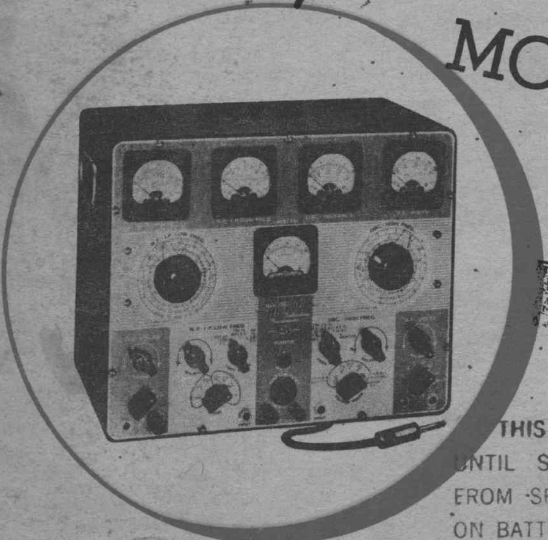
HICKOK

INDICATING TRACEOMETER MODEL 156



IMPORTANT

THIS UNIT WILL NOT OPERATE UNTIL SCOTCH TAPE IS REMOVED FROM SPRING (POSITIVE CONTACTOR) ON BATTERY PLATE IN REAR OF CASE.

SPEAKER OPERATION - - SEE PAGE 4

Manufactured by

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

10514 DUPONT AVENUE • CLEVELAND 8, OHIO

INDICATING TRACEOMETER
MODEL 156

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
10514 Dupont Avenue Cleveland 8, Ohio

Form IB-156-7-46

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LIST OF ILLUSTRATIONS

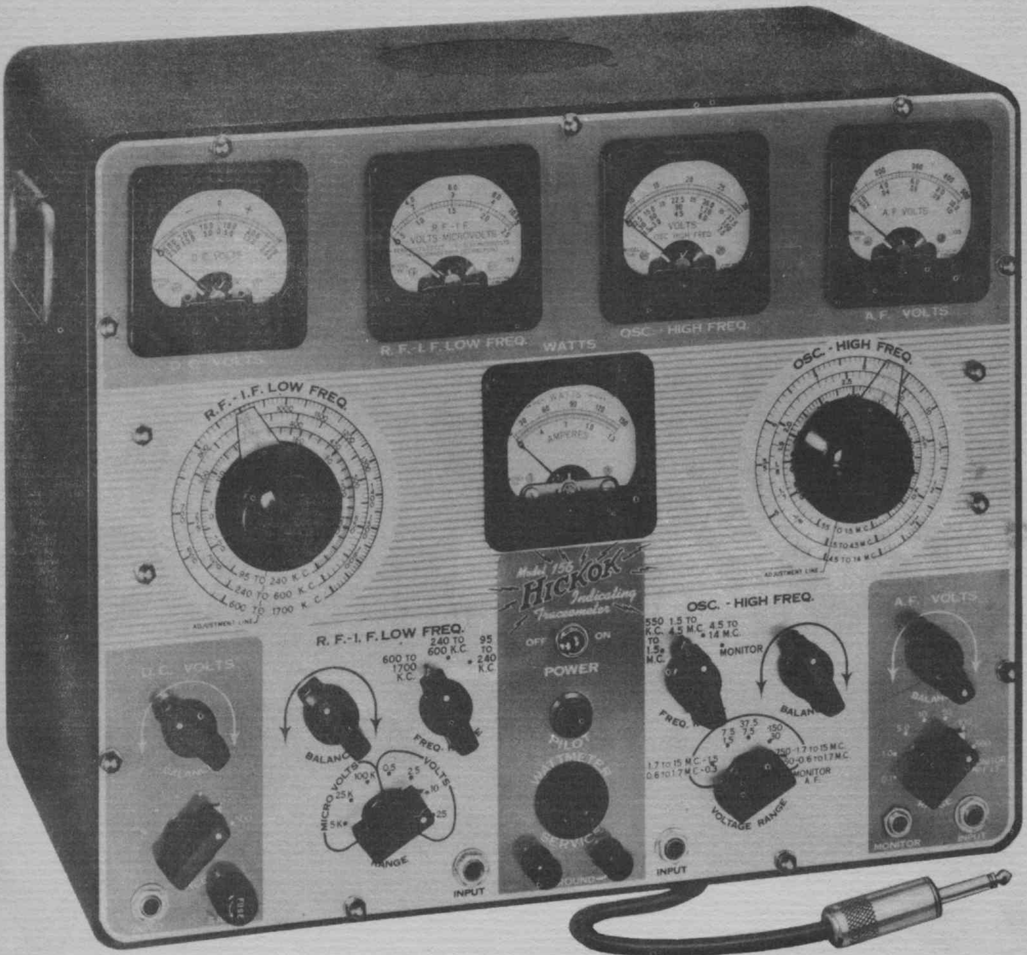


Figure 1.1 - Indicating Traceometer, Model 156

TECHNICAL DATA SHEET

EQUIPMENT SUPPLIED

(One Complete Unit)

Quan.	Name	Type	Stock No.	Dimensions	Weight
1	Indicating Traceometer	156		14" x 16½" x 11"	32 lbs.
1	Lead - Ground		12450-95	42"	
1	Lead - AF Voltmeter		3030-19	42"	
1	Lead - DC Voltmeter		3030-20	42"	
1	Lead - OSC-HI FREQ Voltmeter		3030-21	42"	
1	Lead - RF-IF Voltmeter		3030-22	42"	
1	Instruction Book		2490-29		

TECHNICAL CHARACTERISTICS

1. Power Supply Required: 105-125 V, 50-70 cycles, a-c. Other voltages and frequencies are available on request at a slight additional cost.

2. Power Consumption: 55 watts at 115 volts.

3. Frequency Range:

   a. RF-IF - LOW FREQ: 95-240 kc
      240-600 kc
      600-1700 kc

   b. OSC-HIGH FREQ: 600-1700 kc
      1.7-5 mc
      5-15 mc

   c. AF VOLTMETER: 20-20,000 cycles ± 2 db

4. Voltage Ranges:

   a. DC VOLTS: 0 + 2.5, 5, 25, 250, 500

   b. RF-IF VOLTS - MICROVOLTS:

      1. MICROVOLTS: 0 - 5K - 25K - 100K (where K = 1000)

      2. VOLTS: 0 - .5 - 2.5 - 10 - 25

   c. OSC-HIGH FREQ: 0 - .3 - 1.5 - 7.5 - 30 - 150 - 750

   d. AF VOLTS: 0 - .1 - 1 - 10 - 100 - 500

5. Wattage Range: 0 - 150

6. Input Impedance:

   a. DC VOLTS: 18 megohms

   b. RF-IF VOLTS - MICROVOLTS: 0.85 mmf

   c. OSC-HIGH FREQ: 1.2 mmf

   d. AF VOLTS: 2.0 megohms

7. Tube Complement:

TUBE		STOCK NO.	FUNCTION
V1	6SK7GT/G	20875-18	R-f amplifier
V2	6SK7GT/G	20875-18	R-f amplifier
V3	6SK7GT/G	20875-18	R-f amplifier
V4	6SQ7GT/G	20875-20	Diode rectifier and voltmeter tube
V5	6AC7	20875-53	Audio amplifier and oscillator input amplifier
V6	6SQ7GT/G	20875-20	Diode rectifier and voltmeter tube
V7	6SQ7GT/G	20875-20	A-f amplifier
V8	6SQ7GT/G	20875-20	Diode rectifier and voltmeter tube
V9	6J5	20875-12	D-c voltmeter tube
V10	5Y3GT/G	20875-6	Power rectifier
V11	OD3/VR150	20875-39	Voltage regulator

GUARANTEE

HICKOK TESTING EQUIPMENT IS GUARANTEED AGAINST INACCURACY OR DEFECT IN MATERIAL OR WORKMANSHIP FOR A PERIOD OF 90 DAYS AFTER DATE OF SHIPMENT FROM OUR FACTORY. ADJUSTMENT UNDER TERMS OF THIS GUARANTEE WILL BE MADE BY THE FACTORY OR OUR REPAIR STATIONS WITHOUT CHARGE. THIS GUARANTEE DOES NOT COVER TRANSPORTATION CHARGES TO OR FROM OUR FACTORY OR REPAIR STATIONS.

RETURNING EQUIPMENT FOR REPAIRS

Before returning any equipment for service, under warranty or otherwise, the factory must first be contacted giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Address all service inquiries to The Hickok Electrical Instrument Company, 10514 Dupont Avenue, Cleveland 8, Ohio.

REGISTRATION CARD

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

Often some signal is required in testing receivers and while the INDICATING TRACEOMETER MODEL 156 will measure such signal, it is not a source of signal. Either the HICKOK UNIVERSAL CRYSTAL CONTROLLED SIGNAL GENERATOR MODEL 288X or the HICKOK CRYSTAL CONTROLLED MICROVOLT SIGNAL GENERATOR MODEL 191X are excellent signal generators - manufactured under the high standards of quality of material and workmanship of a HICKOK instrument. The MODEL 288X will produce pure r-f, amplitude modulated and frequency modulated signal over a wide range of frequencies. The MODEL 191X is a microvolt generator with calibrated output throughout its wide range in frequencies, which permits tests such as selectivity, sensitivity and fidelity tests.

The INDICATING TRACEOMETER MODEL 156 is designed for monitoring with the self-incorporated speaker or a pair of headphones. It may be desirable, however, to visually analyze the wave-form under test with an oscilloscope. Jacks are provided which will permit such analysis for which use either the HICKOK MODEL 305 OSCILLOSCOPE with the 3" viewing screen or the HICKOK MODEL 195 OSCILLOSCOPE with the 5" viewing screen will give the same accurate and stable performance as all of the HICKOK electrical instruments.

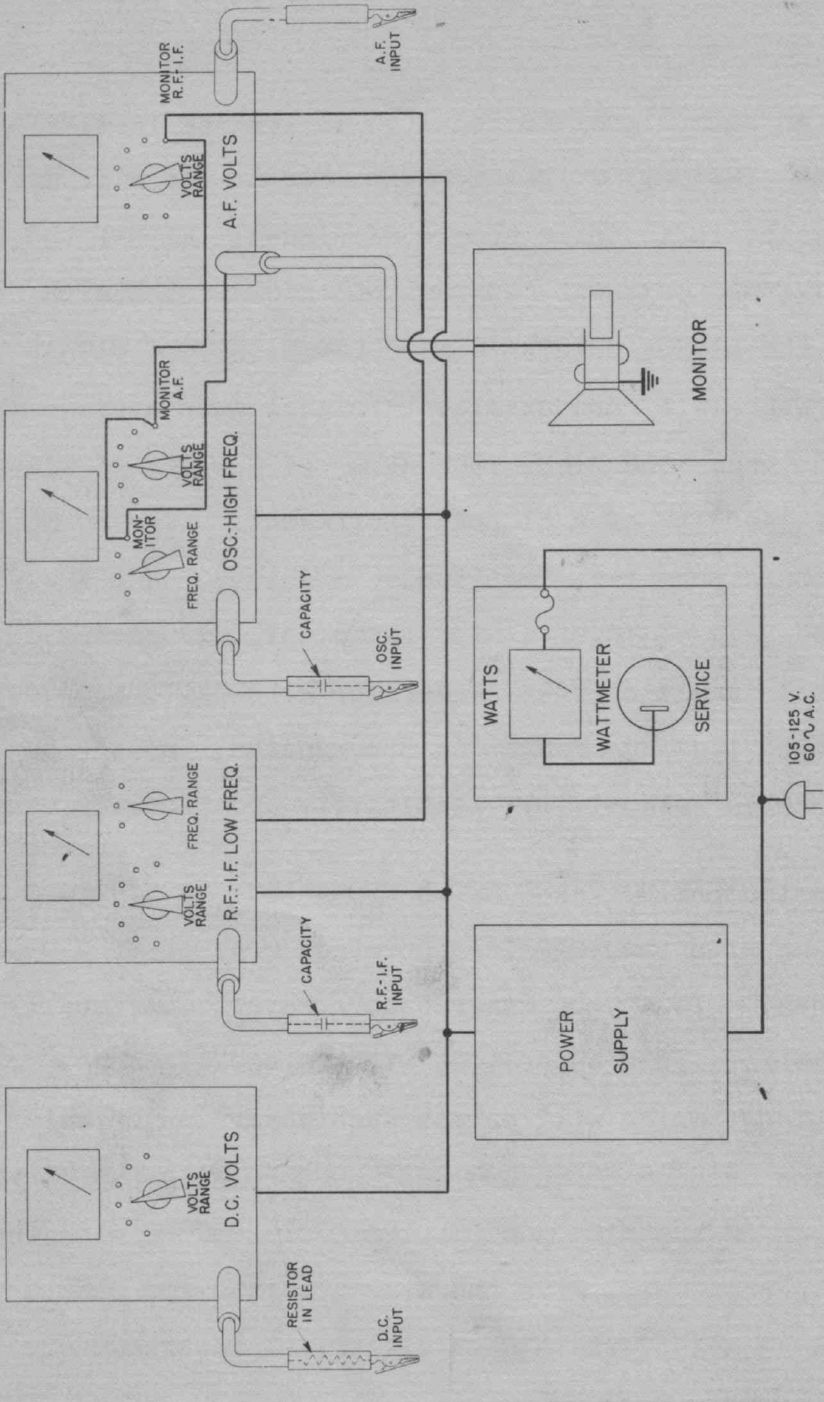


Figure 1.2 - Block Circuit Diagram, Indicating Traceometer, Model 156

1.1 PURPOSE

The Model 156 Indicating Traceometer has been designed to provide a means of not only rapidly locating troubles in radio and television receivers but also to facilitate the alignment and the checking of the over-all or individual stage performance of such electronic equipments. Five precision meters make possible seven simultaneous measurements without interfering with the normal operation of the receiver: two frequency measurements, four voltage measurements and one wattage measurement. With this instrument any possible trouble in radio receivers can readily be located and isolated.

