INSTRUCTION MANUAL
FOR
TRANSCONDUCTANCE TUBE TESTER
MODEL 539C

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
10514 DUPONT AVENUE • CLEVELAND 8, OHIO

STANDARD EIA GUARANTEE

The Hickok Electrical Instrument Company warrants instruments manufactured by it to be free from defective material or factory workmanship and agrees to repair such instruments which, under normal use and service, disclose the defect to be the fault of our manufacturing. Our obligation under this warranty is limited to repairing any instrument or test equipment which proves to be defective, when returned to us transportation prepaid, within 90 days from the date of original purchase, and provided the serial number has been made known to us promptly for our records.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons or service stations in any way so as, in our judgment, to injure their stability or reliability, or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced or removed. Neither does this warranty apply to any of our products which have been connected, installed, or adjusted otherwise than in accordance with the instructions furnished by us. Accessories, including all vacuum tubes not of our manufacture, used with this product are not covered by this warranty.

This warranty is in lieu of all other warranties expressed or implied, and no representative or person is authorized to assume for us any other liability in connection with the sale of our products.

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

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, under warranty or otherwise, the Service Department in Cleveland must first be contacted giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment to one of our service stations. All correspondence pertaining to repairs should be directed to the Hickok Electrical Instrument Company 10636 Leuer Avenue, Cleveland 8, Ohio - Attn. Service Department.

REGISTRATION CARD

The above guarantee is contingent upon the attached registration card being returned to the factory immediately upon receipt of the equipment.

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
Cleveland, Ohio

AUTOMOBILE RADIO TUBES

It often happens that automobiles operated at night with radio, light, fans, etc., all turned on at the same time, put such a severe load on the auto battery that the battery is unable to deliver full voltage, especially in slow moving traffic or when waiting for traffic light. If auto radio trouble is experienced, much time can be saved by first checking the tubes at 6.3 volts, then switching the filament voltage to 5 volts. If tube reading drops markedly at 5 volts, the tube should be replaced.

If the automobile has 12 volt radio system, first check the tubes at 12.6 volts, then drop to 10 volts for recheck.

ACORN TUBES

Adapter, Code 1050-9, is available for testing Acorn tubes with the 539C.

OPERATING INSTRUCTIONS
FOR
MODEL 539C
TRANSCONDUCTANCE TUBE TESTER

FOREWORD

The Model 539C Mutual Conductance (Transconductance) Tube Tester is designed for use by technicians, engineers and others who demand an instrument of the very highest quality for rapid and accurate testing of vacuum tubes. Like all Hickok Tube Testers, it is based upon the well known formula for mutual conductance,

$$\frac{\triangle ip}{\triangle eg} = Gm,$$

where ip is the plate current change, eg is the grid voltage change, and Gm is the Mutual Conductance (Transconductance). Mutual Conductance and Transconductance are used interchangeably.

This instrument is equipped with three meters, all made in our own plant, and calibrated with great accuracy.

(a) A sensitive Transconductance meter measuring micromhos in six ranges up to 60, 000 micromhos. This meter also has a scale reading to 200 volts for V. R. tube testing, and a scale reading to 50 megohms for leakage testing.

(b) An A. C. voltmeter which insures standardized voltages to the tube's base, and

(c) A two range (0-10, 0-50) D. C. voltmeter to accurately adjust the negative bias on the tube's control grid. Also a scale to 100 M. A. d. c. for V. R. milliamperes.

Voltage adjustments are made while the tube being tested is delivering its rated load.

NOTE: Always check a tube for shorts before proceeding with Mutual Conductance test.

OPERATING INSTRUCTIONS

Read these instructions through before attempting to operate the tester.

1. There are two rectifier tubes, an 83 and a 5Y3GT necessary to operate this tester. They are included.

   The Short Lamp is a 1/ 25 watt, 110 volt, miniature bayonet base neon signal lamp. This lamp will last indefinitely unless broken.

   The Fuse Lamp is a standard No. 81, single contact auto bulb. This can be procured from any auto dealer or gasoline station attendant. This fuse lamp is in the primary circuit of the transformer.

3. The line adjustment control rheostat in the 539C Tester is connected with a small A.C. voltmeter as a constant calibration indicator which is normally always in circuit. The small A.C. voltmeter may also be used to register 60 cycles A.C. line voltage fed to the set by operating the test button P7 designated "LINE TEST" in the lower right part of the control panel. Readjust after pressing the P4 Test Button.

4. Selectors: The row of seven selector switches across the center of the control panel is for the purpose of conducting proper voltages to the tube's base pins. On the roll data chart, below the word "Selectors" appear the switch settings. Example: JR-6237-5. Starting at the left the first switch is set at "J", the second switch at "R", the third at "6", the fourth "2", the fifth "3", the sixth "7" and the seventh "5".

   The first two switches control the filament or heater connections. The other switches control the GRID, PLATE, SCREEN, CATHODE and SUPPRESSOR in that order. In the example given above, the heater terminals are connected to pins 8 and 1. The GRID is connected to pin 6; PLATE, to pin 2; SCREEN, to pin 3; CATHODE, to pin 7 and SUPPRESSOR, to pin 5.

   These switches are electrically interlocked in such a way that it is impossible to connect two different voltage elements to the same pin. Thus accidental shorts are avoided.

5. Short Test: In the Model 539C, Hickok has introduced an entirely new concept in short and leakage testing. In addition to the conventional neon lamp short indication, there is a d.c. leakage test which registers up to 50 megohms on the scale of the large Gm meter.

   Neon Lamp Short Test. Turning the SHORTS switch successively through the positions 1-2-3-4-5 connects the various pairs of elements in turn across the test voltage. Tubes having shorted elements will complete the circuit and cause the neon SHORT lamp to glow. Tubes may be tested for shorts, either hot or cold. Normal sensitivity of the neon lamp is about 1/3 Megohm.

   A short is indicated by a steady glow of the neon lamp in certain positions of the SHORTS switch. A shorted tube should be discarded without further test.

   An improved neon Short Test is incorporated in the design of this tube tester. Wide experience has demonstrated that most satisfactory results are obtained when tubes are classified for short test purposes.

   The toggle switch is thrown to miniature and subminiature position for all subminiature, button seven pin and button nine pin tubes. The other position is used for tubes having regular base pins, including loktal base tubes.

6. Locating Shorted Elements by Neon Lamp. In the following table (X) under any position indicates that the neon lamp glows in that position.

KIND OF SHORT	1	2	3	4	5
HEATER - CATHODE	X				
HEATER - GRID	X	X			
HEATER - SCREEN	X	X	X		
HEATER - PLATE	X	X	X	X	
HEATER - SUPPRESSOR	X	X	X	X	X
CATHODE - GRID		X			
CATHODE - SCREEN		X	X		
CATHODE - PLATE		X	X	X	
CATHODE - SUPPRESSOR		X	X	X	X
GRID - SCREEN			X		
GRID - PLATE			X	X	
GRID - SUPPRESSOR			X	X	X
SCREEN - PLATE				X	
SCREEN - SUPPRESSOR				X	X
PLATE - SUPPRESSOR					X

6a. Heater Cathode Leakage: A particularly troublesome defect in tubes, especially those used in television, is a leakage between heater and cathode. This leakage may be quite high, sometimes running to several megohms. It may be too high to cause the neon lamp to glow in the ordinary way. However, these leaks may be detected on your new 539C.

You will note that a heater-cathode short will cause the neon lamp to glow on position 1 (one). While the short switch is resting on position 1 (one), during short test operation a condenser will be charging through the leak. If the switch is turned from position 1 (one) to position 2 (two), a sharp flash of the neon lamp will be seen. This will not repeat until the switch is again turned to position 1 (one) allowing the condenser to recharge through the leakage. Many baffling cases of trouble can be located in this way.

It has been established that heater cathode leakage as high as 30 megohms will cause "noise" in repeater circuits in television service on coaxial lines.

6b. Noise Test: The short test circuit is also used in making noise tests on vacuum tubes. Connections are made from the noise test jacks to the antenna and ground posts of any radio receiver. The tube under test is tapped with the finger as the SHORTS switch is turned through positions 1-2-3-4-5.

Intermittent disturbances which are too brief to register on the neon lamp will be reproduced by the loud speaker as static.

7. Leakage Test on Meter: An added feature in the Model 539C is its ability to measure element leakage up to 50 megohms on the dial of the large Gm meter. The research

engineer and technician will find this feature a great aid in routine investigations.

Every engineer knows that in certain tube applications, leakage is more significant than in others. The metered leakage feature of the Model 539C will enable him to form sound judgment as to the leakage to be tolerated in different applications.

7a. Operating Leakage Test: Turning the SHORTS switch through positions A, B, C, D, E isolates tube elements successively from all other elements and registers the leakage in megohms between the chosen element and all others connected in parallel. Forty volts d. c. is applied in this test. The significance of the lettered positions of the short switch is as follows:

*A - HEATER isolated from other elements.

B - GRID isolated from other elements.

C - SCREEN isolated from other elements.

D - PLATE isolated from other elements.

E - SUPPRESSOR isolated from other elements.

*NOTE: Position A includes heater-cathode leakage. In tubes having filamentary cathodes, the heater and cathode are identical; therefore the meter will normally indicate near the zero mark on position A of the shorts switch.

8. Gas Test: The push switches P5 (Gas 1)and P6 (Gas 2) are used to test amplifier tubes for gas content.

a. Make Micromho test in the ordinary way.

b. Set the Bias Voltmeter switch to the 50 volt range and the Function switch to position D. Hold down P5 and adjust the Bias control to bring the meter reading down to 500 on the 3000 scale.

c. Hold down P5 and press P6. Because of a charging capacitor the meter will deflect either up scale or down scale about one division, after P6 is pressed, and will settle to a new reading. An upscale reading after settling is the result of grid current due to gas or grid emission (sometimes referred to as poisoned grid). If the upward movement is not more than one large division (two small divisions), the gas content is satisfactory.

