rolls it will bind when rolled to the extreme ends.

CROSS REFERENCE TO TUBE TYPES

Tube Type	Listed Under	Tube Type	Listed Under	Tube Type	Listed Under
2B22	R6279	DL92	3S4	EN93	6D4
6AG6	EL33	DL93	3A4	EQ80	6BE7
6F18	6EC7	DL94	3V4	EY80	6U3
6/30L2	6GA8	DL95	3Q4	EY88	6AL3
6GE7	6DL7	DL96	3C4	EZ35	6X5
10F18	10EC7	DL98	3B4	EZ90	6X4
12A/11A	12A	DM70	1M3	G84	2Z2
30F5	7ED7	DP61	6AK5	GZ30	5Z4
30FL1	9GB8	E80CC	6085	GZ32	5V4
30P4	25GF6	E80CF	7643	H63	6F5
30P12	12FB5	E80L	6227	HABC80	19T8
30PL1	13GC8	E80F	6084	HBC90	12AT6
5I	35	E83F	6689	HBC91	12AV6
57S	57	E88CC	6922	HD14	1H5
X99	99	E90CC	5920	HD30	3B4
108C1	0B2	E180CC	7062	HF93	12BA6
150C2	0A2	E180F	6688	HF94	12AU6
150C3	0D3	E182CC	7119	HK90	12BE6
396A	2C51	E188CC	7308	HL92	50C5
403B	5591	EA76	5647	HL94	30A5
417A	5842	EAA91	6AL5	HM04	6BE6
482B	182B	EABC80	6AK8	HY90	35W4
483	183	EB34	6H6	KH183	3EH7
585	50	EB91	6AL5	KR1	1V
1003	0Z4	EBC81	6BD7	KR5	6A4
1649	6AC7	EBC90	6AT6	KR25	2A5
1662	3A4	EBC91	6AV6	KR98	6Z4
2523N1	128A	EBF80	6U8	L77	6C4
5913	6007	EBF89	6DC8	N14	1C5
6046	25L6	EC80	6Q4	N17	3S4
6187	6AS6	EC86	6CM4	N18	3Q4
6678	6U8	EC90	6C4	N19	3V4
6687	E91H	EC92	6AB4	N144	6AM5
7034	4X150A	ECC33	6SN7	OE3	85A1
18042	6086	ECC83	12AX7	PC86	4CM4
A2521	6CR4	ECC85	6AQ8	PCC85	9AQ8
AX9903	5894	ECC86	6GM8	PCC88	7DJ8
B152	12AT7	ECC88	6DJ8	PCF80	9A8
B309	12AT7	ECC91	6J6	PCF82	9U8
BPM04	6AQ5	ECC189	6ES8	PJ7	5742
CIJ	5683	ECF82	6U8	PL81	21A6
CK568AX	5677	ECF86	6HG8	PL82	16A5
CK569AX	5678	ECH81	6AJ8	PL83	15A6
CK1003	0Z4	EF22	7G7	PM04	6BA6
DA90	1A3	EF86	6267	PY80	19X8
DAC32	1H5	EF93	6BA6	QV03-12	5763
DAF91	1S5	EF94	6AU6	QV06-20	6146
DAF92	1U5	EF95	6AK5	RR3-250	3B28
DAF96	1AH5	EF183	6EH7	U25	2L2
DCC90	3A5	EF184	6EJ7	U78	6X4
DDR7	6AM5	EH90	6CS6	U147	6X5
DF33	1N5	EK90	6BE6	V2M70	6X4
DF60	5678	EL37	6L6	W17	1T4
DF62	1AD4	EL81	6CJ6	X17	1R5
DF91	1T4	EL86	6CW5	X155	55
DF92	1L4	EL91	6AM5	XCC189	4ES8
DF96	1AJ4	EL94	3V4	XF184	3EJ7
DH63	6Q7	EL620	5672	XL	7A4
DH77	6AT6	EL821	6CH6	XXB	3C6
DK91	1R5	EM80	6BR5	XXD	14AF7
DL33	3Q5	EM81	6DA5	XY88	16AQ3
DL35	1C5	EN70	5643	Z63	6J7
DL36	1Q5	EM84	6FG6	ZD17	1S5
		EN92	5696		