1.2 BRIEF DESCRIPTION

a. Physical - The Model 156 Indicating Traceometer, illustrated in Figure 1.1, is a portable test instrument, self-contained in a metal carrying case with two bail-type handles on the sides and four blister feet on the bottom. The panel is of modern design with all connectors, scales and switches clearly marked.

b. Functional - As the traceometer consists of five independent indicating meters, the function of the instrument will depend on the meter, or meters, used. Section IV, Applications, gives, in greater detail, the type of test which may be made. Special leads are furnished to permit measurements without loading the circuit under test, thereby making possible measurements under normal operating conditions of the equipment under test.

1. DC Voltmeter - zero-center type with ranges of 2.5 to 500 volts d-c, positive or negative with respect to ground. It may be conveniently used for measuring a-v-c, discriminator, grid and plate voltages and other similar voltages.

2. AF Voltmeter - with ranges from 0.1 to 500 volts, may be used to measure any a-c or a-f voltage within the range of 40-20,000 cycles.

3. RF IF Low Frequency - with ranges from 5,000 microvolts to 25 volts within the frequency range of 94 to 1700 kc.

4. The RF IF Low Frequency meter may also be used to determine the frequency of the signal under test if it is within the frequency range of 94 to 1700 kc.

5. Osc-High Freq - with ranges from 0.3 to 150 volts for the 0.6 to 1.7 mc frequency range and 1.5 to 750 volts for the 1.7 to 15 mc frequency range.

6. The Osc-High Freq meter may also be used to determine the frequency of the signal under test if it is within the frequency range of 530 kc to 14 mc.

7. Watts - will measure the wattage, up to 150 watts (unity power factor), of any electrical instrument plugged in the WATTMETER SERVICE socket.

c. Electrical - The basic electrical circuit of the traceometer is illustrated in the block form in Figure 1.2. The theory of the operation of the unit is given in greater detail in Section II, Theory.

d. Components - An 8 ft. a-c power line cable is permanently attached to the unit. The speaker has a permanently attached cable with a plug on the free end for connection to the MONITOR jack when the speaker is in use. In addition, five separate leads, as shown in Figure 1.3, are furnished:

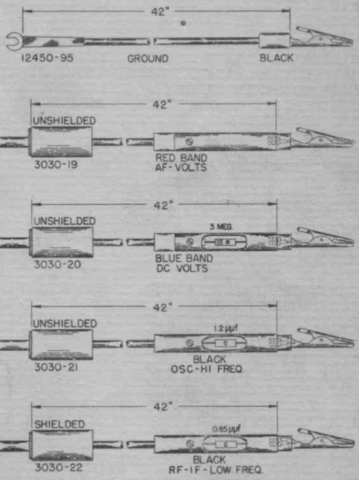


Figure 1.3 Test Leads

1. A 42" black, unshielded lead is used as the ground lead for all circuits except the wattmeter.

2. A 42" shielded cable, terminated at one end by an alligator clip (red band) and at the other end by a microphone plug, used as the lead in making measurements of audio frequency. The alligator clip may be unscrewed, leaving a

pin tip for making contact at the point of measurement.

3. A 42" shielded cable, terminated at one end by an alligator clip (blue band) and at the other end by a microphone plug, is used for making d-c voltage measurements. The alligator clip may be unscrewed, leaving a pin tip for making contact at the point of measurement. A 3 megohm isolating resistor has been added in the lead for light loading on the circuit under test.

4. A 42" shielded special low capacity cable, terminated at one end by an alligator clip and at the other by a microphone plug, is used as the lead in making oscillator-high frequency r-f measurements. The alligator clip may be unscrewed, leaving a pin tip for making contact at the point of measurement. As illustrated in Figure 1.2, a capacity has been built into the lead.

5. A 42" shielded special low capacity cable, terminated at one end with an alligator clip and at the other with a shielded microphone plug, is used as the lead in making r-f i-f measurements. The alligator clip may be unscrewed, leaving a pin tip for making contact at the point of measurement. As illustrated in Figure 1.2, a capacity has been built into the lead.

SECTION II - THEORY

2.1 GENERAL

a. A thorough understanding of the theory behind the operation of any instrument will enable the user to obtain greater utility and satisfaction from the instrument. For this reason the following brief explanation of the individual circuits of the Hickok Model 156 Indicating Traceometer is given.

b. The full schematic, shown in Figure 7.1, is divided into the partial schematics pertaining to each independent circuit to assist in the explanation of those circuits. As these circuits are independent of each other, simultaneous measurements are possible.

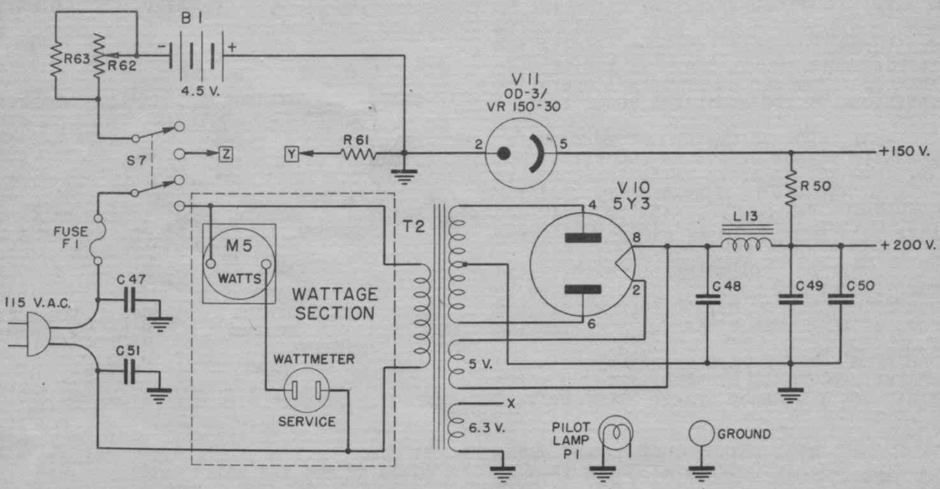


Figure 2.1 - Power Supply

2.2 POWER SUPPLY - WATTMETER

a. Power Supply - The power supply, shown in Figure 2.1, is of the conventional type utilizing a power transformer, full-wave rectifier, condenser input filter circuit and voltage regulator tube. Capacitors C47 and C51 are used to by-pass any r-f voltages to ground so that any stray r-f voltages will not cause the r-f i-f or oscillator-high frequency voltmeters to read. Operation of the POWER switch, S7, closes both the a-c supply line and the d-c circuit of the dry cells.

1. A-c voltages supplied are the 5 volts required for the heater of the rectifier tube, V10, type 5Y3, and 6.3 volts for the heaters of all other vacuum tubes.

2. D-c voltages supplied are +150 volts, regulated, from the voltage regulator tube, V11, type OD3/VR150, and +200 volts, unregulated, directly from the filter network.

3. An additional +4.5 volts, d-c is obtained from dry cells. This d-c voltage is utilized as a bucking potential necessary for the correct zero adjustment of the indicating meters.

b. Wattmeter - The wattmeter consists of an a-c ammeter connected in series with the WATTMETER SERVICE outlet, as shown in Figure 2.1. It has two scales: one calibrated to 150 watts, based on a 115 volt line at unity power factor load; the other scale calibrated from 0 to 1.3 amperes, independent of the type of load.

2.3 DC VOLTMETER

a. The input from the d-c voltmeter probe is fed through the input jack to RANGE switch, S6, and its associated voltage dividing network. The range of voltage which may be measured is determined by the position of the switch. D-c voltage, positive or negative with respect to ground, from the RANGE switch is fed to the grid of V9, type 6J5, where it will control the plate and, consequently, the cathode current of that tube. The indicating meter, M4, calibrated in volts, is connected in the cathode circuit. It is normally adjusted to zero voltage (center scale) with the BALANCE adjust control, R53, located on the main panel.

b. Internal control R60 is adjusted at the factory during calibration and should not require further adjustment unless tube V9 is replaced. A 3 megohm resistor has been placed in the lead used

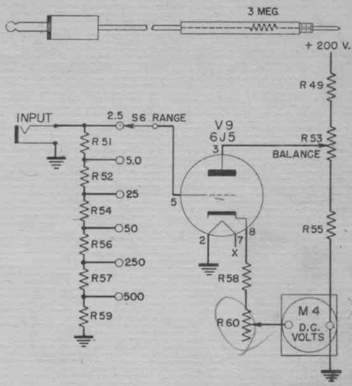


Figure 2.2 - DC Voltmeter

with the meter so that there will be no loading effect on the circuit under test, making it possible, thereby, to determine actual operating values.

2.4 METER CIRCUIT

a. Figure 2.3 illustrates the basic meter circuit which is common to the a-f voltmeter, r-f i-f voltmeter and the oscillator-high frequency voltmeter circuit. For this explanation all symbol designations have been arbitrarily assigned with no reference to any particular meter circuit. Input to the duo-diode section, used for half-wave rectification of the input voltages, is through C1, which builds up a charge or voltage during the positive half-cycle equal approximately to the peak value of the a-c voltage being applied. This rectified signal or voltage of the duo-diode section is fed through isolating resistor, R1, to the grid of the triode section, used as the vacuum tube voltmeter, the indicating meter of which is in the cathode circuit. A d-c voltage from points Y-Z of the battery circuit is maintained across the meter as a bucking potential.

b. The solid arrows indicate the direction of current through the meter due to the tube V1. The dotted arrows indicate the direction of the current

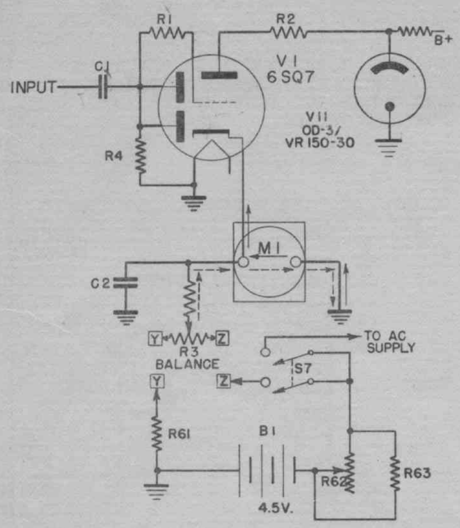


Figure 2.3 - Meter Circuit

through the meter due to the bucking potential supplied by the battery circuit. With no a-c signal applied to the diode rectifier, BALANCE control, R3, (located on the main panel) is adjusted until these two currents are equal and the meter reads zero. As an a-c voltage is applied to the diode, the grid of V1 goes negative, reducing the current through the meter due to V1. The bucking potential will then cause the meter to read up scale.

c. R62 is a screw-driver control rheostat, located at the rear of the chassis and accessible through the rear of the case, used to compensate for the aging of the dry cells. S7, a single throw, double pole switch, closes the a-c power supply line and d-c circuit simultaneously.

2.5 AF VOLTMETER

a. The audio-frequency range voltmeter circuit is shown in Figure 2.4. A-f voltages are fed through C36 to a resistance voltage dividing network. The RANGE switch, S5, selects the range in voltage which may be measured except in the MONITOR AF position in which it becomes a switch in the monitoring system.