Some tubes develop gas after being heater for a period of time. If a tube is suspected, allow it to heat for a few minutes. This constitutes a very sensitive gas test. Gas content on the order of 0. 1 microampere can be detected.

Gas content is a very important factor in modern receivers of all types, containing AVC and AFC circuits as the presence of gas causes the grid to become conductive and as changes in grid bias operate through resistors of comparatively high value, correct functioning cannot be obtained with a gassy tube. The presence of gas results in actually changing the grid bias. Gas is especially harmful in television tubes.

9. Dynamic Transconductance: The Push Switch P4 is mechanically divided into two sections, non-locking and locking. Both sections perform identical electrical functions. If momentary contact is needed, press the non-locking button. If extensive tests are to be made, use the locking button. The locking button is released by pressing the non-locking button.

The indicating meter will register the tube's value in eight ranges:

A. 60,000 µmho at .25 Volt signal.
B. 30,000 µmho at .25 Volt signal.
C. 15,000 µmho at .25 Volt signal.
D. 6,000 µmho at .5 Volt signal.
E. 3,000 µmho at 2.5 Volt signal.
F. 600 µmho at 1. Volt signal.
G. Rectifiers and Diodes, no signal.
H. Voltage Regulator tubes.

The 600 micromho range was designed especially to test subminiature tubes. Low plate and screen volts are automatically applied when FUNCTION switch is set on position F.

The FUNCTION switch automatically changes the signal volts when the appropriate setting is made.

The chart setting for the tube to be tested will indicate where the FUNCTION switch should be set, such as A, B, C, D, E, F, G or H, in the column preceding Micromhos.

The Micromho values printed on the data roll are minimum values. Good tubes will read above these values.

In the column headed BIAS VOLTS is listed the exact voltage to which the BIAS VOLTS meter is to be set when testing a tube. Make final bias adjustment after the P4 button is pressed.

Certain pentode tubes, such as the 3A4, are tested with reduced screen voltage. This is accomplished by holding down P1 and pressing P4. Specific instructions are printed in the NOTATIONS column for each tube requiring reduced screen voltage.

10. Rectifier Test. The push switches P1, P2 and P3 are used to test various types of rectifier elements.

a. The push switch P1 is used when testing detector diodes. It applies a low voltage which will not injure the delicate cathode. Good diodes will cause the meter pointer to read above mark, RECTIFIERS and DIODES O.K.

b. Push switch P2 is used when testing cold cathode rectifiers such as the OZ4. This applies a voltage sufficiently high to ionize the tube and start conduction. Good tubes will read above the mark, RECTIFIERS and DIODES O.K.

c. Push switch P3 is used when testing ordinary rectifier tubes such as the 5Y3. This switch applies a medium voltage which is best adapted to reveal defects in this type of tube. Good tubes will read above the mark, RECTIFIERS and DIODES O.K.

In the chart column headed SHUNT are listed the numbers to which the SHUNT dial is to be set when testing Rectifiers and Diodes.

11. Socket Numbering. Sockets are wired according to EIA numbering, and the numerical values of the lettered dials are as follows:

Selector Positions			Socket Connections
A	P	0	No Connection
B	R	1	1
C	S	2	2
D	T	3	3
E	U	4	4
F	V	5	5
G	W	6	6
H	X	7	7
J	Y	8	8
K	Z	9	9
1	1	W	10
2	2	X	11
3	3	Y	12
4	4	Z	No Connection

12. Meter Reverse. Directly below the indicating meter is a switch marked REVERSE-NORMAL. With certain tubes such as the 117N7, the meter, when set on NORMAL, will deflect backwards (to the left) when push switch P3 is pressed for rectifier test. In such case turn the meter switch to REVERSE which will cause the pointer to move up the scale. After this test has been made, return the switch to NORMAL.

13. Top Caps. There are two jacks in the upper center of the control panel marked GRID and PLATE. These are used when making connection to the top cap of the tube being tested. On the data chart in the NOTATIONS column opposite tube types having top caps, is the notation CAP = G, or CAP = P. G means that the top cap is connected to the GRID and P, to the PLATE jack.

14. Special Notes. Power line voltage varies with different localities. It may also vary with the different hours of the day.

While a national survey indicates that the average voltage for the USA is 117 volts, it does not mean that every locality maintains a constant voltage at that level.

Occasionally we have had the complaint that a used tube will test GOOD, but will not work in the radio receiver; but when a NEW tube is substituted, the receiver will operate correctly. The answer is this: Tubes are built to specifications. Our tube testers are designed to test tubes in conformity with these specifications.

The used tube that would not perform in a certain receiver was not receiving its specified filament voltage. The new tube performed because of its initial reserve capacity. The used tube would have performed if it had received its specified filament voltage.

Tube failure frequently occurs in A.C. - D.C. sets where several tubes are connected with their heaters or filaments in series. Sometimes, even though the power line voltage is normal, a series tube with abnormally high filament resistance will rob its companion tube of its normal filament voltage. The robbed tube apparently fails; but when tested under specified conditions, the tube will test GOOD.

The Model 539C is valuable in matching tubes for push-pull stages and other applications where matched tubes are essential.

15. Life Test. The Model 539C DYNAMIC MUTUAL CONDUCTANCE TUBE TESTER is equipped with a special feature to enable Life Test to be made on the tube. In the center of the control panel is a switch designated CATH. ACT., NORM. and TEST. While holding everything else at normal this switch reduces the filament voltage by 10%.

a. Measure the mutual conductance in the ordinary way with switch set on NORMAL.

b. Throw the CATH. ACT. switch to TEST position. The mutual conductance should not drop more than 20%.

c. After making life test return the switch to NORMAL for all other tests.

In testing the 35Z5 and 45Z5 rectifier tubes it is advisable to turn the power off for about 15 seconds after throwing the CATH. ACT. switch to TEST to allow the cathode to cool. Then turn the power on and note new reading of the meter.

16. Self Bias. Provision is made to test tubes under self bias condition. In the upper edge of the control panel are two binding posts designated SELF BIAS. These posts are normally shorted by an attached bar. To use SELF BIAS, connect a suitable bias resistor together with an electrolytic capacitor of 2000 μfd in parallel across these binding posts. The positive terminal of the capacitor should be connected to the positive binding post.

The toggle switch in the upper left of the control panel is thrown from NORMAL position to the SELF BIAS position. The bias volts under self bias condition depends upon the value of the resistor inserted between the self bias posts mentioned above, and also upon the plate current flowing.

Tube handbooks can be used as a guide to the value of the self bias resistance to use. When completing the self bias test, reconnect the two binding posts by the normal shorting bar and throw the toggle switch back to the NORMAL position.

17. Plate Current. In the upper center of the control panel are two posts designated PLATE CURRENT. These posts are normally shorted by an attached bar. A suitable low resistance D.C. milliammeter connected across these posts will measure the plate current flowing through the tube being tested. Connect the positive terminal of the meter to the positive binding post.

NOTE

A D.C. milliammeter connected into the SELF BIAS circuit will measure the total cathode current. In measuring rectifier tube current the meter reading must be multiplied by two, because rectifier tubes conduct only during a positive half-cycle, whereas the meter integrates over a complete cycle.

In checking thyratrons such as the 884 and 885, the bias voltmeter should be set initially at its highest negative value (about 40 volts). The designated button is held down while the bias voltage is gradually reduced until the tube "strikes", that is, begins to conduct, which is indicated by a sudden deflection of the meter. The chart indicates the approximate voltage at which the tube strikes. There may be a small variation above or below the given striking voltage. The meter indication for a good tube is above the point designated "RECTIFIERS OK".

18. Filament and Heater Continuity.

1. Turn the tester on.

2. Set the selectors as per chart for the tube to be tested.

3. Set the FILAMENT switch on BLST instead of voltage indicated on the chart.

4. Set the SHORT TEST switch on position 5.

5. Place the tube in the proper socket.

If the neon lamp glows, the filament is good and a complete test should then be made on the tube, by setting FILAMENT switch on the proper tap, and while the tube heats, rotate the SHORT TEST SWITCH several times thru 1 to 5 positions. If no shorts are indicated, set the switch in TUBE TEST position and proceed to test the tube as per chart.

If the neon lamp does not glow, the filament is open and further test is unnecessary. Certain tubes such as the 35Z5-50Z7, etc., with tapped filaments have special continuity test settings; see roll chart.

NOTE

It sometimes happens that a filament will show continuity when cold, but will open when it warms up.

19. Voltage Regulator Tubes.

a. Set the selectors for V.R. tube to be tested. The test data for V.R. tubes will be found at the top end of the roll chart. For example, the OA3.

b. Set FIL VOLTAGE switch to OFF.

c. Set selector switches to AP-0502-0.

d. Set function switch on range H, V.R. TEST.

e. Turn the bias volts toggle switch to V.R. volts and mils.

f. Turn V.R. volts knob fully counter clockwise.

g. Turn power adjust knob fully clockwise. Press P4-LOCK.

h. Place V.R. tube in proper socket and turn power ON.

i. Turn V.R. voltage control knob slowly clockwise. The large Gm meter should start to read d.c. volts on the 0-200 volt scale.

j. Example: In the notations column for the OA3 tube appears, "Starts at about 100 Volts - Regulation = 5 volts from 5 to 40 m.a.". In the column marked MIN. MUT. COND. is the nominal operating voltage for this tube - 75V.

k. When the V.R. tube strikes as explained in (j) above, the voltmeter reading will drop back to operating voltage. The V.R. current is read on the 0-100 m.a. range of the bias meter.

l. For the OA3 example adjust the m.a. current from 5 to 40 milliamperes by turning the V.R. volts and mils knob. The OA3 tube should not exhibit a voltage change of more than 5 volts.

m. When completing a V.R. tube test unlock P4 push button.