REPLACEABLE PARTS

REF. NO.	REQ.	DESCRIPTION	PART NO.
M	1	Meter	52-3914
	16	Knob, Pointer Type	34-64
	1	Knob, Round	2558-1
	1	Socket Panel (Complete Assembly)	28-927
X3, X4, X5, X6, X7	5	Diode (Rectifier)	2250-55
X9	1	Zener Diode	2250-63
X1, X8	2	Diode	2250-64
X2	1	Rectifier	2250-65
Q1, Q2, Q4, Q5, Q6	5	Transistor (2N3394)	127-29
Q3	1	FET (Motorola MPF 103)	127-26
SW1 thru SW10	10	Element Switches	22-548
SW11	1	Short-Leakage Switch	22-326
SW12	1	Pushbutton Switch (Value and Gas)	22-549
SW13	1	Pushbutton Switch (Line Test)	22-250
SW14	1	Pushbutton Switch (Gm Check)	22-335
SW15	1	Plate Voltage Switch	22-547
SW16	1	Filament Switch	22-334
SW17	1	Plate Voltage Switch	22-325
SW18	1	ON-OFF Toggle Switch	22-116
BD2	1	Power Supply Circuit Board Assembly	87-156
BD4	1	Amplifier Circuit Board Assembly	87-157
BD6	1	Main Power Supply Board Assembly	203-197
BD8	1	Pushbutton Circuit Board Assembly	87-158
R1, R8, R16	3	Resistor, 1 Meg. ohm	15-824
R2, R47	2	Resistor, 2.2K ohm	15-1188
R3	1	Resistor, 825K ohm	15-3818
*R4	1	Resistor, 47K-91K ohm	
R5	1	Resistor, 588K ohm	15-5193
R6	1	Resistor, 2K ohm	15-1012
R7	1	Resistor, 47 ohm	15-1538
R9	1	Resistor, 33.3 ohm	15-3075
R10	1	Resistor, .67 ohm	15-5081
R11	1	Resistor, 6.02 ohm	15-5082
R12	1	Resistor, 466.8 ohm	15-5083
R13	1	Resistor, 133.4 ohm	15-5084
R14, R15	2	Resistor, 33.3 ohm	15-3039
R17	1	Resistor, 5K ohm, Variable	16-196
R18, R37, R52, R53,	4	Resistor, 4.7K ohm	15-1687
R19	1	Resistor, 5K ohm	16-195
R20	1	Resistor, 20 ohm	15-3045
R21, R22	2	Resistor, 10K ohm	15-1272
R23	1	Resistor, 2K ohm	15-3056
R24	1	Resistor, 5.6K ohm	15-1483
R25	1	Resistor, 150K ohm	15-4836
R26	1	Resistor, 75K ohm	15-1166
R27	1	Resistor, 1750 ohm, Variable	16-62
R28	1	Resistor, 2K ohm	3995
R29	1	Resistor, 175 ohm, Variable	8595
*R30	1	Resistor, 47K-91K ohm	
*R31	1	Resistor, 1K-5.1K ohm	
R32	1	Resistor, 30K ohm	15-1115
R33	1	Resistor, 3.16 ohm	15-1256
R34	1	Resistor, 1500 ohm	15-2480
R35	1	Resistor, 10K ohm	15-5113
R36	1	Resistor, 5K, Variable	16-193
R38	1	Resistor, 64K ohm	15-2296
R39	1	Resistor, 2.7K ohm	15-5091
R40, R41, R42, R43, R44, R49	6	Resistor, 33K ohm	15-2507
R45	1	Resistor, 100K ohm	15-5044
R46	1	Resistor, 270K ohm	15-1885
R48	1	Resistor, 1K ohm	15-4835
R50	1	Resistor, 500 ohm, Variable	16-197
R51	1	Resistor, 1 Meg. ohm, Variable	16-173
R54	1	Resistor, 470 ohm	15-5087
R55	1	Resistor, 150 ohm	15-5088
R56	1	Resistor, 1333.2 ohm	15-5085