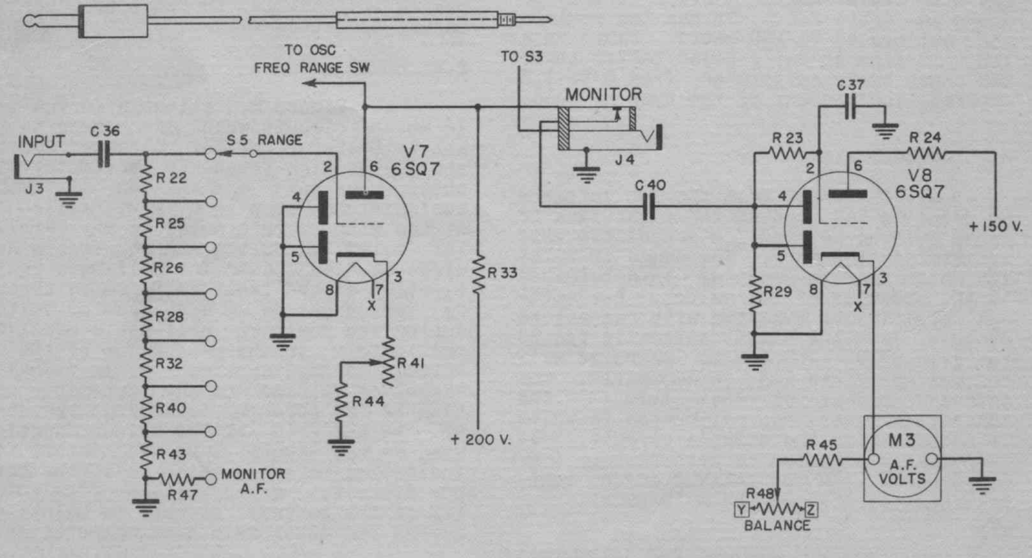


Figure 2.4 - AF Voltmeter

With S5 in any position other than MONITOR AF, the input voltage is fed to the grid of the voltmeter tube, V7, type 6SQ7, used as an amplifier. The sensitivity of the amplifier is calibrated internally by R41.

b. The output of V7 is fed, through the MONITOR jack, to the meter circuit which functions as explained in paragraph 2.4. Zero-adjustment of the meter is by means of the BALANCE control, R48. When the a-f is monitored, the output from V7 is disconnected from the meter circuit at the MONITOR jack and is fed through S3 to V5 of the oscillator section used as an amplifier tube, and from there to the speaker.

2.6 RF IF LOW FREQUENCY

The circuit for the r-f i-f section is shown in Figure 2.5. It consists of a capacity voltage dividing input circuit and three stages of tuned r-f amplification in cascade which terminates in the meter circuit explained in paragraph 2.4. This circuit may be used to determine both the frequency and the voltage of frequencies within the range of 95-1700 kc.

1. Frequency - the r-f stages are tunable in three ranges: 95-240 kc, 240-600 kc and 600-1700 kc. The range selection is made with FREQ RANGE switch, S1, and the frequency adjustment within the range is made with the three gang tuning condenser, C17-C28-C29, which has a calibrated scale for the three ranges on the main panel.

2. Voltage - Input is to a capacity voltage dividing network with the position of RANGE switch, S2, determining the r-f i-f input to the first stage of r-f amplification. The stages of r-f amplification are of the conventional type, utilizing type 6SK7 vacuum tubes V1, V2 and V3.

2.7 OSCILLATOR - HIGH FREQUENCY

The circuit for the oscillator-high frequency voltmeter section is shown in Figure 2.6. It consists of an attenuation network and a tuned-plate stage of r-f amplification which terminates in the meter circuit explained in paragraph 2.4. As in the case of the r-f i-f Voltmeter, this circuit may be used to determine both the frequency and the voltage of signals within the range of 600kc to 15 Mc.

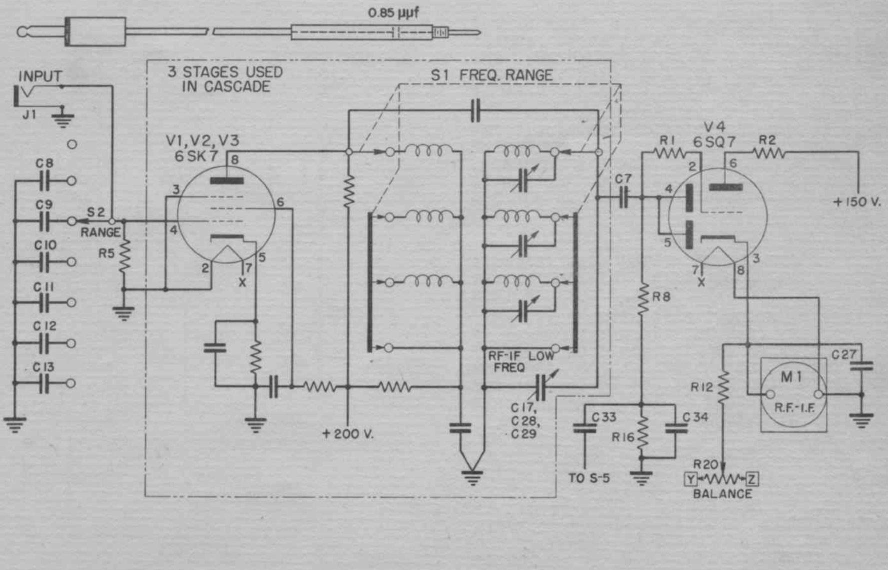


Figure 2.5 - RF IF Low Frequency Voltmeter

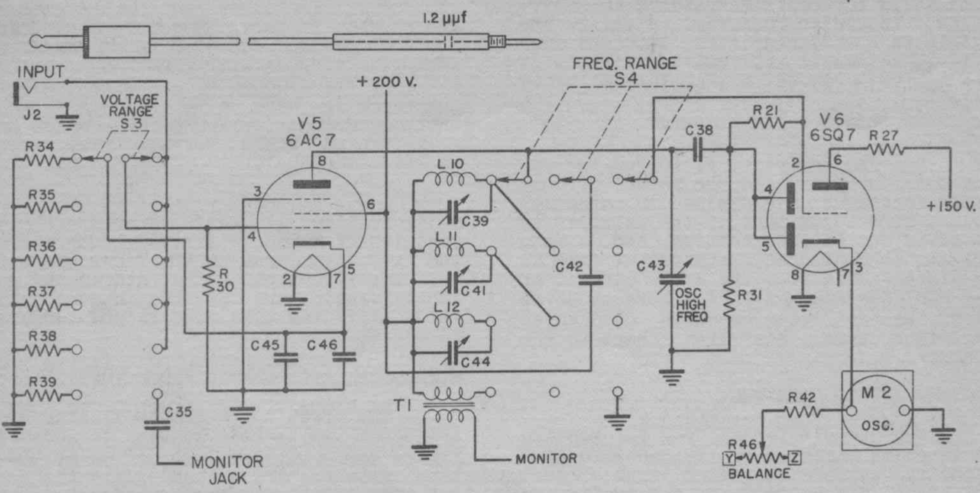


Figure 2.6 - Oscillator-High Frequency Voltmeter

1. Frequency - The stage of r-f amplification is tunable in three ranges: 600-1700 kc, 1.7 -5 mc and 5-15 mc. The range selection is made with the FREQ RANGE switch, S4, and the adjustment of frequency within the range is made with tuning condenser C43 which has a calibrated scale for the three ranges on the panel. In monitoring the r-f channels, the oscillator-high frequency section is used as the final audio stage for the speaker.

2. Voltage - The input circuit is non frequency discriminating with the signal fed directly to the grid of tube V5, type 6AC7, and with attenuation network in the cathode circuit. Input to the grid of V5 is through the VOLTAGE RANGE switch, S3, which, at the same time, determines the resistance of the cathode circuit. Output of V5 is to the indicating meter circuit.

2.8 AF-RF-IF MONITORING

a. AF Monitoring - Figure 2.7 illustrates the circuit utilized in monitoring the a-f or r-f i-f channels with the self-incorporated speaker. The a-f input is fed to the RANGE (AF VOLTS) switch, S5, its position in the voltage

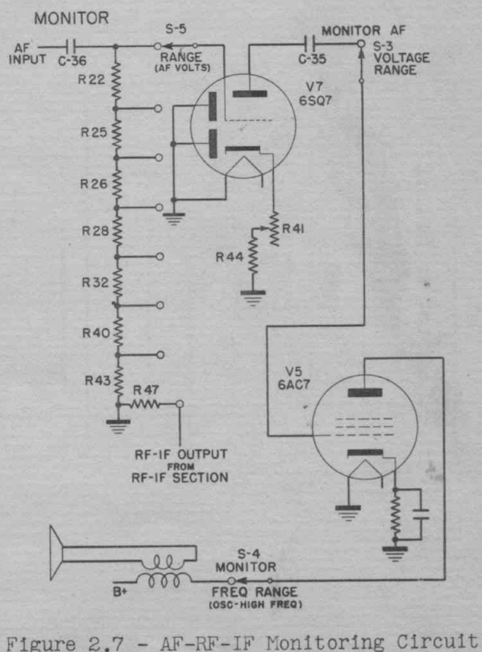


Figure 2.7 - AF-RF-IF Monitoring Circuit

dividing network determining the voltage input to the grid of V7. V7, type 6SQ7, acts as an a-f amplifier with its output to V5 only when the VOLTAGE RANGE (OSC-HIGH FREQ) switch, S3, is in the MONITOR AF position. V5, type 6AC7, is the power tube with its output across the primary of the speaker matching transformer.

b. RF IF Monitoring - The output from the last stage of r-f amplification of the r-f i-f section is connected to the MONITOR RF IF position of RANGE (AF VOLTS) switch, S5, so that, when this switch is in that position, the signal is fed to the grid of V7. V7 is common to both circuits so that the r-f i-f signal is fed through the same circuit, following V7, as the a-f signal.

c. A pair of crystal, or any other type, of headphones may be used instead of the speaker in monitoring as there is no d-c voltage in the monitoring circuit.

SECTION III - OPERATION

3.1 GENERAL

a. Connect the traceometer to a source of 105-125 volts, 50-70 cycle, a-c.

b. Connect the ground lead to either GROUND binding post and to the ground of the equipment under test (generally the chassis).

c. Operate the POWER switch to ON.

d. The circuits of the meters have been designed to give the meters adequate protection against damage due to overload; however, if the approximate range is known, it is well to set the RANGE switches to the correct range.

3.2 WATTMETER

a. Plug the a-c power supply cord of the equipment under test in the WATTMETER SERVICE socket.

b. Note the reading on the WATTS meter. (This meter has been calibrated in terms of a unity power factor.)

3.3 DC VOLTS

a. Adjust the meter to zero by means of the BALANCE control (DC VOLTS section).

b. Connect the d-c voltmeter lead (blue) to the INPUT jack (DC VOLTS section) and to the point at which measurement is desired.

c. Rotate the RANGE switch to the proper range.

d. Read the voltage from the DC VOLTS meter.

3.4 AF VOLTS

a. Adjust the meter to zero by means of the BALANCE control (AF VOLTS section).

b. Connect the a-f voltmeter lead (red) to the INPUT jack (AF VOLTS section) and to the point at which measurement is desired.

c. Turn the RANGE switch to the proper range.

3.5 RF IF LOW FREQ

a. Frequency

1. Connect the r-f i-f meter lead (shielded microphone plug) to the INPUT jack (RF IF LOW FREQ section) and to the point at which measurement is to be made.

2. Rotate the FREQ RANGE switch to the range in which the frequency is located. If this is unknown, start with the lowest range to assure that the fundamental frequency rather than one of its harmonics is being measured.

3. Set the voltage RANGE switch to its most sensitive position.

4. Rotate the RF IF LOW FREQ knob until the meter peaks or indicates a maximum. It may be necessary to readjust the position of the RANGE switch if the voltage is in excess of the range of the most sensitive position.

5. Using the scale indicated by the position of the FREQ RANGE switch, read the frequency indicated.

b. Voltage

1. Adjust the meter to zero by means of the BALANCE control (RF IF LOW FREQ section).

2. Connect the r-f i-f meter lead (shielded microphone plug) to the INPUT jack (RF IF LOW FREQ section) and to the point at which measurement is to be made.

3. Rotate the FREQ RANGE switch to the range in which the frequency is located. If this is unknown, determine it as given in a, above.