20. Ohmmeter Feature. The Model 539C tube tester can be used as a utility ohmmeter as follows:

a. Set the SHORTS switch on position B.

b. Connect two prod leads into the grid and plate jacks in the center of the control panel. The red plate jack will be the positive lead.

c. Touch together the two prods and adjust the ohmmeter pointer to zero. Resistance up to 50 megohms can be read directly on the megohm range.

d. Electrolytic capacitors can be checked for leakage. Observe that the red (plate) jack is connected to the positive pole of the capacitor.

21. NORMAL-LOW Plate Volts. In the NOTATIONS column of the data chart for some tubes will be found PLATE VOLTS = LOW. This notation indicates that the PLATE VOLTS switch located just above the FUNCTION switch is to be set on the LOW position. Return the switch to NORMAL for all other tubes.

22. Heater - Current. In the lower right hand corner of the panel will be found two binding posts which are normally connected together by a jumper. By removing this jumper and connecting a suitable Milliammeter or Ammeter between these two binding posts, the indicating instrument will read the current being drawn by the heaters of the tube under test.

The actual voltage at the tube under test will be the voltage as indicated by the filament selector switch minus the voltage drop across the indicating Milliammeter or Ammeter. This voltage will generally be of a very low magnitude, but can be calculated by multiplying the current normally drawn by the tube under test by the impedance of the meter connected in series with this tube, or it can be actually measured with a sensitive AC Voltmeter.

If the impedance of the meter is much more than 0.2 ohms, the voltage drop might be appreciable percentage-wise to the voltage delivered to the tube. For example, if the current at the tube is normally 0.6 amperes, and the impedance of the current measuring instrument were 0.5 ohms, the resultant loss would be the product of these two, or 0.3 of one volt.

23. Pilot Lamp Testing. The center of the large 7-pin socket is used to check pilot lamps. Set the filament selector switches on HR. Set the filament voltage switch to the proper voltage for the lamp being tested.

TO TEST BALLAST TUBES

1. Turn Tester on.
2. Set filament switch to BLST.
3. Set SHORT TEST switch on 5.
4. Set first selector switch to letter shown in column marked (first selector switch). Set all numbered selectors on zero.
5. ROTATE second selector switch. NEON LAMP SHOULD LIGHT IN POSITIONS NOTED.

TUBE TYPE	First Selector	Neon Lamp Should Light in these positions							
1A1-1B1-1C1-1E1-1F1-1G1-1J1-1K1-1V1 1Y1-1Z1	E	R							
1L1-1N1-1P1-1Q1-1R1G-1S1G-1T1G-1U1G	H		S						
2	E	R							
2UR224	H			T					Y
2LR212	J	R	S		U				
3	E	R							
O3G	H			T					
4-5	E	R							
6-133	H			T					
6-6AA-7-8-9	E	R							
10A-10AG	H			T					
10AB	E	R							
K17B-M17C-BM17C	H			T					Y
M17HG-M17H	H D	R 	 S						Y
K23B-K23C	H			T					Y
KX23B	E	R		T					
KX30C	E	R		T					
M30H	H D	R 	 S						Y
30A-K30A	H			T					
K30D	H		S	T					Y
33A-33AG	H			T					
K34B	H			T					Y
36A	H			T					
K36B-BK36B-L36B-L36C	H			T					Y
KX36Z	E	R							
KX36C	E	R		T					
36D-L36D	H		S	T					Y
L36DJ	H	R	S	T	U				Y
K36H-M36H-M36HG	H D	R 	 S						Y
40A1	H		S						
L40S1-L40S2	H		S	T		V			
42A	H			T					

TUBE TYPE	First Selector	Neon Lamp Should Light in these positions								
42A1	J				U					
42A2-42B2	J	R			U					
K42B-L42B-M42B	H			T					Y	
KX42B-LX42B-L42BX	E	R		T						
K42C-L42C-M42C	H			T					Y	
BK42D-K42D-L42D	H		S	T					Y	
LX42D-L42DX	E	R	S	T						
K42E-L42E	H			T					Y	
L42F	H								Y	
	D		S							
42HA-42HJ	H	R								
	E		S	T						
M42H-M42HG	H	R							Y	
	D		S							
KX42C	E	R		T						
L42SI	H		S	T		V				
49A-49AJ-K49AJ	H			T						
KX49A	E	R		T						
49A1	J				U					
49A2-49B2	J	R			U					
K49B-L49B-M49B-BM49B-K49C	H			T					Y	
M49C-BM49C-BK49C-K49E-L49E										
K49D-BK49D-L49D	H		S	T					Y	
L49F	H								Y	
	D		S							
M49H-M49HG	H	R							Y	
	D		S							
KZ49B-KZ49C	H		S			V				
K49BJ-L49BJ	H			T	U				Y	
L49S2	H		S	T		V				
49AJ-K49AJ	H			T						
KX49B-LX49B-LX49C	E	R		T						
L49DJ	H		S	T	U				Y	
L49S3	H		S	T		V				
50A2	E	R		T						
50A2MG-50B2	H		S			V				
50X3	E	R								
K52H-M52H	H	R							Y	
	D		S							
K54B	H			T					Y	
55A-K55A	H			T						
55A1	J				U					
KX55A	E	R								
55B-K55B-M55B-BM55B-L55BG	H			T					Y	
LX55B	E	R		T						
55A2-55B2	J	R			U					
K55C-L55C	H			T					Y	

TUBE TYPE	First Selector	Neon Lamp Should Light in these positions							
KX55C	E	R		T					
K55CP	H			T		V			Y
K55D-L55D	H		S	T					Y
L55E-M55E	H			T					Y
L55F-M55F-BL55F	H								Y
	D		S						
K55H-M55H-M55HG	H	R							Y
	D		S						
L55S1-L55S2	H		S	T		V			
60R30G	E	R		T					
64. 23	H			T					
67A	H			T					
K67B-L67B	H			T					Y
L73B-K74B-L74B	H			T					Y
KX74C	E	R		T					
80A	H			T					
K79B-K80B-K80C-L80B	H			T					Y
KX80B	E	R		T					
K80F	H								Y
	D		S						
KX87B-LX87B	E	R		T					
L90B	H			T					Y
K90F-M90F-K92F-M92F	H								Y
	D		S						
92A	H			T					
L92B-95K2	H			T					Y
L99D	H		S	T					Y
100R8	E	R		T					
120R	E	R							
120R8	E	R		T					
135K1	H			T					Y
135K1A	H			T	U				Y
140L4-140L8-140R4-140R8	E	R		T					
140R	E	R							
140L44	E	R		T					
140R44	E	R	S	T					
165L4-165R4-165R8	E	R		T					
165R	E	R							
165L44-165R44	E	R	S	T					
185L4-185L8-185R4-185R8	E	R		T					
185R	E	R							
185L44-185R44	E	R	S	T					
200R-250R	E	R							
250R8	E	R		T					
290L4	E	R		T					
300R4-320R4	E	R		T					
340	E	R							
808-1	H			T	U				Y

TUBE TYPE	First Selector	Neon Lamp Should Light in these positions							
E14980-W43357-W45788-3613	H			T					Y
3334-3334A	H		S	T					Y
3613	H			T					Y
8593-8598-8601-8664	H			T					Y
3CR241	H		S	T					Y
3ER248	H		S	T	U				Y
B9M15822	C			T					
	E					V			
	G							X	Y
B9M16067	H		S	T		V	W		Y
B9M16275	C			T	U	V	W	X	Y
B9M16534	H		S	T		V	W		Y
B9M17571	J		S	T					
	H				U	V			Y
B9M18941	C	R		T					
	E					V			
	G							X	Y
17A470303	H	R	S			V			
	J						W		
	E			T					
17A485459	H	R	S				W		
	E			T					
TBR102D-TBR104D	C	R		T	U	V			
	G							X	Y
TBR103D	C	R			U	V			
	G							X	Y
397021	C	R		T					
397022	E					V	W		
397023	H								Y
397036	B					V			
407100	H	R	S			V			
408100	H	R	S			V			
	D				U				
SW407300	H		S	T		V	W		Y
571606	C	R		T					
	E					V	W		
	H								Y

PARTS LIST FOR MODEL 539C

NOTE: There is a minimum billing charge of $3.50 for any one parts order. Prices will be furnished upon request.

Hickok Code No.	Name and Description	Ref. Symbol or Function
2490-273	BOOKLET: Instructions	
2920-7	BUTTON: Push, Black	
2920-8	BUTTON: Push, Red	
3085-40	CAPACITOR: 100 Mfd, 6 volts	C4
3085-68	CAPACITOR: 8 Mfd, 350 volts	C1
3095-8	CAPACITOR: 470 Mmf, 10%, 500 volts	C5
3105-112	CAPACITOR: .5 mfd, 200 volts	C3
3105-175	CAPACITOR: .05 mfd, 400 volts	C2
3200-55	CHART: Data Roll	
4160-66	DIAL: Shunt	
10300-1	JACK: Pin plug type, red	
10300-2	JACK: Pin plug type, black	
11500-11	KNOB: with pointer	
11505-46	KNOB: with white dot	
11505-49	KNOB: 1"	
12270-2	LAMP: #81	Fuse Lamp
12270-12	LAMP: #47	Pilot Lamp
12270-14	LAMP: NE51	Short Test
12450-145	LEAD: Assembly, plate	
12450-180	LEAD: Assembly, plate	
16925-88	POTENTIOMETER: 1000 ohms	R25
16925-270	POTENTIOMETER: 3000 - 1000 ohms	R14-R16
18413-361	RESISTOR: 36K, 5%, 1/2 watt	R47
18414-121	RESISTOR: 120K, 5%, 1/2 watt	R35-R36
18414-151	RESISTOR: 150K, 5%, 1/2 watt	R34
18415-102	RESISTOR: 1 Meg, 10%, 1/2 watt	R46
18414-472	RESISTOR: 470K, 10%, 1/2 watt	R2
18422-101	RESISTOR: 1000 ohms, 5%, 1 watt	R20-R21
18422-122	RESISTOR: 1200 ohms, 10%, 1 watt	R6
18423-151	RESISTOR: 15K, 5%, 1 watt	R5
18525-685	RESISTOR: 150 ohms, 1%, 1/2 watt	R26
18525-686	RESISTOR: 50 ohms, 1%, 1/2 watt	R11-R12
18525-687	RESISTOR: 470K, 1%, 1/2 watt	R23
18525-700	RESISTOR: 200 ohms, 1%, 1/2 watt	R51
18525-719	RESISTOR: 270 ohms, 1%, 1/2 watt	R29
18525-717	RESISTOR: 40K, 1%, 1/2 watt	R49
18525-722	RESISTOR: 9900 ohms, 1%, 1/2 watt	R50
18550-153	RESISTOR: 1200 ohms, 1%, 1 watt	R19
18525-718	RESISTOR: 100 ohms, 1%, 1/2 watt	R10-R28
18525-720	RESISTOR: 230 ohms, 1%, 1/2 watt	R33
18525-723	RESISTOR: 750 ohms, 1%, 1/2 watt	R27
18525-721	RESISTOR: 300 ohms, 1%, 1/2 watt	R9
18550-154	RESISTOR: 2250 ohms, 1%, 1 watt	R17
18525-681	RESISTOR: 500 ohms, 1%, 1/2 watt	R13-R37-R42
18525-729	RESISTOR: 330K, 1%, 1/2 watt	R48
18575-12	RESISTOR: 1800 ohms, 10%, 10 watt	R7
18575-19	RESISTOR: 100 ohms, 10%, 10 watt, center tapped	R3-R4
18575-89	RESISTOR: 8500 ohms, 10%, 10 watt	R18
18575-126	RESISTOR: 150 ohms, 1%, 2 watt	R1
18750-24	RHEOSTAT: 150 ohms	R13
18750-26	RHEOSTAT: 10K, 50 watt	R24