* Calibration Resistors

REPLACEABLE PARTS

REF. NO.	REQ.	DESCRIPTION	PART NO.
	1	Socket, 4-5-6 Pin Combination	2455-202
	1	Socket, 7 Pin With Pilot Socket	2455-165
	1	Socket, 7 Pin Miniature	2455-59
	1	Socket, 5-6-7 Pin Subminiature	2455-80
	1	Socket, 8 Pin Subminiature	2455-162
	1	Socket, Octal	2455-164
	1	Socket, 9 and 10 Pin Miniature	2455-234
	1	Socket, 10 Pin Decal	2455-280
	1	Socket, Loctal	2455-163
	1	Socket, 7 Pin Septar	2455-248
	1	Socket, Acorn	2455-159
	1	Socket, 9 Pin Novar	2455-242
	1	Socket, 12 Pin Compactron	2455-237
	1	Socket, 5 Pin Nuvistor	2455-222
	1	Socket, 7 Pin Nuvistor	2455-281
	1	Socket, Lighthouse	2455-219
	10	Capacitor, 470 MMFD	43-149
C1	1	Capacitor, .03 MFD	43-222
C2, C16	2	Capacitor, .01 MFD	43-198
C3	1	Capacitor, .001 MFD	43-289
C4	1	Capacitor, .0033 MFD	43-290
C5, C6	2	Capacitor, 50 MFD	43-277
C7, C23	2	Capacitor, 50 MFD	43-221
C8, C9	2	Capacitor, 5 MFD	43-281
C10, C11, C12, C13	4	Capacitor, 30 MFD	43-103
C14	1	Capacitor, 30 MFD	43-279
C15	1	Capacitor, .0022 MFD	43-291
C17, C18, C20	3	Capacitor, .01 MFD	43-244
C19	1	Capacitor, .0015 MFD	43-292
C21	1	Capacitor, 10 MFD	43-282
C22	1	Capacitor, 1.0 MFD	43-199
II		Lamp, No. 43	67-105
LI		Choke	3022-55
TI		Power Transformer	23-187
FI	1	Fuse, 3 Amp, 250 Volt 3AG	3207-12
	1	Lead Assembly (1 Red and 1 Black)	79-146
	1	Carrying Case	10-2388
	1	Roll Chart Assembly	12086
	1	Roll Chart and Data	84-177
	1	Chart Supplement	84-179

