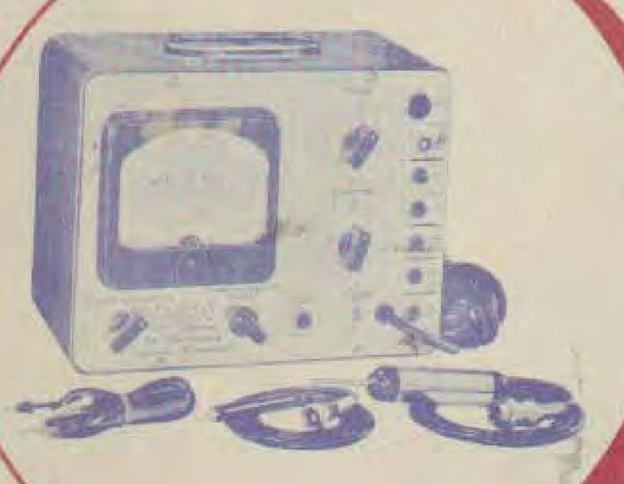
HICKOK

OPERATING INSTRUCTIONS
FOR
ELECTRONIC VOLT-OHM-CAPACITY-MILLIAMMETER

MODELS
203 - 203 PR



Manufactured by

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

ELECTRONIC VOLT-OHM-CAPACITY-MILLIAMMETER

MODELS 203 - 203 PR

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

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FIGURE 1.1 - ELECTRONIC VOLT-OHM-CAPACITY-MILLIAMMETER,

MODELS 203-203PR

TECHNICAL DATA SHEET

EQUIPMENT SUPPLIED

(ONE COMPLETE UNIT)

Quan.	Name	Type	Stock No.	Dimensions	Weight
1	Electronic Volt-Ohm-Capacity-Milliammeter	203 203PR	902-101 902-102	11¼ x 9 x 5¼ 11¼ x 9 x 5¼	12.5 lbs. 13 lbs.
1	Instruction Book		2490-122		
1	Test Lead - Red		12450-93	48"	
1	Test Lead - Black		12450-99	48"	
1	Cable Assembly: D.C., shielded, yellow		3030-29	48"	
1	Cable Assembly: A.C., shielded, red (203 only)		3030-38	48"	
1	Probe Assembly: A.C. (203PR only)		16970-12	48"	

1. Power Supply Required: 105-125 V, 50-70 cycles, a.c.
2. Power Consumption: 20 watts at 115 V.
3. Scales:
   - a. Volts - Mils: 0-3, 0-12
   - b. 0-3 Volts A.C. only: 0-3
   - c. Ohms: 0-10,000 - Inf.
   - d. Capacity: MMF - 0-1000 - Inf. MFD - 0-10 - Inf.
   - e. Decibel: -20 to +5, -8 to +17, 0 to +25
4. Ranges:
   - a. Volts, A.C.: 0-3, 12, 30, 120, 300
   - b. Volts, D.C.: 0-3, 12, 30, 120, 300, 1200
   - c. Mils, D.C.: 0-3, 12, 30, 120, 300, 1200
   - d. Capacity: 0-10,000 mmf in 2 ranges
0-1000 mfd in 5 ranges
Inductance: 50 mh - 100 henries (use conversion chart)
   - e. Ohms: .1 ohm to 10,000 megohms in 8 ranges
5. Frequency:
   - a. 203 : A.C. up to approximately 5 mc.
   - b. 203PR: A.C. up to approximately 200 mc.
6. Input Impedance:
   - a. Volts, D.C.: 15 megohms
   - b. Volts, A.C.: 12 megohms shunted by 6 mmf. (203PR)
12 megohms shunted by 150 mmf. (203)
7. Meter:
   - a. Type: 844
   - b. Sensitivity: 350 microamperes
8. Tube Complement:

Quan.	Tube	Stock No.	Function
2	6X5GT	20875-22	A.C. rectifiers
1	6SJ7	20875-17	Cathode follower
1	6SN7GT	20875-19	Vacuum tube voltmeter
1	OD3/VR-150	20875-39	Voltage regulator
1	9006	20875-46	A.C. input rectifier (203PR only)

GUARANTEE

Hickok testing equipment is guaranteed against inaccuracy or defect in material or workmanship for a period of 90 days after DATE OF ORIGINAL PURCHASE BY DEALER FROM JOBBER. 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 station. FAILURE TO RETURN REGISTRATION CARD PROPERLY EXECUTED WITHIN 10 DAYS, VOIDS GUARANTEE.