4. Rotate the RF IF LOW FREQ knob to the frequency being measured.

5. Set the RANGE switch to the range of the voltage being measured, if known. If not known, set at any position which will permit a reading.

6. Read the voltage on the RF IF LOW FREQ meter.

3.6 OSC - HIGH FREQ

a. Frequency

1. Connect the osc-high frequency meter lead (unshielded microphone plug) to the INPUT jack (OSC-HIGH FREQ section) and to the point at which measurement is to be made.

2. Rotate the FREQ RANGE switch to the range in which the frequency is located. If this is unknown, start with the lowest range to assure that the fundamental frequency rather that one of its harmonics is being measured.

3. Set the VOLTAGE RANGE switch to its most sensitive position.

4. Rotate the OSC-HIGH FREQ knob until the meter peaks or indicates a maximum. It may be necessary to readjust the position of the VOLTAGE RANGE switch if the voltage is in excess of the range of the most sensitive position.

5. Using the scale indicated by the position of the FREQ RANGE switch, read the frequency indicated.

b. Voltage

1. Adjust the meter to zero by means of the BALANCE control (OSC-HIGH FREQ section).

2. Connect the osc-high frequency meter lead (unshielded microphone plug) to the INPUT jack (OSC-HIGH FREQ section) and to the point at which measurement is to be made.

3. Rotate the FREQ RANGE switch to the range in which the frequency is located. If this is unknown, determine it as given in a, above.

4. Rotate the OSC-HIGH FREQ knob to the frequency being measured.

5. Set the VOLTAGE RANGE switch to the range of the voltage to be measured, if known. If unknown, set at any position which will permit a reading.

6. Read the voltage on the RF IF LOW FREQ meter.

3.7 MONITORING

a. AF Monitoring

1. Connect the audio frequency meter test lead to the INPUT jack (AF VOLTS section) and at the point of a-f signal.

2. Plug in the speaker, or headphones at the MONITOR jack.

3. Rotate the VOLTAGE RANGE (OSC HIGH FREQ section) switch to MONITOR AF.

4. Rotate the FREQ RANGE switch (OSC-HIGH FREQ section) to MONITOR.

5. Adjust the volume by means of the RANGE control (AF VOLTS section).

b. RF IF Monitoring

1. Connect the r-f i-f meter test lead to the INPUT jack (RF IF LOW FREQ section) and at the source of r-f signal.

2. Plug in the speaker, or headphones, at the MONITOR jack.

3. Rotate the FREQ RANGE switch (RF IF LOW FREQ section) to the proper range for the frequency to be monitored.

4. Set the RANGE switch (RF IF LOW FREQ section) to the most sensitive position, usually MICROVOLTS 5K or 25K.

5. Rotate the RF IF LOW FREQ knob until the meter peaks (indicates a maximum).

6. Operate the VOLTAGE RANGE switch (OSC-HIGH FREQ section) to MONITOR AF.

7. Adjust the volume by means of the RANGE control (RF IF LOW FREQ section).

4.1 GENERAL

a. As the Traceometer Model 156 is, in effect, voltmeters and frequency meters which operate over wide ranges of voltages and frequencies, it has a great many applications. Even where conventional voltmeters could be used, the Model 156 will do the job even better as (1) it will measure wattage, a-c and d-c voltages and frequencies simultaneously; (2) it has meter leads especially designed for minimum loading effect, and (3) all meter circuits are designed to protect the meters from damage due to overload.

b. The applications given here are of a general nature. Any technical information and data available on the equipment under test should be consulted for the actual procedure of measurement. In selectivity, sensitivity and fidelity tests and the alignment of receivers, the meters may be used as the indicating medium.

c. The traceometer is an ideal piece of test equipment for locating any trouble in receivers, especially in cases of intermittent operation or when there is no clearly indicated trouble. As the name implies, it is possible to trace a signal from the antenna post, through the entire receiver, to the speaker. The special leads furnished insure that all measurements are the true values existing in the equipment under test during operation.

d. As the traceometer circuits are so designed that seven measurements may be made simultaneously without disturbing the operation, correct or incorrect, of the circuit under test, any trouble may be readily isolated. A block diagram of the basic circuit of a typical receiver is shown in Figure 4.1.

1. The receiver under test may be plugged in the WATTMETER SERVICE socket and a check made of its power consumption. It should not be in excess of its rated or estimated wattage.

2. The RF IF VOLTMETER may be connected at point 1 where it can be used to check the frequency and voltage of the r-f stages. No reading at this point would indicate trouble in some r-f stage or stages. Paragraph 4.2 gives, in detail, the method of using the traceometer to check these stages.

3. The OSCILLATOR-HIGH FREQUENCY VOLTMETER may be connected at point 2 where it can be used to check the frequency and voltage of the local oscillator.

NOTE

The oscillator frequency should be the sum of the i-f and the incoming r-f fre-

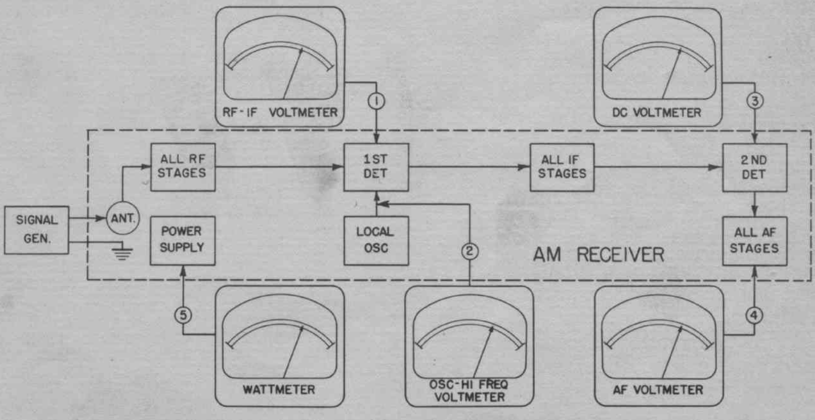


Figure 4.1 - Basic Circuit Typical Receiver

quencies, i.e., if the incoming r-f were at 1000 kc and the i-f at 456 kc, the oscillator should be at 1456 kc. No reading at this point would indicate trouble in the oscillator section. Paragraph 4.3 gives, in detail, the method of using the traceometer to check this stage.

4. If the i-f stages are operating properly an a-v-c voltage will be developed at point 3 which may be measured with the DC VOLTMETER thereby giving a check on the i-f stages. (The RF IF VOLTMETER may be used at this point but it is assumed in this case that it is being used at point 1.) If there is no voltage, it is an indication of trouble in either the a-v-c or i-f stages. Paragraphs 4.4 - 4.7 give, in detail, the method of using the traceometer to check these stages.

5. The AF VOLTMETER may be connected at point 4 where it can be used to check the audio output to the speaker. No reading at this point would indicate trouble in the a-f stages. Paragraphs 4.8 and 4.9 give, in detail, the method of using the traceometer to check these stages.

e. In the following discussion circuits are given of the various stages of a typical superhetrodyne receiver similar to that discussed in d, above. Points are indicated to which the traceometer might be connected in testing the various components, voltages and frequencies appearing in each section. For convenience in discussion, each section is discussed separately but it is to be remembered that many of the tests indicated may be made simultaneously, thereby giving an over-all picture of conditions existing in the receiver.

4.2 RF AMPLIFIER SECTION - Figure 4.2

a. Point 1: Measure the voltage delivered to the antenna post using the r-f i-f voltmeter. Adjust the voltage output of the signal generator to any desired level.

b. Point 2: Connect the lead for the r-f i-f voltmeter at point 2 and tune the traceometer to the frequency of the signal being delivered by the signal generator.

1. If C1 is normal, $E_1 = E_2$, approximately, unless the receiver is a high gain automotive type receiver in which case E_2 may exceed E_1 a little.

2. To check the tracking of the receiver dial, tune the signal generator and the traceometer for the same frequency and then tune the receiver until the meter peaks. It should peak at the same frequency as that to which the signal generator and traceometer are tuned. Should the receiver indicate resonance at a frequency much lower, it is probably an indication of a shorted turn.

3. Connect the d-c voltmeter lead in place of the r-f i-f voltmeter lead and measure the a-v-c bias voltage applied to the grid of tube V1.

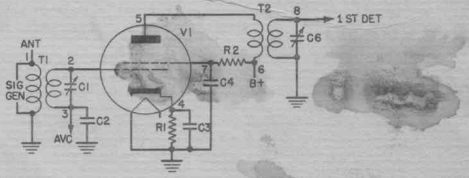


Figure 4.2 - RF Amplifier Section

c. Point 3:

1. Connect the d-c voltmeter lead at point 3. The a-v-c voltage measured should correspond to that measured at point 2. Any difference in voltage would indicate trouble in the secondary of the transformer T1. Zero a-v-c bias would indicate that C2 were shorted out.

2. Connect the r-f i-f voltmeter lead at point 3. An r-f voltage would indicate that C2 were open.

d. Point 4:

1. Connect the d-c voltmeter lead and measure the cathode bias voltage. This bias is a result of the IR drop through cathode biasing resistor R1. Zero bias indicates that C3 has been shorted out.

2. Connect the r-f i-f voltmeter lead and check for r-f voltage from the cathode to ground. Such a voltage would indicate that C3 has opened.

e. Point 5:

1. Using the r-f i-f voltmeter lead, compare the voltage at point 5 with that at point 2. Under ordinary operating conditions, a gain of 10 might be expected but as the voltage gain of the

tube used and type of input and output transformers, the gain might vary from 10.

2. The d-c plate voltage may be determined with the d-c voltmeter.

f. Point 6: Connect the d-c voltmeter lead to determine whether the B+ voltage supplied is correct.

g. Point 7:

1. Check for the proper voltage on the screen with the d-c voltmeter. Zero voltage would indicate either R2 had opened or C4 had shorted out.

2. An r-f voltage between the screen and ground, as determined by the r-f i-f voltmeter, would indicate C4 to be open or of too small a capacity.

h. Point 8:

1. Connect the r-f i-f voltmeter lead and check r-f transformer T2. The voltage should be approximately the same as that at point 5.

2. Check the tracking of condenser C5 by adjusting the main tuning dial on the receiver and noting if a maximum indication of voltage is obtained when the signal generator and receiver are tuned to the same frequency. Double peaking, i.e., maximum indication at two points, can be eliminated by feeding the signal generator in at point 2 rather than at point 1 as the selector tuning effect of T1 and C1 would thus be eliminated.

4.3 OSCILLATOR SECTION - Figure 4.3

a. Point 1:

1. Using the oscillator-high frequency voltmeter lead, measure the voltage at point 1. This voltage will be determined by the circuit design of the oscillator section but, in general, oscillator sections deliver from 50 to 120 volts. No appreciable d-c voltage should be present.

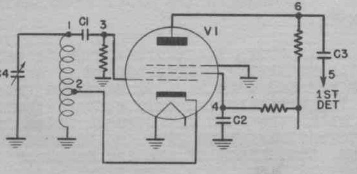


Figure 4.3 - Oscillator Section

2. Determine the frequency generated by the oscillator section. THIS FREQUENCY SHOULD BE EQUAL TO THE I-F OF THE RECEIVER PLUS THE FREQUENCY INDICATED ON THE MAIN TUNING DIAL OF THE RECEIVER.

b. Point 2: The frequency, as measured by the oscillator-high frequency voltmeter, should be the same as that of point 1 but the voltage will probably be somewhat lower. In general, however, E2 should be the same as E1.

c. Point 3:

1. Using the oscillator-high frequency voltmeter lead, measure the voltage. It should be approximately that of point 1.

2. A negative d-c voltage, measured with the d-c voltmeter lead, of approximately 1 volt indicates the oscillator is operating normally.

d. Point 4:

1. Measure the d-c voltage applied to the screen of the oscillator tube with the d-c voltmeter.

2. C2 can be checked with the oscillator-high frequency voltmeter. Very little r-f should exist at this point if C2 is normal. An r-f voltage is indicative of C2 being open.

e. Point 5: Voltage measured with the oscillator-high frequency voltmeter will be approximately that measured at point 6.

f. Point 6:

1. Measure the B+ voltage with the d-c voltmeter.

2. The r-f voltage, measured by the oscillator-high frequency voltmeter, will depend upon the circuit but, in general, will not exceed 1 or 2 volts. It should not be as high as the voltage at points 1 and 2.