PARTS LIST FOR MODEL 539C

NOTE: There is a minimum billing charge of $3.50 for any one parts order. Prices will be furnished upon request.

Hickok Code No.	Name and Description	Ref. Symbol or Function
19350-1	SOCKET: Bayonet for 81 Lamp	
19350-113	SOCKET: Bayonet Neon and Pilot Lamp	
19350-364	SOCKET: 10 pin	
19350-367	SOCKET: Novar	
19350-365	SOCKET: Compactron	
19350-381	SOCKET: Nuvistor, 5 pin	
19350-383	SOCKET: Nuvistor, 7 pin	
19350-76	SOCKET: 7 pin miniature	
19350-93	SOCKET: 4 pin	
19350-94	SOCKET: 5 pin	
19350-95	SOCKET: 6 pin	
19350-96	SOCKET: 7 pin	
19350-97	SOCKET: Loktal	
19350-98	SOCKET: Octal	
19350-220	SOCKET: Subminiature, combination 7 and 8 pin	
19910-61	SWITCH: Gang, 8 buttons	
19911-7	SWITCH: Meter reverse	
19911-55	SWITCH: Toggle DP-DT	
19912-480	SWITCH: Suppressor and Cathode	
19912-479	SWITCH: Selectors	
19912-202	SWITCH: Filament Volts	
19912-304	SWITCH: 3 P-DT	
19912-308	SWITCH: Function	
19912-312	SWITCH: Short Test	
20800-103	TRANSFORMER: Filament	
20800-169	TRANSFORMER: Plate	
20875-6	TUBE: 5Y3GT/G	
20875-28	TUBE: 83	

TESTING TELEVISION PICTURE TUBES WITH THE CRT-1 ADAPTER

	Selectors	Fil	Bias	Shunt	Range	Press
Emission	HS-3508-4	6.3	----	0	G	P1
Grid Control and Gas Test	HS-5308-4	6.3	*	----	D	P5

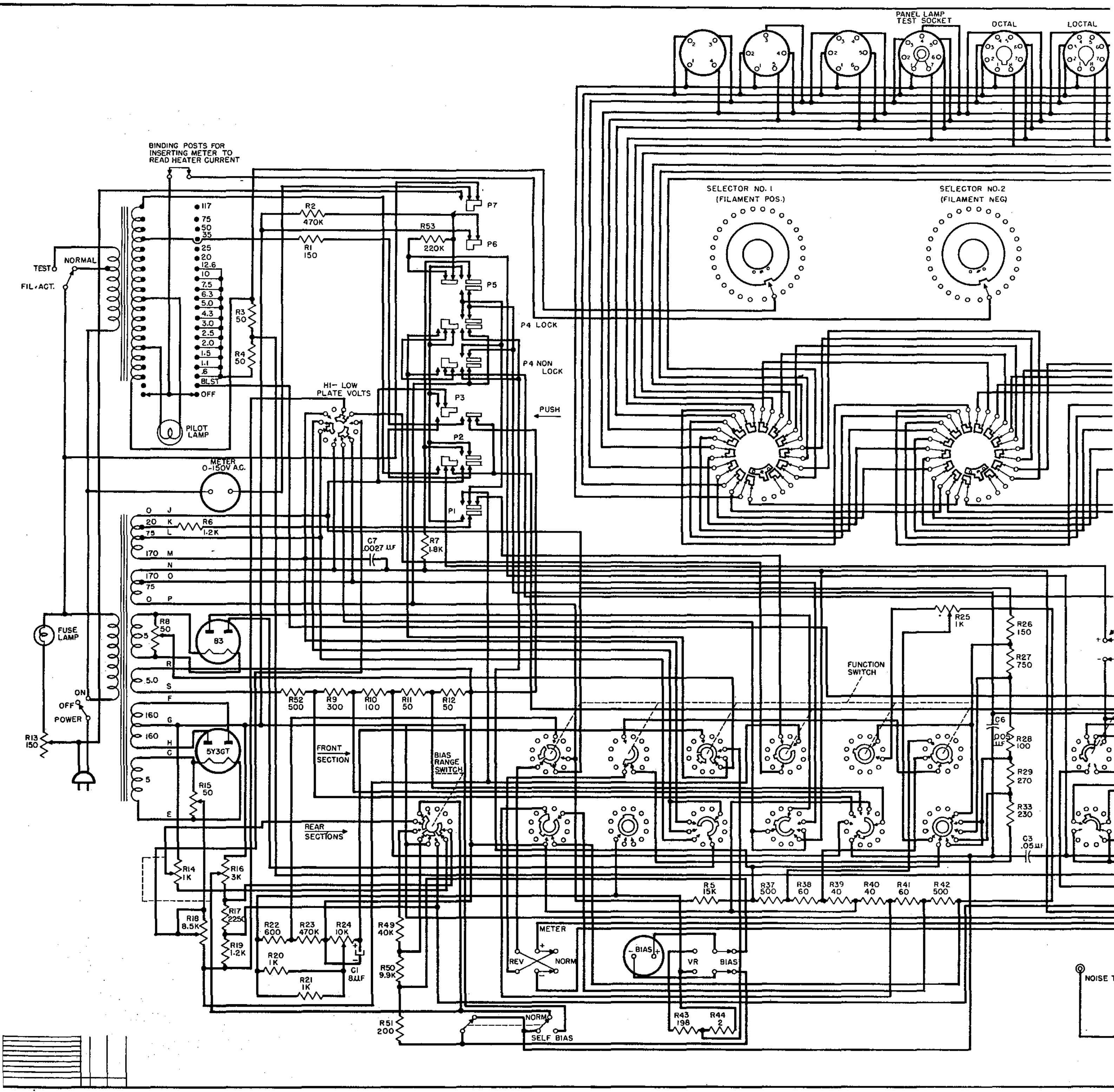
Emission: Good tubes should read above line marked RECTIFIERS AND DIODES OK.

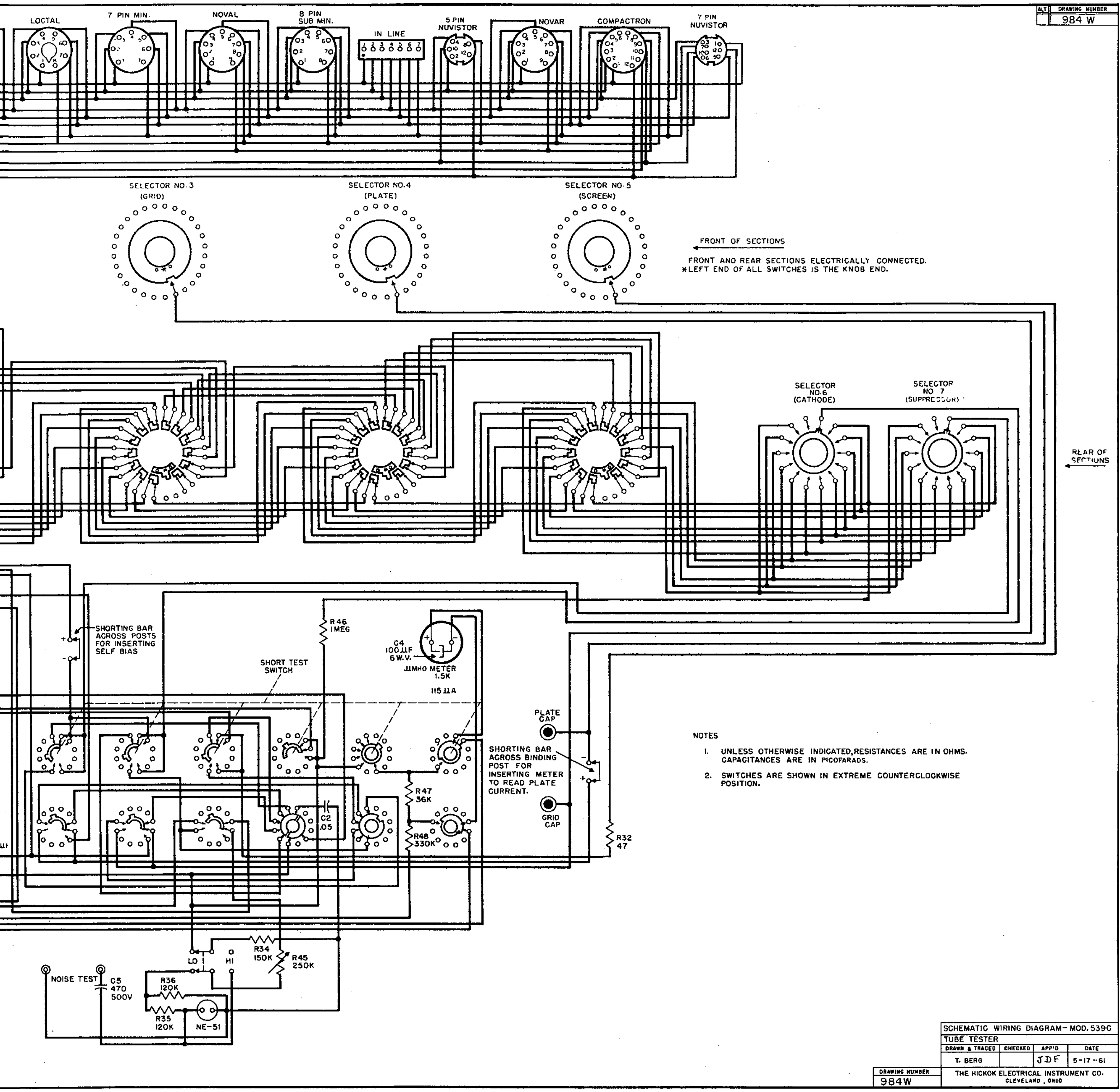
Grid Control and Gas Test:

* Hold down P5 and rotate Bias knob. Meter should move up and down scale if grid is operation.

GAS TEST: Hold down P5 and adjust bias until meter reads one small division. While holding P5 down, press P6. If meter pointer moves up scale more than one division, tube is gassy.

NOTE: In ordering parts or materials for this instrument, the serial number must be given in order to identify properly the material required.


PANEL LAMP TEST SOCKET
OCTAL
LOCTAL
BINDING POSTS FOR INSERTING METER TO READ HEATER CURRENT
SELECTOR NO. 1 (FILAMENT POS.)
SELECTOR NO. 2 (FILAMENT NEG)
TEST
NORMAL
FIL. ACT.
117 75 50 35 25 20 12.6 10 7.5 6.3 5.0 4.3 3.0 2.5 2.0 1.5 1.1 .6 BLST OFF
PILOT LAMP
R2 470K
R1 150
R3 50
R4 50
R53 220K
P7
P6
P5
P4 LOCK
P4 NON LOCK
P3
P2
P1
PUSH
HI- LOW PLATE VOLTS
METER 0-150V A.C.
R6 1.2K
C7 .0027 µF
R7 1.8K
FUSE LAMP
R8 50
83
ON
OFF
POWER
R13 150
5Y3GT
R15 50
R52 500
R9 300
R10 100
R11 50
R12 50
FRONT SECTION
REAR SECTIONS
BIAS RANGE SWITCH
FUNCTION SWITCH
R25 1K
R26 150
R27 750
C6 .005 µF
R28 100
R29 270
R33 230
C3 .05 µF
R14 1K
R16 3K
R17 2250
R18 8.5K
R19 1.2K
R22 600
R23 470K
R24 10K
C1 8 µF
R20 1K
R21 1K
R49 40K
R50 9.9K
R51 200
METER
REV
NORM
BIAS
VR
R5 15K
R37 500
R38 60
R39 40
R40 40
R41 60
R42 500
R43 198
R44 2
NORM
SELF BIAS
NOISE T


984 W
LOCTAL
7 PIN MIN.
NOVAL
8 PIN SUB MIN.
IN LINE
5 PIN NUVISTOR
NOVAR
COMPACTRON
7 PIN NUVISTOR
SELECTOR NO. 3 (GRID)
SELECTOR NO. 4 (PLATE)
SELECTOR NO. 5 (SCREEN)
FRONT OF SECTIONS
FRONT AND REAR SECTIONS ELECTRICALLY CONNECTED.
*LEFT END OF ALL SWITCHES IS THE KNOB END.
SELECTOR NO. 6 (CATHODE)
SELECTOR NO. 7 (SUPPRESSOR)
REAR OF SECTIONS
SHORTING BAR ACROSS POSTS FOR INSERTING SELF BIAS
R46 1MEG
C4 100µF 6W.V.
µMHO METER 1.5K
115µA
SHORT TEST SWITCH
PLATE CAP
SHORTING BAR ACROSS BINDING POST FOR INSERTING METER TO READ PLATE CURRENT.
GRID CAP
R47 36K
C2 .05
R48 330K
R32 47
NOTES
1. UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS. CAPACITANCES ARE IN PICOFARADS.
2. SWITCHES ARE SHOWN IN EXTREME COUNTERCLOCKWISE POSITION.
LO
HI
R34 150K
R45 250K
NOISE TEST
C5 470 500V
R36 120K
R35 120K
NE-51
SCHEMATIC WIRING DIAGRAM– MOD. 539C
TUBE TESTER
DRAWN & TRACED: T. BERG
APP'D: JDF
DATE: 5-17-61
DRAWING NUMBER 984W
THE HICKOK ELECTRICAL INSTRUMENT CO.
CLEVELAND, OHIO

Hickok Model 539C
Mutual Conductance Tube Tester
Checkout & Calibration Testing

Use this procedure to test and calibrate the Hickok Model 539C mutual conductance (AKA transconductance) tube tester. Except as noted, all of the readings are taken with a 1000 ohms per volt meter. If an accurate 1000 ohms per volt meter is not available a modern high impedance analog or digital voltmeter can be used with appropriate shunt resistors in parallel with the input to simulate proper loading. The following resistor values should be used: 10 volt scale use 10K, 50 volt scale use 51K, 250 volt scale use 250K. All resistors are 1/2 watt 5% carbon composition. Calibration will be easier if you supply AC power through a constant voltage regulation type transformer to do the tests, but this is not essential. Recalibrate the tester any time either rectifier tube is replaced. The correct type #81 (#63 for 230VAC mains) fuse lamp must be installed in the tester or false readings can result.

For the identification and location of adjustments refer to the adjustments section of each test. Because Hickok made production changes to the 539 series of testers through the manufacturing lifetime of the model, the illustration of the location of the adjustment controls may vary from your tester.

It is assumed that the person performing the testing and adjustment is knowledgeable in electronic service and aware of the dangers in working on equipment using high voltages. Do not attempt to service equipment if you are not experienced in such work. Serious shock or death could result in improper action or procedure.

Table of Contents

1 PREPARATION

Remove the screw from the bottom of the case. Remove all of the screws around the outside of the panel that hold the tester to the case. Remove the tester from the case and set it up on spacers so that the front panel is facing up in the normal operating position. Before applying power adjust the mechanical zero on the meters that have that capability to set the pointers exactly at the zero line on the scale.

The following components are needed to complete the testing in the specified steps:

Step	Component
5	300K, 1/2W, 5% resistor
6	1M, 1/2W, 5% resistor
13	2K, 5W, 1% resistor
15, 16, 18	10K, 10W, 1% resistor
17	Calibrated 6L6, Hickok p/n 20877-1
18	1K, 10W, 1% resistor 1N4005 diode
19	10M, 1/2W, 5% resistor Known good 6L6

2 LINE ADJUST METER

Plug in the AC power cord and turn the **POWER** switch on. Connect an AC voltmeter across the AC supply and read the voltage. Push button **P7 LINE TEST** and verify that the AC panel meter, just above the power switch, reads the correct AC line supply voltage. It is important that this meter reads correctly or the calibration procedure will be erroneous. When the panel meter is verified to be correct, release the **P7** button. Rotate the **POWER ADJUST** control until the AC panel meter needle is exactly over the red line. Remove the external AC voltmeter from the AC supply. See also section 11.1 (V.R. VOLTMETER TEST Adjustment).

2.1 Adjustment

No adjustment possible. High readings can be brought into calibration by the addition of an appropriate value resistor placed in series with the meter. Low readings cannot be raised without disassembly of the meter and replacing the internal calibration resistor with a slightly smaller value.

3 SHUNT POSITION

Rotate the **SHUNT** control fully counter clockwise and verify that the pointer lines up with the 0 mark on the scale.

3.1 Adjustment

Loosen the set screw on the knob and reposition the knob to the correct location. Retighten the set screw.

4 SHORTS TEST

Set the **SHORTS** switch to the ***TUBE TEST*** position and the **SHORT TEST** switch to the ***OTHER TUBES*** position. Set both the **CATHODE** and the **SUPPRESSOR** switches to the number ***1*** position. Rotate the **SHORTS** switch counter clockwise. The **SHORTS** lamp should light in all positions except number ***1***. Repeat the procedure setting both the **CATHODE** and **SUPPRESSOR** switches simultaneously in positions ***2*** through ***Z***. Return the **SHORTS** switch to the ***TUBE TEST*** position.

4.1 Adjustment

No adjustment. Failure to read a short on any switch position means the switch contacts are dirty or damaged. Cleaning and de-tarnishing the contacts may help.

5 SHORTS LIGHT SENSITIVITY

Set the **CATHODE SWITCH** to position ***8*** and the **PLATE** switch to position ***3***. Connect a 300K, 1/2W, 5% resistor between pins *3* and ***8*** of the octal socket. Rotate the **SHORTS** switch counter clockwise to position ***4***. The **SHORTS** lamp should be glowing or flickering dimly. Rotate the **SHORTS** switch to the ***TUBE TEST*** position and disconnect the 300K resistor.

5.1 Adjustment

If the lamp fails to light, replace the lamp and/or perform the test again and adjust **R45** until the **SHORTS** light just comes on.

6 LEAKAGE RESISTANCE METER TEST

Connect a 1M, 1/2W, 5% resistor between pins *3* and ***8*** of the octal socket. Rotate the **SHORTS** switch clockwise to position ***D***. The main meter should be reading approximately 1M ohms on the resistance scale. Rotate the **SHORTS** switch back to the ***TUBE TEST*** position and disconnect the 1M resistor.