VALUE **P₂ 1A** **P₂ 1B** **P₂ 1C** **P₂ 1D** **P₂ 1E** **P₂ 1F** **P₂ 1G** **P₂ 1H** **P₂ 1I** **P₂ 1J** **P₂ 1K** **P₂ 1L** **P₂ 1M** **P₂ 1N** **P₂ 1O** **P₂ 1P** **P₂ 1Q** **P₂ 1R** **P₂ 1S** **P₂ 1T** **P₂ 1U** **P₂ 1V** **P₂ 1W** **P₂ 1X** **P₂ 1Y** **P₂ 1Z** **P₂ 1AA** **P₂ 1AB** **P₂ 1AC** **P₂ 1AD** **P₂ 1AE** **P₂ 1AF** **P₂ 1AG** **P₂ 1AH** **P₂ 1AI** **P₂ 1AJ** **P₂ 1AK** **P₂ 1AL** **P₂ 1AM** **P₂ 1AN** **P₂ 1AO** **P₂ 1AP** **P₂ 1AQ** **P₂ 1AR** **P₂ 1AS** **P₂ 1AT** **P₂ 1AU** **P₂ 1AV** **P₂ 1AW** **P₂ 1AX** **P₂ 1AY** **P₂ 1AZ** **P₂ 1B1** **P₂ 1B2** **P₂ 1B3** **P₂ 1B4** **P₂ 1B5** **P₂ 1B6** **P₂ 1B7** **P₂ 1B8** **P₂ 1B9** **P₂ 1B0** **P₂ 1C1** **P₂ 1C2** **P₂ 1C3** **P₂ 1C4** **P₂ 1C5** **P₂ 1C6** **P₂ 1C7** **P₂ 1C8** **P₂ 1C9** **P₂ 1C0** **P₂ 1D1** **P₂ 1D2** **P₂ 1D3** **P₂ 1D4** **P₂ 1D5** **P₂ 1D6** **P₂ 1D7** **P₂ 1D8** **P₂ 1D9** **P₂ 1D0** **P₂ 1E1** **P₂ 1E2** **P₂ 1E3** **P₂ 1E4** **P₂ 1E5** **P₂ 1E6** **P₂ 1E7** **P₂ 1E8** **P₂ 1E9** **P₂ 1E0** **P₂ 1F1** **P₂ 1F2** **P₂ 1F3** **P₂ 1F4** **P₂ 1F5** **P₂ 1F6** **P₂ 1F7** **P₂ 1F8** **P₂ 1F9** **P₂ 1F0** **P₂ 1G1** **P₂ 1G2** **P₂ 1G3** **P₂ 1G4** **P₂ 1G5** **P₂ 1G6** **P₂ 1G7** **P₂ 1G8** **P₂ 1G9** **P₂ 1G0** **P₂ 1H1** **P₂ 1H2** **P₂ 1H3** **P₂ 1H4** **P₂ 1H5** **P₂ 1H6** **P₂ 1H7** **P₂ 1H8** **P₂ 1H9** **P₂ 1H0** **P₂ 1I1** **P₂ 1I2** **P₂ 1I3** **P₂ 1I4** **P₂ 1I5** **P₂ 1I6** **P₂ 1I7** **P₂ 1I8** **P₂ 1I9** **P₂ 1I0** **P₂ 1J1** **P₂ 1J2** **P₂ 1J3** **P₂ 1J4** **P₂ 1J5** **P₂ 1J6** **P₂ 1J7** **P₂ 1J8** **P₂ 1J9** **P₂ 1J0** **P₂ 1K1** **P₂ 1K2** **P₂ 1K3** **P₂ 1K4** **P₂ 1K5** **P₂ 1K6** **P₂ 1K7** **P₂ 1K8** **P₂ 1K9** **P₂ 1K0** **P₂ 1L1** **P₂ 1L2** **P₂ 1L3** **P₂ 1L4** **P₂ 1L5** **P₂ 1L6** **P₂ 1L7** **P₂ 1L8** **P₂ 1L9** **P₂ 1L0** **P₂ 1M1** **P₂ 1M2** **P₂ 1M3** **P₂ 1M4** **P₂ 1M5** **P₂ 1M6** **P₂ 1M7** **P₂ 1M8** **P₂ 1M9** **P₂ 1M0** **P₂ 1N1** **P₂ 1N2** **P₂ 1N3** **P₂ 1N4** **P₂ 1N5** **P₂ 1N6** **P₂ 1N7** **P₂ 1N8** **P₂ 1N9** **P₂ 1N0** **P₂ 1O1** **P₂ 1O2** **P₂ 1O3** **P₂ 1O4** **P₂ 1O5** **P₂ 1O6** **P₂ 1O7** **P₂ 1O8** **P₂ 1O9** **P₂ 1O0** **P₂ 1P1** **P₂ 1P2** **P₂ 1P3** **P₂ 1P4** **P₂ 1P5** **P₂ 1P6** **P₂ 1P7** **P₂ 1P8** **P₂ 1P9** **P₂ 1P0** **P₂ 1Q1** **P₂ 1Q2** **P₂ 1Q3** **P₂ 1Q4** **P₂ 1Q5** **P₂ 1Q6** **P₂ 1Q7** **P₂ 1Q8** **P₂ 1Q9** **P₂ 1Q0** **P₂ 1R1** **P₂ 1R2** **P₂ 1R3** **P₂ 1R4** **P₂ 1R5** **P₂ 1R6** **P₂ 1R7** **P₂ 1R8** **P₂ 1R9** **P₂ 1R0** **P₂ 1S1** **P₂ 1S2** **P₂ 1S3** **P₂ 1S4** **P₂ 1S5** **P₂ 1S6** **P₂ 1S7** **P₂ 1S8** **P₂ 1S9** **P₂ 1S0** **P₂ 1T1** **P₂ 1T2** **P₂ 1T3** **P₂ 1T4** **P₂ 1T5** **P₂ 1T6** **P₂ 1T7** **P₂ 1T8** **P₂ 1T9** **P₂ 1T0** **P₂ 1U1** **P_{2</}**

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THE TRIPLETT ELECTRICAL INSTRUMENT COMPANY
Bluffton, Ohio 45817

Printed in U.S.A.

Part No. 84-176-112668-2



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Vintage Schematics and Publications
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