4.4 1ST DETECTOR SECTION - Figure 4.4

a. Point 1: (corresponds to point 8, r-f amplifier)

1. Connect the r-f i-f voltmeter and check r-f transformer T2. The voltage should be approximately that of the primary (point 5, r-f amplifier).

b. Point 2:

1. Connect the d-c voltmeter and measure the cathode bias voltage. This

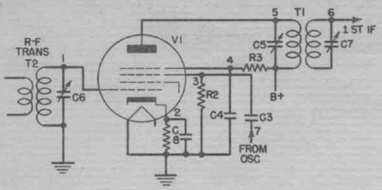


Figure 4.4 - 1st Detector Section

bias is a result of the IR drop through cathode biasing resistor R1. Zero bias indicates that C3 has been shorted out.

2. Connect the r-f i-f voltmeter and check for an r-f voltage from the cathode to ground. Such a voltage would indicate that C1 has opened.

c. Point 3:

1. The r-f voltage, measured by the oscillator-high frequency voltmeter, will depend largely on design of circuits but several volts at least should be delivered. The frequency should be the sum of the i-f and the frequency indicated by the main tuning dial of the receiver.

2. The d-c voltage on the injector grid, as measured with the d-c voltmeter, should be over one volt. If a rather high d-c voltage such as 15 or 20 volts is found at point 3, it probably means that C3 is leaking.

d. Point 4:

1. Using the d-c voltmeter, check the d-c voltage on the screen. Zero voltage would indicate either R2 had opened or C3 had shorted out.

2. An r-f voltage between the screen and ground, as determined by the r-f i-f voltmeter, would indicate C3 to be open or of too small a capacity.

e. Point 5:

1. Checking the frequency at point 5 with r-f i-f voltmeter, the 1000 kc signal which is injected at the control grid of the 1st detector should be found with the same magnitude of voltage as at point 1. There will be no amplification of this voltage as the plate is not tuned to 1000 kc. The 1456 kc signal will also be found at point 5, with the same voltage as at point 3. The intermediate frequency of 456 kc will also be found at point 5 and, as the plate is tuned to this frequency, the voltage will be quite high - on the order of 1 volt or more.

2. Checking the frequency with the oscillator-high frequency voltmeter, a frequency of 2456 kc should be found which is the sum of the oscillator frequency of 1456 kc and the r-f frequency of 1000 kc. This voltage, in general, will be very low.

f. Point 6:

1. Checking point 6 with the r-f i-f voltmeter, the voltage should be the same value as that at point 5. The frequency should be the intermediate frequency of 456 kc. Adjustment of the i-f transformer T1 and trimming condensers C5 or C7 should be checked if the frequency is not correct.

2. If there is a serious loss of voltage at point 6, it is an indication that the i-f transformer T1 might be defective. To check this condition, change the frequency of the input signal and the traceometer until a frequency is reached where the voltage gain is high. This will be the resonant frequency and if it is not the correct i-f for the receiver, the tranformer is defective.

g. Point 7: Check the voltage and frequency with the oscillator-high frequency voltmeter. The voltage should be somewhat higher than the voltage obtained at point 3 but the frequency should be the same.

4.5 I-F SECTION - Figure 4.5

NOTE: As the intermediate frequency of frequency modulated receivers is generally above 2 megacycles, it will be necessary to use the oscillator-high frequency voltmeter, instead of the r-f i-f voltmeter, to measure the i-f of these receivers.

a. Point 1: (Corresponds to point 5, 1st detector) Frequencies of 456 kc, 1000 kc and 1456 kc, as measured by the r-f i-f voltmeter, should appear at point 1, with the 456 kc signal being the strongest as that is the frequency to which the plate of the 1st detector is tuned.

b. Point 2: (Corresponds to point 6, 1st detector) Using the r-f i-f voltmeter, the frequency at point 2 should be 456 kc with a voltage approximately the same as that at point 1.

c. Point 3: Measure the a-v-c voltage at point 3 with the d-c voltmeter.

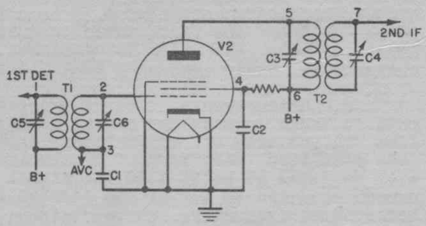


Figure 4.5 - IF Section

d. Point 4:

1. Using the r-f i-f voltmeter, measure the i-f voltage at this point. With C2 operating normally there should be practically no voltage; an i-f voltage at this point would indicate C2 were open; zero voltage would indicate that C2 were shorted out.

2. No d-c voltage at point 4, as measured by the d-c voltmeter, would indicate that resistance R1 were opened up.

e. Point 5:

1. The i-f voltage, as measured by the r-f i-f voltmeter should show a gain of approximately 40 with respect to point 2.

2. Check the d-c voltage at the plate of the tube with the d-c voltmeter.

3. With the r-f i-f lead connected at point 5, trimmer condenser C3 may be checked. If the voltage is still increasing when C3 is at its minimum or maximum capacity, it is an indication that the primary of T2 is probably defective.

f. Point 6: Check the B+ voltage with the d-c voltmeter.

g. Point 7:

1. The i-f voltage, as measured by the r-f i-f voltmeter, will be approximately that at point 5.

2. Adjust C4 until a maximum voltage is obtained. If the voltage is still increasing when C4 is at its minimum or maximum capacity, it is an indication that the primary of transformer T2 is probably defective.

4.6 2ND DETECTOR - AVC SECTION - Figure 4.6 - (Amplitude Modulated Receiver)

a. Point 1: (Corresponds to point 5, i-f section)

1. Using the r-f i-f voltmeter, measure the i-f voltage.

2. Using the d-c voltmeter, measure the plate B+.

3. Adjust C1 for proper tuning of the i-f transformer as indicated by a maximum voltage output.

b. Point 2: (Corresponds to point 7, i-f section)

1. The i-f voltage, as measured by the r-f i-f voltmeter, should be approximately that at point 1.

2. Adjust C2 until a maximum voltage is obtained. If the voltage is still increasing with C4 at either its maximum or minimum capacity, it is an indication that transformer T1 is defective.

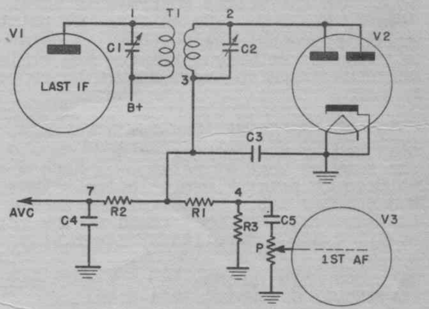


Figure 4.6 - 2nd Detector - A-V-C Section

c. Point 3:

1. As bypass condenser C3 is generally of a fairly low capacity, all of the i-f signal will not be bypassed and a small amount of i-f should be found at point 3 but it should be considerably less than 0.1 of that found at point 2.

2. A negative d-c voltage, built up at point 3 due to the rectifying ac-

tion of the second detector tube, is used for a-v-c. It may be measured by the d-c voltmeter.

3. A 400 cycle audio frequency, used to modulate the r-f, may also be measured at this point with the a-f voltmeter.

4. If C3 is shorted out no r-f voltage, a-f voltage or d-c voltage will be found at point 3. If C3 is opened, a relatively high i-f voltage will be indicated by the r-f i-f voltmeter.

d. Point 4:

1. Zero voltage should be indicated by the r-f i-f voltmeter at this point.

2. The d-c voltage measured by the d-c voltmeter should be less than that found at point 3, depending on the ratio of R1 to R3.

3. The a-f voltage measured by the a-f voltmeter should be less than that found at point 3.

e. Point 5: The a-f voltage measured by the a-f voltmeter should be almost identical to the voltage found at point 4.

f. Point 6: Using the a-f voltmeter, the volume control P1 can be checked. As the volume control is advanced toward maximum, the voltage at point 6 should approach the voltage at point 5; as it is retarded towards the minimum position, the voltage should be reduced to zero.

g. Point 7: The a-v-c voltage, as measured by the d-c voltmeter, should be the same as that at point 3. Zero a-v-c voltage at point 7 would indicate that C4 had shorted out. This voltage should be the same value as that found at the grids of all tubes controlled by a-v-c bias.

4.7 2ND DETECTOR SECTION - Figure 4.7 (Frequency Modulated Receivers)

a. General - It will be noted that the circuit of the second detector of frequency modulated receivers corresponds almost identically to the circuit used for obtaining automatic frequency control voltage in amplitude modulated receivers with the exception that the output of the discriminator tube (point 6) goes through a capacitor to the first audio frequency amplifier while the output for the a-f-c goes directly to the grid of the control tube.

b. The theory of operation of the second detector of a frequency modulated receiver is that no d-c or a-f voltage will appear at point 6 if the correct, unmodulated i-f is being delivered from the discriminator transformer to the discriminator tube. When the incoming signal is frequency modulated, however, the a-f voltage appearing at point 6 will vary, with respect to ground, in accordance with the audio frequency being used to modulate the signal. This demodulated signal appearing at point 6 is then fed to the grid of the first audio frequency amplifier tube and which is followed by conventional audio frequency amplifiers.

c. Measurements at point 6 correspond to those made at the second detector load in the case of conventional amplitude modulated receivers. D-c voltage will be found at point 6 if the signal is unmodulated and is not of the correct intermediate frequency, as explained in paragraph 4.11.

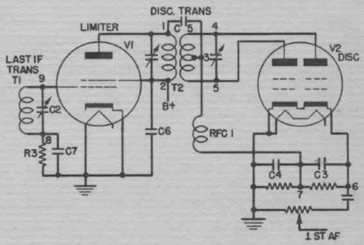


Figure 4.7 - 2nd Detector (FM Receiver)

d. Point 1:

1. Using the oscillator-high frequency voltmeter, measure the voltage being delivered by the discriminator tube. If the discriminator tube is operating properly, the r-f voltage as measured at this point should remain essentially constant regardless of the input voltage to the i-f stages above the threshold or point where limited action takes place.

2. Measure the d-c voltage supplied to the plate of the discriminator tube with the d-c voltmeter.

e. Point 2: There should be a d-c voltage at this point which can be measured with the d-c voltmeter.

f. Point 3:

1. Measure the r-f voltage with the oscillator-high frequency voltmeter. It should be approximately the same value as the voltage at point 1. If it is considerably lower than at point 1, it is an indication that coupling condenser C5 is open.

2. Check point 3 with the d-c voltmeter for any d-c voltage. Such a voltage is an indication that coupling condenser C5 is shorted out or leaky.

g. Point 4 - Point 5: The r-f voltages at these points, measured by the oscillator - high frequency voltmeter, should be approximately the same and should be equal to that found at point 3.

h. Point 6:

1. If the discriminator transformer is correctly aligned there should be zero d-c voltage, with respect to ground, as measured by the d-c voltmeter.

2. Using the a-f voltmeter, an audio frequency should exist at this point if the signal supplied is frequency modulated.

i. Point 7: Very little r-f should be measured by the oscillator-high frequency voltmeter due to the choke action of RFC1.

j. Point 8:

1. Very little r-f voltage, as measured by the oscillator-high frequency voltmeter, should be found at this point, due to the bypassing action of condenser C7.

2. The d-c voltmeter should measure a d-c voltage, negative with respect to ground, the magnitude of which will be dependent upon the amount of signal being supplied from a signal to the i-f stages.

3. Connect the d-c voltmeter to point 8, and align the i-f stages for maximum deflection of the meter. In general, however, manufacturers recommend that the alignment of i-f stages be made with an oscillograph with the vertical plates connected at point 8.

k. Point 9: The oscillator-high frequency voltmeter should measure a high frequency i-f voltage being delivered by the secondary of the last i-f transformer.

4.8 1ST AF SECTION (RESISTANCE COUPLED PHASE INVERSION) - Figure 4.8

a. General - The signal supplied to the first audio frequency amplifier can either be fed directly in as an audio frequency at point 1, which is the high end of the volume control, or it can be fed in through the antenna in the conventional manner as a 400 cycle modulated r-f signal.

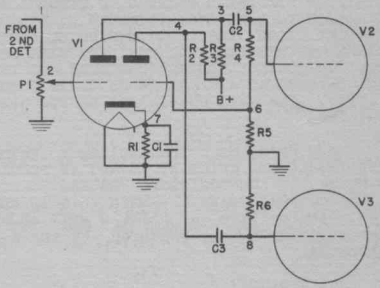


Figure 4.8 - 1st AF Section (Resistance Coupled Phase Inversion)

b. Point 1: Using the a-f voltmeter, the a-f voltage from the 2nd detector can be measured.

c. Point 2: Assume that volume control potentiometer P1 is so adjusted that maximum voltage delivered from the second detector, or signal generator, is applied directly to the grid of V1. For this discussion, assume that the signal supplied to grid 1, as measured with the a-f voltmeter, is one-half volt.

d. Point 3:

1. The a-f voltage, as measured with the a-f voltmeter, should be the voltage gain of the tube times the voltage supplied the grid. If the gain of the tube in this case were 10, the a-f voltage should be 5 (10x½).