6.1 Adjustment

No adjustment. If the reading is wrong check resistors R46 / 1M, R47 / 36K and R48 / 330K. Also check the main meter movement sensitivity as described in section 16 (MUTUAL CONDUCTANCE READING TEST) below.

Set up the tester for the remainder of the tests by setting the switches to the following positions (6L6):

NORMAL/SELF BIAS = NORMAL
VR VOLTS & MILS CONTROL = COUNTERCLOCKWISE
BIAS RANGE = 50V
BIAS VOLTS/VR VOLTS & MILS (toggle switch) = BIAS VOLTS
BIAS VOLTS CONTROL = COUNTERCLOCKWISE (Zero volts)
METER = NORMAL

SELECTORS:

FILAMENT	*= H*	*SCREEN*	*= 4*
FILAMENT	*= S*	*CATHODE*	*= 8*
GRID	*= 5*	*SUPPRESSOR*	*= 1*
PLATE	*= 3*		

SHORT TEST = OTHER TUBES
SHORTS = TUBE TEST
CATH. ACT. = NORMAL
SHUNT = 0
FILAMENT = 6.3
PLATE VOLTS = NORMAL
FUNCTION SWITCH = C (15,000)

7 FILAMENT VOLTAGE TEST

Connect an AC voltmeter to pins *2* and *7* of the octal socket. While observing the reading on the meter, rotate the **FILAMENT** switch from the ***minimum*** through the ***maximum*** voltage positions and verify that the voltage agrees with the setting. The readings should be within ± 10% of nominal. Set the **FILAMENT** switch to the ***10 volt*** position. Set the **CATHODE ACTIVITY** switch to the ***TEST*** position. The filament voltage should drop by about 10%. Return the **CATHODE ACTIVITY** switch to the ***NORMAL*** position and set the **FILAMENT** switch to the ***6.3 volt*** position.

7.1 Adjustment

No adjustment. This voltage is entirely dependent on the power transformer and the AC line setting. Some voltages may read slightly higher due to the lack of loading on the transformer.

8 PLATE VOLTAGE TEST

Connect the positive lead of a DC voltmeter to pin *3* of the octal socket. Connect the negative lead to pin ***8***. Push the **P4 GM** button and read the voltage. Normal plate voltage is 150 ± 5 volts. Release **P4**. Set the **PLATE VOLTS** switch to the ***LOW*** position and press **P4**. The reading should be 65 ± 3 volts. Release **P4** and return the **PLATE VOLTS** switch to the ***NORMAL*** position.

8.1 Adjustment

No adjustment. This voltage is entirely dependent on the power transformer and the AC line setting. If the voltage is low, check and/or replace the type 83 rectifier tube

9 SCREEN VOLTAGE TEST

Move the positive lead of the DC voltmeter to pin *4* of the octal socket. Push **P4** and read the screen voltage. Normal is 130 ± 5 volts. Hold **P4** and press **P1**. The reading should drop to 56 ± 3 volts. Release **P1** and **P4**.

9.1 Adjustment

No adjustment. This voltage is entirely dependent on the power transformer and the AC line setting. If the voltage is low, check and/or replace the type 5Y3 rectifier tube. For the 539C the P1 low screen voltage is not adjustable.

10 BIAS VOLTAGE RANGE AND VOLTMETER TEST

Connect the positive lead of a high impedance DC voltmeter to pin *5*. Connect the negative lead to pin ***8***. *Do not use a compensating shunt resistor for this test*. Set the **BIAS RANGE** switch to the ***50V*** position. Adjust the **BIAS VOLTS** control ***fully clockwise***. Verify that the maximum voltage is -40 volts. Return the **BIAS VOLTS** control to the counter clockwise, ***zero volts***, position. Set the **BIAS RANGE** switch to the ***10V*** position. Adjust the **BIAS VOLTS** to ***-5.00 volts*** as read on the DC voltmeter. Verify that the tester meter reads 5.0 volts. Change the **BIAS RANGE** switch to the ***50V*** position. Adjust the **BIAS VOLTS** to ***-25.00 volts*** as read on the DC voltmeter. Verify that the tester meter reads 25.0 volts.

10.1 Adjustment

If necessary, adjust the maximum bias voltage by loosening the screw on the sliding tap of R18 / 8.5K tapped power resistor and sliding it to the position which gives the correct reading. This is the tap with the jumper wire to the end tab of the resistor. Gently hold the tap with insulated pliers and slide the tap until the voltage is as close to -40 volts as you can get it. This adjustment may also affect the screen voltage that was tested in the previous step. The screen voltage should be retested if an adjustment is made. If the bias volts meter calibration is off check resistors R49 / 40K, R50 / 9.9K and R51 / 200 ohms.

11 GRID SIGNAL VOLTAGE TEST

Set the **BIAS VOLTS** control to ***zero***. Connect a high impedance AC voltmeter to pins ***5*** and ***8*** of the octal socket. *Do not use a compensating shunt resistor for this test*. Set the **FUNCTION** switch to positions ***A*** (60,000) through *F* (600) and verify that the voltages are:
A=.25, B=.25, C=.25, D=.50, E=2.5, F=1.0 volts AC.

11.1 Adjustment

The grid signal is provided from a 5.0 volt winding on the power transformer. If the voltages are incorrect measure the 5.0 volts across taps R and S on the power transformer to verify it is correct. Individual grid signal voltages are obtained by fixed divider resistors R52 / 500 ohms, R9 / 300 ohms, R10 / 100 ohms, R11 / 50 ohms and R12 / 50. Check these resistors for proper value. If the 5.0 volts is incorrect, this voltage is directly affected by the POWER ADJUST control. Carefully check the LINE ADJUST METER for inaccuracy and correct it as necessary. If however, all other operating voltages are correct and only the 5 VAC grid winding is wrong, replace the grid signal divider resistor R52 with an appropriate new value to correct the error and bring the grid signal voltages to the specified values.

12 V.R. VOLTMETER TEST

Set the **FUNCTION** switch to the ***H (V.R. TEST)*** position. Connect the positive lead of a DC voltmeter to pin *3* of the octal socket. Connect the negative lead to pin ***8***. Push **P4** and read the voltage. Adjust the **V.R. VOLTS & MILS** control for a reading of ***150 volts***. Verify that the main panel meter reads 150 volts. Release **P4**. Set the **V.R. VOLTS & MILS** control to ***zero***.

12.1 Adjustment

Check resistors R20 / 1K, R21 / 1K, R22 / 600 ohms and R23 / 470K. Also check the main meter sensitivity as described in step 15 (METER BRIDGE BALANCE) below.

13 V.R. MILLIAMPERE METER TEST

Set the **BIAS VOLTS/VR VOLTS & MILS** (toggle switch) to the ***VR VOLTS & MILS*** position. Connect a 2K, 5W, 1% resistor across the DC voltmeter used in the last test. Push **P4** and adjust the **V.R. VOLTS & MILS** control for a reading of ***100 volts***. Verify that the V.R. VOLTS & MILS meter is reading 50 mA. Release **P4**, disconnect the DC voltmeter and remove the 2K resistor. Return the **BIAS VOLTS/VR VOLTS & MILS** (toggle switch) to the ***BIAS VOLTS*** position. Set the **VR VOLTS & MILS** control ***fully counterclockwise***.

13.1 Adjustment

Check resistors R43 / 198 ohms and R44 / 2 ohms.

14 POWER SUPPLY BALANCE CALIBRATION

A. Set the **FUNCTION** switch to the ***G*** (diode rectifier) position. Connect a DC coupled oscilloscope to pin ***3*** of the octal socket. Use pin ***8*** as a common for the scope. Press **P4** (locked). Observe the plate voltage and obtain a display on the scope that shows the rounded positive peaks of the 120Hz (100Hz) pulsating DC with as high a gain as possible. Set the vertical position on the scope to move the trace downward as you adjust the gain upward to maintain the top of the trace on the screen. Adjust **R8** for peaks of equal amplitude. Release **P4**.

B. Connect the scope to pin ***4*** of the octal socket. Press **P4** (locked). Adjust the scope as before to display the 120Hz (100Hz) peaks, and observe the screen bias voltage. Adjust **R15** for equal peaks of the 120Hz (100Hz) pulsating DC. Release **P4** and disconnect the scope.

14.1 Adjustment

If balance is not obtainable replace the 83 and/or 5Y3 tube.

15 METER BRIDGE BALANCE

Set the **FUNCTION** switch to the *C* (15,000) position. Connect a 10K, 10W, 1% resistor between pins *3* and *8* of the octal socket. Press **P4** (locked) and observe that the meter reads zero. Adjust **R8** to trim out small errors. Release **P4** and remove the resistor.

15.1 Adjustment

If balance is not correct check the bridge resistors R37 / 500 ohms, R38 / 60 ohms, R39 / 40 ohms, R40 / 40 ohms, R41 / 60 ohms and R42 / 500 ohms for proper value. Note that resistors of equal value in this series should be matched closely in value for good bridge balance. Also confirm that the plate power supply is correctly balanced as tested in step 14 (POWER SUPPLY BALANCE CALIBRATION).

16 MUTUAL CONDUCTANCE READING TEST

Verify that the panel switches are set up to the conditions as given in the list immediately following step 6. (**HS 5348-1) FILAMENT** at ***6.3 volts.***

For the following mutual conductance tests you will need to set up an isolated current limited source of AC voltage. Use the setup drawing in Figure 1 to connect the equipment to the tester. Be careful because improper connection can cause serious damage. Connect the source to pins 3 and 8 of the octal socket. If the main meter deflects downward instead of up when you perform the test, swap the connections to pins 3 and 8. All voltages are measured directly across the secondary of the isolation transformer.