2. Using the d-c voltmeter, check the d-c voltage at the plate of V1.

e. Point 4:

1. The d-c voltage, as measured by the d-c voltmeter, should be the same as that at point 3.

2. The a-f voltages, as measured by the a-f voltmeter, should be the same as that at point 3.

f. Point 5:

1. If the a-f voltage at point 5

as measured with the a-f voltmeter, is considerably lower than that at point 3, it would be an indication that condenser C2 is of too low a value or has opened up.

2. At point 5 the d-c voltage on the grid of the following tube can be measured with the d-c voltmeter. It should be zero with respect to ground; if it should be positive, it would be an indication that the grid was being overdriven and was swinging positive with respect to ground. Unless the tube was being operated as a Class AB or Class B amplifier, the grid should not be operated positive.

g. Point 6: The voltages being supplied to the grids of V2 and V3 should be equal if the resistors R4 and R5 are of the correct value. When this is the case, the voltage at point 6 will equal that of point 2, as measured by the a-f voltmeter.

h. Point 7:

1. Very little audio frequency voltage, as measured by the a-f voltmeter, should appear at point 7 if C1 is operating normally and is of the correct capacity.

2. Using the d-c voltmeter, measure the d-c voltage at point 7. It should correspond to that specified by the manufacturer as the correct operating bias. If this d-c voltage is found to be zero, it is an indication that either condenser C1 or resistance R1 has shorted out.

i. Point 8: The a-f voltage, as measured by the a-f voltmeter, should be equal to that measured at point 4. If this voltage is lower than that at point 5 but with the voltage at point 4 still equal to that at point 3, it is an indication that condenser C3 has opened up or is of too low a value. It might also be an indication that resistor R6 is not equal to the combined resistance of R4 and R5. Should the voltage be positive with respect to ground, it might be an indication that either condenser C2 or condenser C3 is leaking, thereby allowing some of the B+ voltage from the plates of V1 to be fed to the grids of V2 or V3.

4.9 FINAL AF SECTION (TRANSFORMER COUPLED) - Figure 4.9

a. Point 1:

1. Measure the d-c voltage delivered to the plate of V1 with the d-c voltmeter.

2. Measure the a-f delivered by the plate of V1 with the a-f voltmeter.

b. Point 2 - Point 3: The a-f voltages, as measured with the a-f voltmeter, should be equal and should be approximately that of point 1 or not much below. If the voltage at either point 2 or point 3 is found to be zero, it is a definite indication that either the grids of V2 or V3, respectively, are shorted to ground or that transformer T2 has a defective secondary winding.

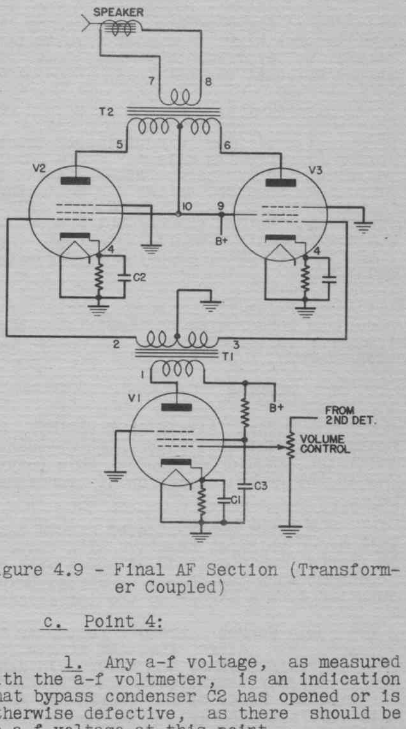


Figure 4.9 - Final AF Section (Transformer Coupled)

c. Point 4:

1. Any a-f voltage, as measured with the a-f voltmeter, is an indication that bypass condenser C2 has opened or is otherwise defective, as there should be no a-f voltage at this point.

2. The d-c bias voltage can be measured with the d-c voltmeter.

d. Point 5 - Point 6:

1. Measure the a-f voltage at point 5 and point 6 with the a-f voltmeter. The ratio of the voltages at point 5 and point 2, also at point 6 and point 3,

will give the voltage gain of tubes V2 and V3, respectively. This gain will vary with tubes but should be 15 to 20 for triodes and 100 to 150 for high gain pentodes.

2. The voltages measured at point 5 and point 6 should be equal. If they are not, it is an indication that either V2 or V3 is not operating properly or that there is a defective primary in transformer T2.

e. Point 7 - Point 8:

1. To measure the voltage of the secondary of the voice coil, clip the ground lead to point 7 or 8 and the a-f voltmeter lead to the remaining point. If it should be necessary for the ground lead to be connected to the chassis, ground point 7 or 8 to the chassis and make the a-f measurement at the remaining point.

2. The voltage across points 7 and 8 will be less than that from point 5 or 6, to ground as the transformer is a step-down transformer for impedance matching purposes. The voltage to be expected will vary with the coil design but can be approximated from the following formula if the impedance of the voice coil is known:

$$\frac{E^2}{R} = \text{WATTS},$$ where R is the impedance and WATTS the power output.

f. Point 9 - Point 10: The voltage of the screen of the final amplifier tube, as measured by the d-c voltmeter, will approximately equal the B+ voltage supply of the receiver under test.

g. Point 11: Measure the a-f voltage with the a-f voltmeter. The voltage gain, with respect to point 1, might be over 100 if V1 is a pentode and under 50 if V1 is a triode.

4.10 POWER SUPPLY SECTION - Figure 4.10

a. WATTMETER

1. Most radio receivers will have the correct wattage rating for the receiver, for normal operation, on the nameplate. If it is not given, a rough estimate may be made of the power consumption by assuming 20 watts plus 5 watts per tube.

.2. If the wattmeter indicates the wattage of the equipment under test to be in excess of the rated value, check for a defective power supply transformer or short circuit in the receiver itself.

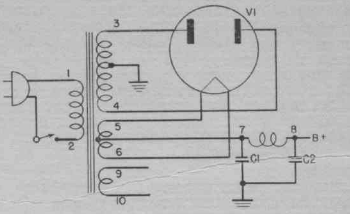


Figure 4.10 - Power Supply Section

b. Point 1 - Point 2:

1. Since the a-f voltmeter has a blocking condenser in its input it will neglect any d-c voltage, making it possible to measure an a-c voltage irrespective of whether or not there is a d-c component present. Therefore the a-f voltmeter can be used to make measurements of the power supply.

2. To measure the voltage between points 1 and 2, connect the ground lead to one side of the power supply and the a-f voltmeter lead to the other. Be sure that the chassis of the receiver under test is not connected to an earth ground.

c. Point 3 - Point 4: With the ground lead connected to B- (usually the chassis of the receiver under test) measure the a-c voltage at points 3 and 4 with the a-f voltmeter. These voltages should be equal.

d. Point 5 - Point 6: With the ground lead connected at either point 5 or point 6 and the a-f voltmeter lead connected at the remaining point, measure the filament supply voltage to the rectifier tube, T1.

e. Point 7 - Point 8:

1. Using the a-f voltmeter, measure the hum voltage at point 7 and at point 8. The hum voltage at point 7 will be relatively high, 15 or 20 volts, but it should drop down to a fraction of a volt at point 8 if the system is operating normally.

2. Using the d-c voltmeter, measure the voltage at points 7 and 8. The voltage at point 7 is somewhat higher than the voltage at point 8.

f. Point 9 - Point 10: If the heater voltage supply is grounded measure the heater voltage with the a-f voltmeter at the ungrounded side. If center-tapped, measure to either side from ground as these voltages should be identical. If not grounded, connect the ground lead to one side of the supply and the a-f voltmeter lead to the other.

4.11 AUTOMATIC FREQUENCY CONTROL - Figure 4.11

a. In an automatic frequency control circuit the control voltage is developed when the i-f frequency delivered to the discriminator transformer is not correct. With a correct i-f frequency there is no voltage developed at point 6 but when the frequency shifts in either direction, due to an incorrect local oscillator frequency, a voltage develops at point 6 which is fed to the grid of the oscillator control tube, V3, which, in turn, corrects the frequency of the local oscillator.

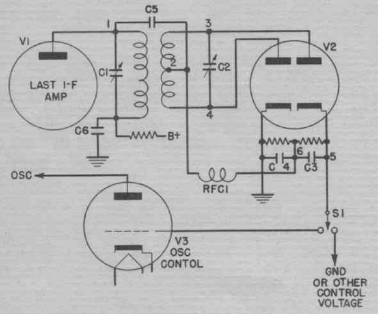


Figure 4.11 - Automatic Frequency Control

b. When aligning automatic frequency control circuits, the a-f-c cut-off switch should be shorted out, disconnecting the a-f-c feature. Then, when the i-f stages are at the correct frequency, condenser C1 should be adjusted for maximum r-f voltage, as measured with the r-f i-f voltmeter, at points 2, 3 and 4. Instead of the r-f i-f voltmeter, the a-f voltmeter may be used as an output meter at the output stage or speaker, in which case condenser C1 should be adjusted for a maximum voltage output.

c. Point 1: Measure the voltage with the r-f i-f voltmeter. The frequency should be that of the i-f amplifiers and the voltage will be determined by the number of stages of i-f amplification and the input signal strength.

d. Point 2: Using the r-f i-f voltmeter, measure this voltage at point 2. It should be the same as that at point 1. Should the voltage be much lower it is an indication that coupling condenser C5 is defective.

e. Point 3 - Point 4: The voltages, measured with the r-f i-f voltmeter, at point 3 and point 4 should be equal and should be at least as much as the voltage measured at point 2.

f. Point 5: Measure the d-c voltage with the d-c voltmeter. Adjust trimmer condenser until the position of the a-f-c switch S1 has no effect on the voltage of the control tube.

g. Point 6: Check point 6 for i-f voltage. There should be very little due to the filtering effect of the r-f choke.

SECTION V - MAINTENANCE

5.1 GENERAL

As the Model 156 has been built under the high standards of workmanship and quality of material of a Hickok instrument, no maintenance other than routine replacement of tubes should be necessary. It is suggested that, should the instrument need maintenance other than routine replacements, the factory be contacted in accordance with "Returning Equipment for Repair," page iv. A schematic, shown in Figure 7.1, and chassis views, shown in Figures 5.1, 5.2 and 5.3, are included to aid in maintenance work.

5.2 FUSES

The power supply and wattmeter are protected by a 5 ampere fuse. This fuse should be checked if the pilot light does not light when the power is turned on. The fuse is readily accessible on the front panel and may be replaced without removing the chassis from the case.

5.3 VACUUM TUBES

All vacuum tubes are operated at, or below, their normal rating to insure long life and uniform service. The locations of the tubes are shown in Figures 5.2 and 5.3. All tubes are easily accessible after the chassis has been removed from the case. To remove the chassis from the case, remove the bolts on the front panel and pull the chassis from the case.

5.4 DRY CELLS

Two dry cells are operated in series as a source of d-c bucking potential for the meters. If it is not possible to bring the meter to zero for any of the meters, it is probable that one or both of the dry cells have aged. To increase the length of time these may be used, adjust the BALANCE controls to mid-point and bring the associated meters to zero with the internal adjust potentiometer control R62, which is a screw-driver adjust control accessible at the back of the case as shown in Figure 5.1. If this fails to give sufficient potential, replace the dry cells. The cells are accessible without removing the chassis from the case by removing the lid from the back of the case as shown in Figure 5.1

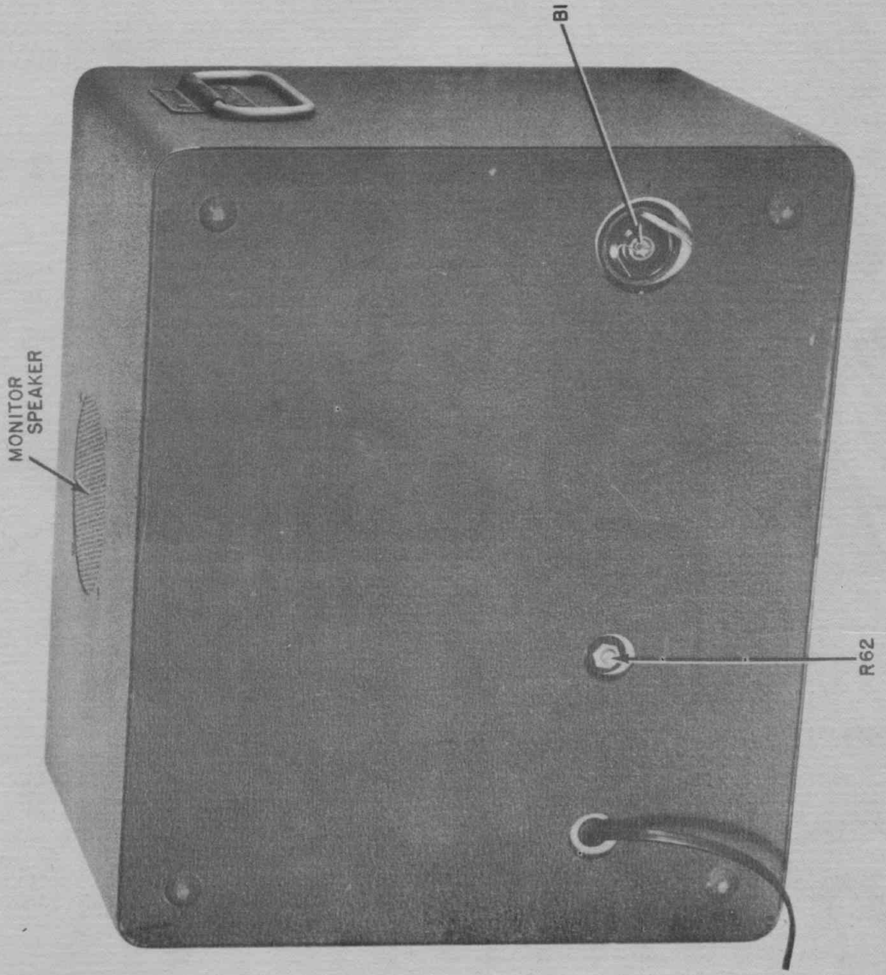


Figure 5.1 - Traceometer Model 156, Rear View

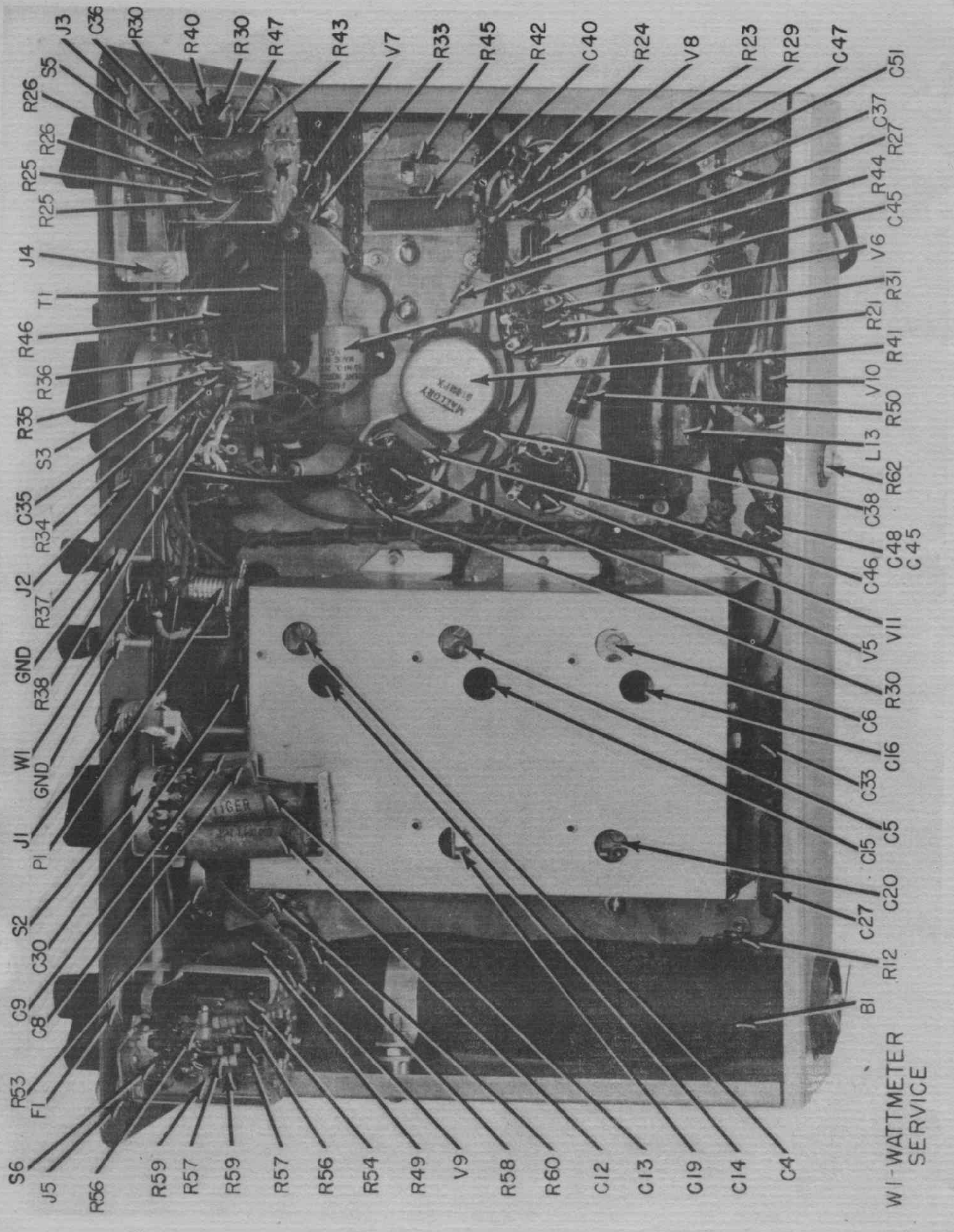


Figure 5.2 - Traceometer Model 156, Case Removed, Bottom View

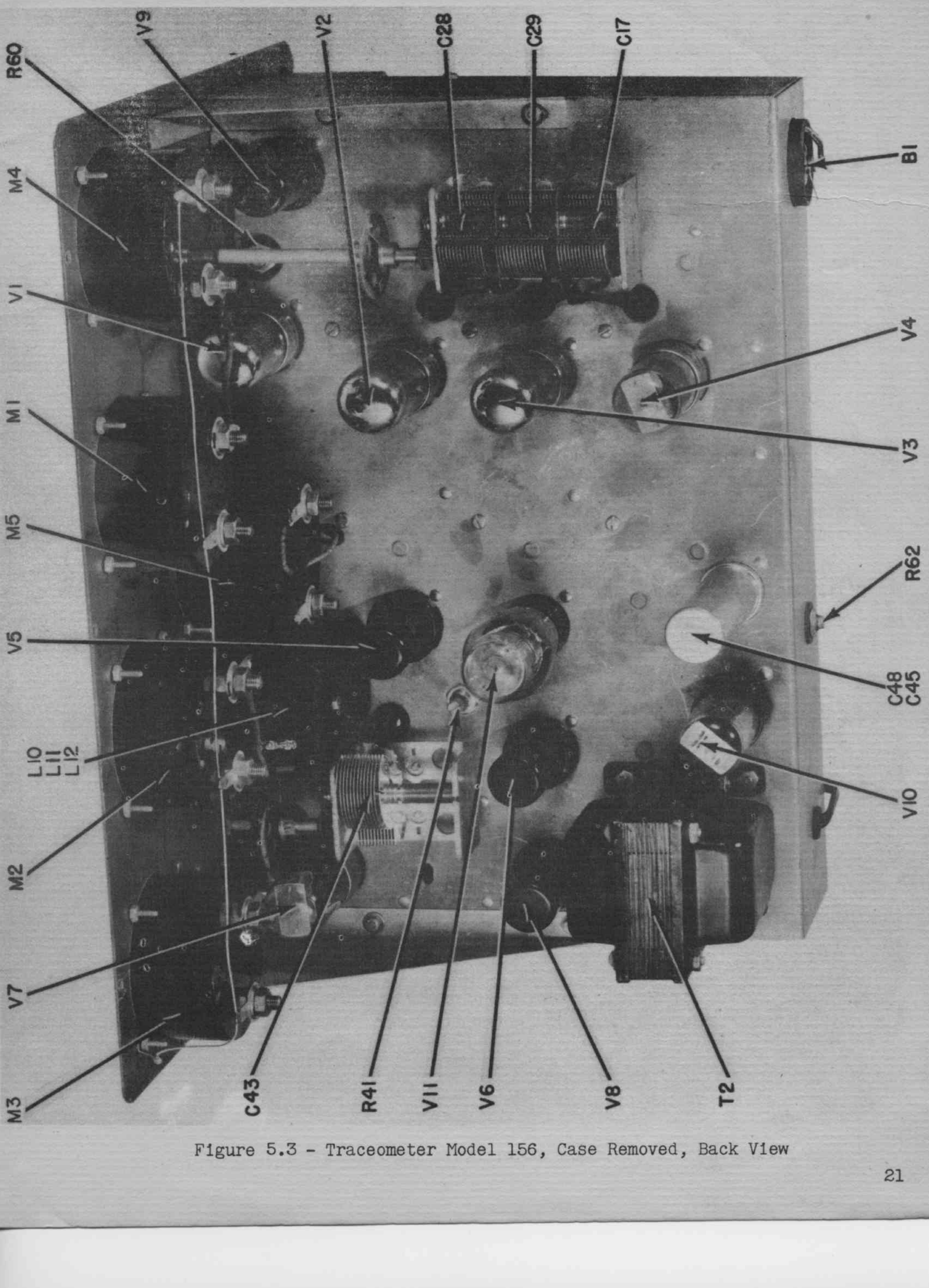


Figure 5.3 - Traceometer Model 156, Case Removed, Back View

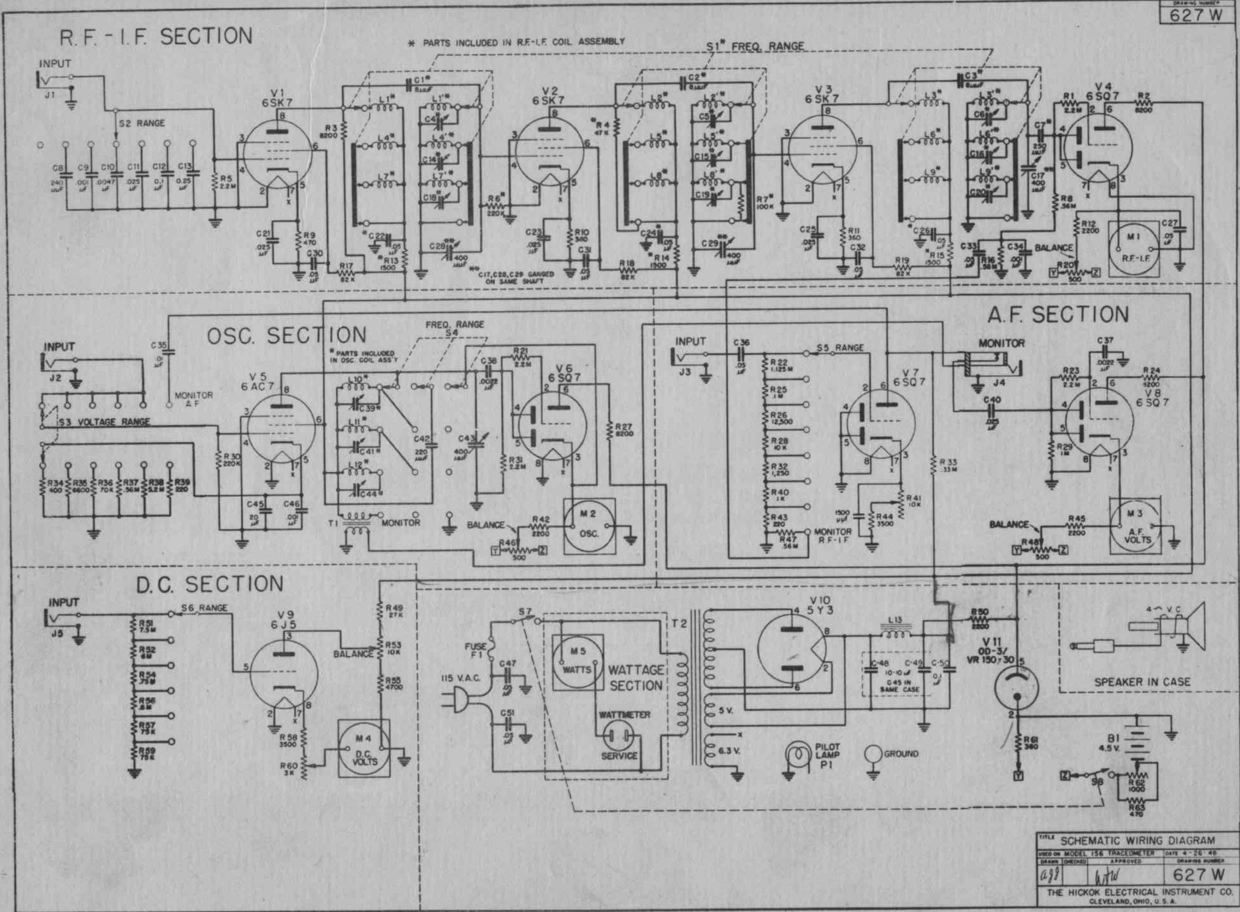
NOTE: There is a minimum charge of $1.50 for the shipment of any one order. Prices are available upon request.