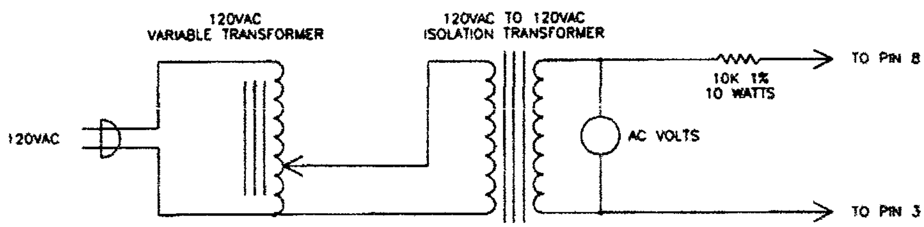


Figure 1

Set the **FUNCTION** switch to each of the positions shown in the chart below. Push **P4** and adjust the voltage source as indicated in the chart. Observe the reading on the main meter and verify that the reading matches the value given in the chart. After each reading set the voltage back to zero, release **P4** and go to the next setting.

FUNCTION	VOLTAGE	METER READING
A	50.0VAC	1000 on 3000 scale
B	25.0	1000 on 3000 scale
C	12.5	1000 on 3000 scale
D	10.0	1000 on 3000 scale
E	25.0	1000 on 3000 scale
F	6.00	Full Scale (600)

16.1 Adjustment

If readings are not correct, repeat steps 14 and 15 and check the bridge resistors R37 / 500 ohms, R38 / 60 ohms, R39 / 40 ohms, R40 / 40 ohms, R41 / 60 ohms and R42 / 500 ohms for proper value. Note that resistors of equal value in this series should be matched closely in value for good bridge balance. Also check the main meter movement and verify that it indicates full scale when exactly 115 µA are passed through it. The metal plate mounted on the side of the meter is a factory applied magnetic shunt. By loosening the mounting screw and sliding the plate back and forth, small adjustments can be made to the full scale deflection of the meter. If the meter reads too high with 115 µA, adding a large value resistor across the meter terminals can shunt some of the current around the meter allowing it to read correctly. The value of the resistor can be calculated or found by trial and error. If the meter reads too low with 115 µA it requires taking the meter apart and making major repairs far in excess of the scope of this document. Bear in mind that changing the meter range will also affect the readings of the other functions it performs so rule out everything else before adjusting the meter.

17 MUTUAL CONDUCTANCE CALIBRATION USING A CALIBRATION TUBE

Set the **FUNCTION** switch to the *C* (15,000) position. Set the **BIAS RANGE** switch to the ***10 volt*** position. Complete the usual setup for a type 6L6 tube setting the bias adjustment for ***3.00 volts***. Insert a calibrated 6L6 tube into the octal socket and allow it to warm up for a minimum of five minutes. Push **P4** (locked). Readjust the AC line voltage to the red line on the meter and **BIAS VOLTS** control to ***3.0 volts*** while the **P4** button is depressed. Observe the mutual conductance reading. If the reading is more than one division high or low of the calibration value of the tube, the grid signal must be adjusted to make the reading correct. Be sure that the tester is blocked up and resting in its normal operating position or the meter calibration may be inaccurate. Release **P4** and remove the 6L6 from the octal socket.

If a calibrated 6L6 is not available a reasonable calibration will be done by performing steps 11 (GRID SIGNAL VOLTAGE TEST) and 15 (METER BRIDGE BALANCE) above. The calibration tube test will verify that all adjustments have been successful.

18 DIODE/RECTIFIER TESTS:

A. Verify that the panel switches are set up to the conditions as given in the list immediately following step 6. (**HS 5348-1**) & **FILAMENT** at ***6.3 volts***. Set the **BIAS** and the **ENGLISH** controls to ***zero***. Connect a 1K, 10W, 1% resistor to the anode lead of a 1N4005 silicon rectifier. Connect the cathode of the rectifier to pin ***8*** of the octal socket. Connect the other lead of the resistor to pin ***3*** of the octal socket. Adjust the **SHUNT** control to ***24***. Press the **P1 DIODE** test button. Verify that the meter reads at or slightly above the ***DIODES OK*** line on the meter. Release **P1**.
B. Adjust the **ENGLISH** control to ***83***. Press the **P3 RECTIFIER** test button. Verify that the meter reads at or slightly above the ***DIODES OK*** line on the meter. Note: for actual rectifier tube tests the REPLACE ? GOOD scale is read for the test results. Release **P3**.
C. Replace the 1K resistor with a 10K, 10W, 1% resistor. Adjust the **ENGLISH** control to ***79***. Press the **P2** 0Z4 test button. Verify that the meter reads at or slightly above the ***DIODES OK*** line on the meter. Note: for actual 0Z4 rectifier tube tests the REPLACE ? GOOD scale is read for the test results. Release P2.

18.1 Adjustment

The diode and rectifier tests measure the voltage drop across the rectifier by applying a fixed voltage with a series limiting resistor and measuring the available plate current. If the readings are not correct for any of the P1, P2 or P3 tests check resistors R1 / 150 ohms, R6 / 1.2K, R7 / 1.8K. The sensitivity of the meter and the accuracy of the transconductance circuits also affect this test.

19 GAS TEST

Obtain a 6L6 tube that is known to be free of gas. Put the tube in the tester and set it up for the standard 6L6 test. Set the **BIAS VOLTMETER** switch to the ***50 volt*** position. Set the **FUNCTION** switch to the ***D*** position. Press **P5**, the gas 1 test button. Adjust the **BIAS** control for a reading of ***500*** on the ***3000*** scale. Hold **P5** and press **P6**, the gas 2 test button and verify that the reading moves up by less than one small division. Release **P6** and **P5**. Connect a 10M resistor between pin 5 and pin 8 of the nine pin miniature socket. Press **P5**, the gas 1 test button. Adjust the **BIAS** control for a reading of ***500*** on the ***3000*** scale. Hold **P5** and press **P6**. This time verify that the reading goes up by 3 to 4 small divisions on the meter. Release **P6** and **P5**. Switch off the AC power to the tester and disconnect the power cord. Reinstall the tester in the cabinet.

19.1 Adjustment

The gas testing circuits depend on the meter bridge circuit and several resistor values. If the mutual conductance tests are functioning properly, check for bad switches or dirty contacts on P5 and P6. Also check R2 / 470K and R53 / 220K resistors. R2 is placed in series with the grid for the gas test when P6 is pressed. Any grid current due to gas will cause a voltage drop across R2. The plate current goes up as the grid bias drops indicating gas in the tube.

20 Transconductance Calibration Notes

Hickok calibration is always an inexact science. Hickok tended to change production details on an individual basis and tweak individual testers as they were assembled to cover irregularities. The test procedure outlined above is to be used as a guideline for the calibration of the typical tester. Individual testers may vary from the design norm. Keep this in mind if certain details in your tester do not match the information given here. It would take a custom test procedure written for each tester in order to be absolutely accurate in every detail.

The sensitivity of the transconductance readout circuit is essentially fixed by the hardware of the tester, the meter, power transformer and the various fixed resistors in the metering circuit. The transconductance circuit is in the form of a bridge that is sensitive to the relative amplitude of the alternate peaks of the full wave rectified 120Hz (100Hz) pulsating DC plate current. Any difference in the amplitude of the peaks is read as an indication of transconductance. This is why it is important to adjust out any difference in the voltage of the alternate peaks of the unfiltered plate voltage. If the alternate peak voltages differ constant errors will be added to the transconductance readings.

An unfiltered pulsating 120Hz (100Hz) DC bias with an added AC signal is applied to the control grid of the tube. For each peak of plate voltage the plate current is alternately higher than or lower than the average by the amount of the AC grid signal times the transconductance of the tube. The measurement circuit senses this difference and reads it out as a value of micromhos of transconductance. The greater the difference there is in the amplitude of the peaks because of the transconductance of the tube, the higher the reading.

Hickok determined a nominal grid signal value and displayed the AC plate current as a transconductance reading assuming the grid signal value is the design value. The 539C has no means of measuring the actual AC grid signal applied to the tube nor does it regulate that voltage in any way so that it is always correct. The tester simply calculates the transconductance of the tube under test assuming a correct grid signal voltage. Therefore if the AC grid signal is something different than the intended value, say for example because the AC line meter is inaccurate, the readings will be off by the amount that the grid signal differs from what it is intended to be. Calibration using the standard 6L6 calibration tube attempts to adjust out any residual error by adjusting the AC signal to the control grid in order to bring the reading to normal.

The zero transconductance reading, that is the meter reading at which the tube plate current has no AC component whatsoever due to transconductance, is trimmed by balancing the plate power supply in step 14A.

Any error in this calibration is called "offset" since it offsets the actual readings by a fixed amount from zero. An error in this adjustment shows up as a constant number added to the measured transconductance.

R8 is a balance control that adjusts the relative amplitude of the plate supply rectified 120Hz (100Hz) pulsating DC peaks. Adjusting the balance of the peaks directly affects the balance of the plate current measurement bridge and thus the zero point of the readings displayed, sort of the electrical equivalent of zeroing the meter so that all of the readings won't have a constant value added. The actual sensitivity or slope of the calibration line is fixed by the hardware and can only be changed by replacing the scaling resistors in the meter circuit.

R15 adjusts the balance of the amplitude of the peaks of the DC grid bias and screen voltages. Any difference in amplitude of the peaks in alternate pulses of unfiltered DC bias is exactly the same as adding an AC voltage to the bias. This directly affects the apparent AC signal on the grid so it must be balanced or additional signal will appear on the grid along with the intended signal. The amount of any additional AC signal added to the grid by an imbalance in peak voltages of the DC bias is directly proportional to the DC bias setting used. A setting of -3 volts will add only half of what a setting of -6 volts will. For this reason it is very important that the grid bias supply be closely balanced in order not to add any AC signal to the grid.

The common Hickok calibration procedure for the 539C used the calibration tube test to adjust R15 in order to trim out any residual unbalance and bring the readings to the nominal value of the calibration tube. The assumption being that everything else is good and adjusting R15 will set the true balance by default. This is a poor method because it opens the possibility that the DC bias is not actually balanced but only compensating for errors in grid signal and metering accuracy. It would have been better to split the function of bias balancing and calibration adjustment by adding another potentiometer to the grid signal divider resistors. Doing so would have added additional cost and complexity to the tester. Probably the problem was dealt with at the factory by selection of resistors in certain areas of the circuit to get close enough or it was not considered a particular problem since service type test equipment does not need laboratory grade accuracy.