Ref. Symbol	Hickok Stock. Number	Name and description	Function
R36	18525-168	RESISTOR: 68,000 ohms, 10%, ½ watt	
R37	18475-84	RESISTOR: 560,000 ohms, 10%, ½ watt	
R38	18450-55	RESISTOR: 5.1 meg, 5%	
R39	18475-104	RESISTOR: 220 ohms, 10%, ½ watt	
R40	18525-284	RESISTOR: 1000 ohms, 2%, paired, ½ watt	
R41	16925-13	POTENTIOMETER: 10,000 ohms, linear, carbon	
R42		RESISTOR: Same as R12	
R43	18525-275	RESISTOR: 220 ohms, 2%, paired	
R44	18475-95	RESISTOR: 3300 ohms, 10%, ½ watt	
R45		RESISTOR: Same as R12	
R46		POTENTIOMETER: Same as R20	
R47		RESISTOR: Same as R37	
R48		POTENTIOMETER: Same as R20	
R49	18550-79	RESISTOR: 27,000 ohms, 10%, 1 watt	
R50	18575-39	RESISTOR: 2200 ohms, 10%, 2 watts	
R51	18525-283	RESISTOR: 7.5 meg, 2%, paired, ½ watt	
R52	18525-207	RESISTOR: 6 meg, 2%, paired, ½ watt	
R53	16925-27	POTENTIOMETER: 10,000 ohms, linear, carbon	
R54	18525-84	RESISTOR: 750,000 ohms, 1%, paired, ½ watt	
R55	18450-33	RESISTOR: 4700 ohms, 10%, ½ watt	
R56	18525-141	RESISTOR: 600,000 ohms, 2%, paired, ½ watt	
R57	18525-279	RESISTOR: 75,000 ohms, 2%, paired, ½ watt	
R58		RESISTOR: Same as R44	
R59		RESISTOR: Same as R57	
R60	16925-12	POTENTIOMETER: 3000 ohms, linear, wire wound	
R61		RESISTOR: Same as R10	
R62	16925-9	POTENTIOMETER: 1000 ohms, linear, wire wound	
R63		RESISTOR: Same as R9	
S2	19912-97	SWITCH: 1 sec., 7 pos., 1 pole, rotary	RF IF input voltage RANGE switch
S3	19912-98	SWITCH: 1 sec., 6 pos., 2 pole, rotary	OSC HIGH FREQ input voltage RANGE switch
S4	19912-101	SWITCH: 1 sec., 4 pos., 3 pole,.rotary	FREQUENCY RANGE switch of OSC-HIGH FREQ section
S5	19912-100	SWITCH: 1 sec., 8 pos., 1 pole, rotary	AF input voltage RANGE switch
S6	19912-99	SWITCH: 1 sec., 6 pos., 1 pole, rotary	DC input voltage RANGE switch
S7	19911-17	SWITCH: d.p.s.t. toggle	POWER-ON OFF switch
T1	20800-56	TRANSFORMER: Output speaker, pri. impedance 10,000 ohms, sec. impedance 4 ohms	Speaker transformer
T2	20800-55	TRANSFORMER: Power, 115-220 V, pri. #1 sec. 6.3 V, at 3.5 A., #2 sec. 5.0 V at 3 A. #3 sec. 400 VCT at 50 MA	Power supply transformer
V1	20875-18	TUBE: 6SK7GT/G	
V2		TUBE: same as V1	
V3		TUBE: same as V1	
V4	20875-20	TUBE: 6SQ7GT/G	
V5	20875-53	TUBE: 6AC7	
V6		TUBE: same as V4	
V7		TUBE: same as V4	
V8		TUBE: same as V4	
V9	20875-12	TUBE: 6J5	
V10	20875-6	TUBE: 5Y3GT/G	
V11	20875-39	TUBE: OD3/VR150	
	3030-19	CABLE: 42" long, alligator clip to microphone plug, red	AF voltage lead
	3030-20	CABLE: 42" long, alligator clip to microphone plug, blue	DC voltage lead
	3030-21	CABLE: 42" long, low capacity cable, alligator clip to microphone plug	Osc-High Freq voltage lead.
	3030-22	CABLE: 42" long, low capacity cable, alligator clip to shieled microphone plug	RF IF voltage lead
	3320-16	COIL: RF IF section	
	3320-17	COIL: Osc-High Freq section	
	6900-3	FUSE: 5 ampere	
	11500-11	KNOB: Hickok bar knob with pointer	
	11500-12	KNOB: Hickok bar knob with white dot	
	11500-17	KNOB: 2" skirt with pointer	
	12270-5	LAMP: #40 Mazda, 6-8 volts, 15 amp.	
	12450-95	LEAD: 42", black	Ground lead all meters
	19350-30	SOCKET: Octal, crimp on, black phenolic	
	19350-31	SOCKET: Panel light	
	19380-1	SPEAKER: 4", perm. magnet, 4 ohm voice coil	

35K7
3-6SK7
4-6SQ7
1-6AC7
1-6J5
1-5Y3
1-0D3

NOTE: There is a minimum charge of $1.50 for the shipment of any one order.
Prices are available upon request.

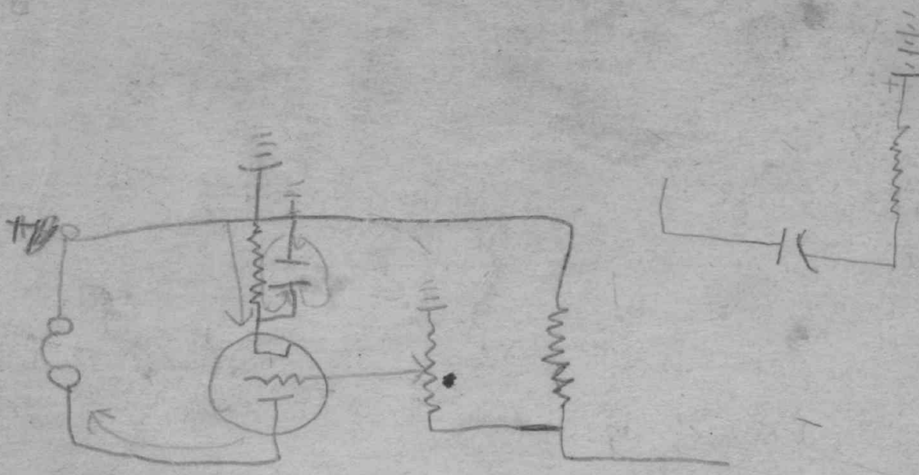
Ref. Symbol	Hickok Stock Number	Name and Description	Function
M1	460-420	METER: Milliammeter,d-c, S46F, .8 milliamp.	RF-IF VOLTS meter
M2	460-419	METER: Milliammeter, d-c, S46F, .8 milliamp.	OSC-HIGH FREQ meter
M3	460-465	METER: Milliammeter, d-c, S46F, .5 milliamp.	AF VOLTS meter
M4	460-229	METER: Milliammeter, d-c, S46F, .8 milliamp.	DC VOLTS meter
M5	470-287	METER: Ammeter, a-c, S47M, 0-1.3 amp.	WATTS meter
B1	2210-2	BATTERY: Unit cell, size D, 1½ volt	Zero-adjustment of meters
C8	3095-6	CAPACITOR: 220 mmf, mica	
C9	3095-9	CAPACITOR: 1000 mmf, 10%, 500 volt, mica	
C10	3095-17	CAPACITOR: 4700 mmf, 10%, 500 volt, mica	
C11	3105-95-or 3105-94	CAPACITOR: .025 mf, 10%, 600 volt, paper	
C12	3105-24	CAPACITOR: .1 mf, 400 volt, paper	
C13	3105-13	CAPACITOR: .25 mf, 400 volt, paper	
C17	3120-12	CAPACITOR: Variable, 12.5 - 420.0 mmf, 3 section	
C21		CAPACITOR: Same as C11	
C23		CAPACITOR: Same as C11	
C25		CAPACITOR: Same as C11	
C27	3105-9	CAPACITOR: .05 mf, 400 volt, paper	
C28		CAPACITOR: Same as C17	
C29		CAPACITOR: Same as C17	
C30		CAPACITOR: Same as C27	
C31		CAPACITOR: Same as C27	
C32		CAPACITOR: Same as C27	
C33		CAPACITOR: Same as C27	
C34		CAPACITOR: Same as C9	
C35	3105-4	CAPACITOR: .01 mf, 400 volt, paper	
C36		CAPACITOR: Same as C27	
C37	3095-21	CAPACITOR: 2200 mmf, 10%, 500 volt, mica	
C38		CAPACITOR: Same as C37	
C40		CAPACITOR: Same as C11	
C42		CAPACITOR: Same as C8	
C43	3120-13	CAPACITOR: Variable, 12.5 - 420 mmf, air	
C45	3085-28	CAPACITOR: 10-10-20 mf, 450-350-25 volt, electrolytic (C48 and C49 also part of C45)	
C46		CAPACITOR: Same as C9	
C47		CAPACITOR: Same as C27	
C48		CAPACITOR: Same as C45 (part of C45)	
C49		CAPACITOR: Same as C45 (part of C45)	
C50		CAPACITOR: Same as C12	
C51		CAPACITOR: Same as C27	
L13	3250-8	CHOKE: 300 ohms, 50 milliamp., 10 henries	
R1	18450-50	RESISTOR: 2.2 meg, 10%, ½ watt	
R2	18475-97	RESISTOR: 8200 ohms, 10%, ½ watt	
R3		RESISTOR: Same as R2	
R5	18475-38	RESISTOR: 220,000 ohms, 10%, ½ watt	
R8	18525-281	RESISTOR: 560,000 ohms, 5%, ½ watt	
R9	18475-53	RESISTOR: 470 ohms, 10%, ½ watt	
R10	18475-94	RESISTOR: 360 ohms, 5%, ½ watt	
R11		RESISTOR: Same as R10	
R12	18450-32	RESISTOR: 2200 ohms, 10%, ½ watt	
R16		RESISTOR: Same as R8	
R17	18475-41	RESISTOR: 82,000 ohms, 10%, ½ watt	
R18		RESISTOR: Same as R17	
R19		RESISTOR: Same as R17	
R20	16925-7	POTENTIOMETER: 500 ohms, linear, wire wound	Meter BALANCE control - R-F I-F section
R21		RESISTOR; Same as R1	
R22	18525-85	RESISTOR: 1,125,000 ohms, 2%, paired, ½ watt	
R23		RESISTOR: Same as R1	
R24		RESISTOR: Same as R2	
R25	18525-280	RESISTOR: 100,000 ohms, 2%, paired, ½ watt	
R26	18525-41	RESISTOR: 12,500 ohms, 2%, paired, ½ watt	
R27		RESISTOR: Same as R2	
R28	18525-290	RESISTOR: 10,000 ohms, 5%, ½ watt	
R29	18450-25	RESISTOR: 1 meg, 10%, ½ watt	
R30		RESISTOR: Same as R5	
R31		RESISTOR: Same as R1	
R32	18525-285	RESISTOR: 1250 ohms, 2%, paired, ½ watt	
R33	18450-44	RESISTOR: 330,000 ohms, 10%, ½ watt	
R34	18525-157	RESISTOR: 390 ohms, 10%, ½ watt	
R35	18525-156	RESISTOR: 6800 ohms, 10%	



SCHEMATIC WIRING DIAGRAM

USED ON MODEL 156 TRACEOMETER	DATE 4-26-46	DRAWING NUMBER 627 W
DRAWN ajj	CHECKED	APPROVED WHW

THE HICKOK ELECTRICAL INSTRUMENT CO.
CLEVELAND, OHIO, U.S.A.



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