Testing with a calibrated tube to match the readings to an actual known value as in step 17 (MUTUAL CONDUCTANCE CALIBRATION USING A CALIBRATION TUBE) acts as a final test of overall calibration. If the readings do not measure correctly after the tester has passed all of the other tests there is little else but to try and adjust the grid signal by replacement of the fixed grid bias divider resistors to make it comply. If a calibration tube is not available, following the balance adjustment step 14 then adjusting the AC grid signal voltage to the design values as in step 11.1 can do a reasonable calibration.

21 Notes on using the Calibrated 6L6 Hickok part number 20877-1

The calibration tube is intended to be used as a tool to compare and adjust the final overall accuracy of any 539C tester against a factory standard 539C tester in order that your tester will give comparable results to the factory standard and comply with the roll chart results. It should be noted that this value is not necessarily the actual "book value" transconductance of the tube measured on precision test equipment according to tube manufacturer's standard procedures but a representation of the transconductance that a factory calibrated Hickok 539C should measure.

Even though the mutual conductance calibration tests performed with the simulated test circuit show the correct readings, other factors and irregularities will noticeably affect the final readings. Power supply loading, small imbalances in screen voltage, plate voltage, mismatches between the two halves of the 83 and 5Y3 rectifiers, resistor values and other things all add up to affect the readings. Even using the wrong type of fuse lamp can substantially change the calibration of the tester.

The tube is not intended to be used to adjust out significant problems or faults in the operation of the 539C. It is only to be used to match the reading of a properly functioning tester to that of the factory standard. If significant errors in operating voltages are found at the time of calibration, first determine that the rectifier tubes are working properly and have substantially equal output from each half of the tube. A good test is to substitute known good replacement rectifier tubes and see if the problem resolves. Replacement of a rectifier tube will always require a recalibration of the tester. Verify that all of the test voltages are correct and that the fixed resistor values have not shifted with age or by electrical damage.

It should be noted that even calibration by this method will never guarantee perfect accuracy. A different calibration tube will seldom read the exact calibration value on any given 539 calibrated with another tube. They will be very close but the tester is simply not capable of that kind of repeatable accuracy from sample to sample. Slight differences in component tolerances, calibration tubes and mostly the lack of regulation of operating voltages due to loading, meter reading inaccuracy and the coarse adjustment capability of the line adjust control will cause a discrepancy in test results.

While Hickok designed the 539C to be a better than average tube tester it is still not a laboratory grade instrument. Some deviation from perfect accuracy must be expected. The calibration tube is carefully tested and specified for use with the Hickok 539C only. Because other Hickok model testers and other manufacturers testers use different voltages for testing than the 539C they may, but more likely will not, read the same value of mutual conductance for the calibration tube. Only a perfect tube would test out to the same mutual conductance value for every tester and every set of operating voltages applied to it. Since there is no perfect tube this should not be expected.

Never place the tube in emission type testers or testers of other brands because of the possibility of permanent changes in calibration value. Because it was specifically calibrated for the 539C circuit using 539C operating conditions its value for checking other testers using different test conditions is marginal at best

22 Notes on Making an Accurate 539C Calibration Tube

Calibration tubes for the 539C must be measured at the specific conditions and voltages that the 539C testers subject the tubes to. According to Hickok documents, a calibration tube must be produced by measuring a sample candidate tube on a Hickok factory prototype instrument known to be in proper calibration. This sets up a kind of chicken-egg situation in which a calibration tube is required to calibrate a tester and a calibrated tester is required to create a calibration tube. Hickok never revealed how the factory prototype tester was calibrated in the first place before calibration tubes were available.

Hickok factory calibration tubes were probably not available to anyone other than internal factory personnel. None have ever been seen even by Hickok authorized repair stations outside the factory. To obtain an accurate calibration tube one must be either made by testing on a known accurate 539C tester or bought from someone who has such a tester and offers the tubes for sale. An individual cannot test one on his own using lab equipment and certify it. As stated above in the notes on using the calibrated 6L6, 539C testers do not represent the actual book value transconductance of a particular tube. They only determine the Hickok derived representation of it for comparison to the 539C roll chart to indicate the tube's worth. Certifying a tube using any other means than a calibrated 539C tester will not provide the same values.

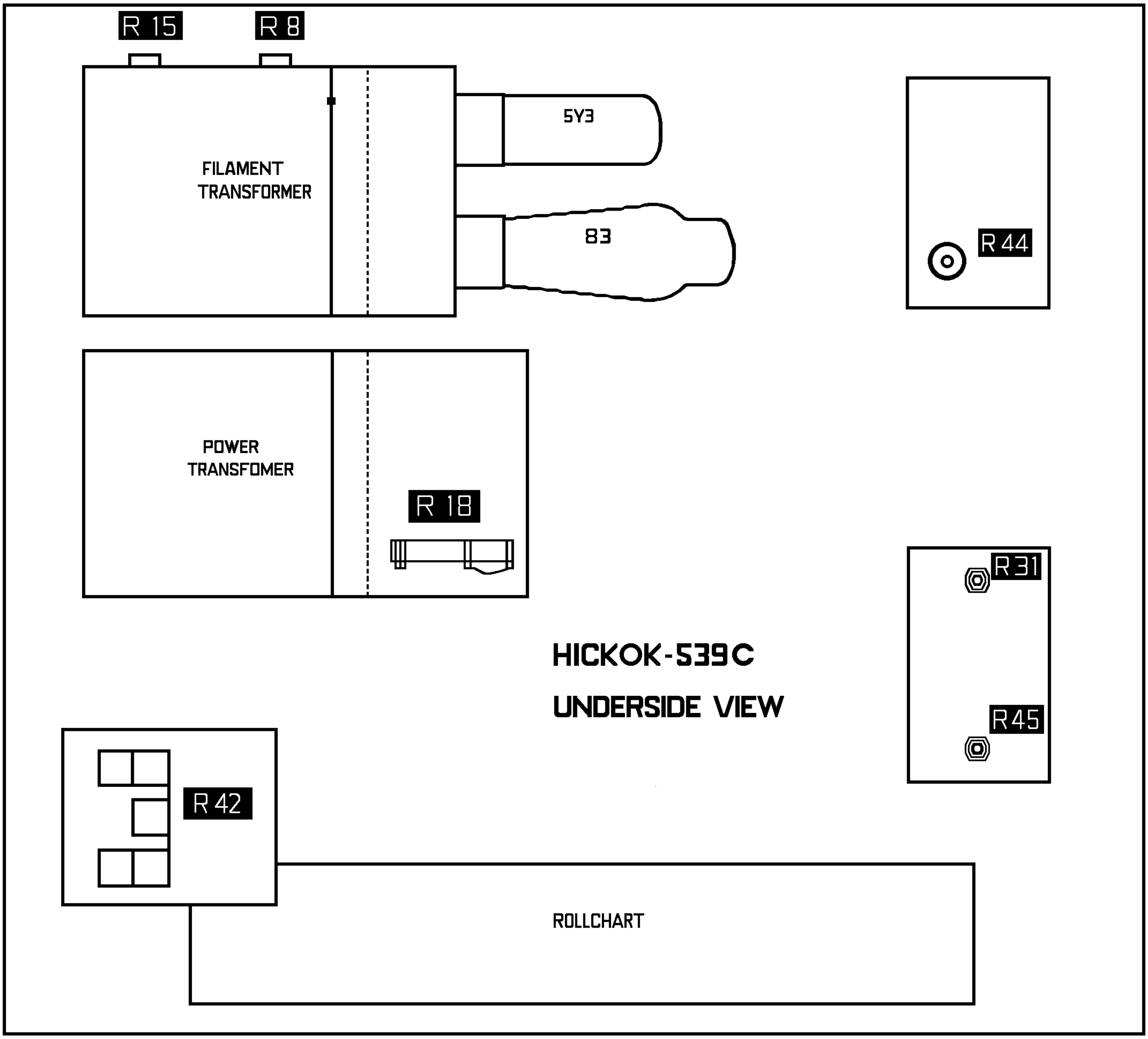
A used tube with good transconductance is likely to be more stable than a new tube due to the need for a certain amount of initial break-in. Test candidate tubes in the usual way for transconductance, leakage and gas. Candidates for calibration tubes must be stable and have no heater hum. It may take a dozen samples to find a suitable tube for a calibration standard. Metal shell tubes tend to be less prone to heater hum but this is not always the case.

Heater hum affects the transconductance reading of the tube by artificially adding a 60Hz signal to the plate current causing the reading to be either abnormally high or low depending on the phase of the added hum with respect to the grid signal. To determine if a tube has hum, set up a candidate 6L6 on a 539C and test it in the usual way. Note the transconductance reading. Change the filament switches from the H S setting to C X and repeat the test. If the reading is different by even one small division reject the tube and try another one.

If the tube passes the hum test the stability should be checked. The quick easy way is to set up a normal tube test on a 539C tester for the candidate tube. Take the reading and write it down. Shut off the tester and repeat the test an hour later. Several repeated cold/warm cycles should be tried to verify that the candidate tube would reliably read the same every time. If not then you cannot depend on it to be used as a calibration standard that is repeatable.

A better verification is to set up the tube on stable laboratory equipment for a DC grid shift test. Use the manufacturers design center book values of 250 volts for the plate, 250 volts for the screen and a nominal –16 volts for the control grid.

Do a grid shift of 2.0 volts around nominal (-17 to -15 volts) and verify that the DC plate current does not take an inordinate amount of time to stabilize and remains stationary at the new value after either the shift up or down. The plate current should also return to close to the same measured lower or higher value with every up or down shift. Plate current stability over time and repeatability are essential. Tubes that tend to wander or take a long time to settle are not acceptable. Perfection is not necessary but the best sample you can find will help assure the best results in the long run.



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