THIS GUARANTEE EXPRESSLY DOES NOT COVER VACUUM TUBES OF ANY DESCRIPTION WHICH ARE SHIPPED WITHIN OR AS ACCESSORIES TO ANY INSTRUMENT. (THESE TUBES ARE GUARANTEED BY THE TUBE MANUFACTURER.)

CAUTION

DO NOT ATTEMPT TO MEASURE OVER 300 VOLTS A.C. AS THIS IS LIABLE TO DAMAGE THE TYPE 9006 RECTIFIER TUBE IN THE PROBE.

RETURNING EQUIPMENT FOR REPAIR

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.

SECTION 1 - DESCRIPTION

1.1 PURPOSE

The Hickok Electronic Volt-Ohm-Capacity-Milliammeter, Model 203PR, shown in Figure 1.1, is a compact universal test instrument which may be used in making measurements in the study of radio and electrical circuits. It is a versatile instrument as the measurement of wide ranges of d.c. currents, a.c. and d.c. voltages, resistances, capacitances and inductances may all be made by the one unit. Built under Hickok high standards of workmanship, it is an accurate and durable test instrument.

1.2 DESCRIPTION

a. Physical

The instrument is enclosed in a metal case with a handle at the top and with feet on two sides so that the instrument may be used in either a horizontal or vertical position. The chassis is mounted on the front panel and is accessible by removing the eight screws holding the panel to the case and then removing the panel. The meter is accurately calibrated with the scales clearly marked. A mechanical adjustment of the zero setting is provided on the front of the meter. A diode probe and shielded cable is supplied for a.c. voltage measurements, and is attached to the unit by means of a four-prong connector plug. Two additional leads are furnished for all the other measurements. All switches, jacks and controls are clearly marked on the front panel.

b. Components

The following leads are furnished with the Model 203PR:

(1) An a.c. probe and shielded cable assembly is furnished for making all a.c. voltage measurements. This cable is 48" long with a four-prong male plug on one end and the special a.c. probe on the other. The circuit of this probe is shown on the schematic wiring diagram, Figure 6.2.

(2) A 48" shielded test lead with an isolating resistor incorporated in the probe is supplied for making all d.c. measurements. This lead has a test prod on one end and a microphone type connector on the other.

(3) Two unshielded test leads, 48" long, are supplied for making all resistance, capacity, inductance and current measurements. One of these leads is black with a pin plug on one end and an alligator clip on the other. This is used as a ground lead for all measurements. The other lead is red and is terminated with a pin plug and test prod.

NOTE

The standard Model 203 instrument is identical to the Model 203PR with the exception of the type of cable assembly supplied for making a.c. voltage measurements. In place of the a.c. probe and shielded cable supplied with the 203PR, the standard 203 has a 48" detachable a.c. cable assembly, also shielded, which is terminated on one end with a microphone connector and on the other with a red test prod.

c. Functional

The Model 203PR is designed to perform the following electrical functions:

(1) To measure a wide range of d.c. currents, a.c. and d.c. voltages, resistances, capacitances and inductances.

(2) To measure a.c. voltages accurately over a wide range of frequencies.

(3) To have a very light loading effect on the circuit under test, thereby insuring greater accuracy.

(4) To have a meter circuit design which will eliminate the possibility of damage to the meter from overload.

d. Electrical

(1) A 105-125 volt, 50-70 cycle a.c. external power source is needed for the operation of the power supply system which has been incorporated in the unit to supply all d.c. plate voltages and a.c. heater voltages. The power supply circuit is of the conventional type consisting of a transformer, rectifier, filter and voltage regulator. D.C. voltage needed for ohmmeter measurements is supplied by two dry cells, in series, also incorporated in the instrument.

(2) Three separate voltage divider networks are used in the input circuit; one for current measurements, one for resistance and capacitance measurements and one for a.c. and d.c. voltage measurements. The SELECTOR switch determines which network is to be used and the RANGE switch determines the position within the network. A switching arrangement has been incorporated so that voltages, either positive or negative with respect to ground, may be measured by merely operating the switch to the correct d.c. position rather than reversing the position of the leads themselves.

(3) In measuring d.c. currents, the unknown is applied directly to the meter with its parallel shunt network. In d.c. voltage measurements, the input is placed across the proper voltage dividing network, from which the correct portion for a given range is ap-

plied to the grid circuit of a vacuum tube bridge. In the 203PR when making a.c. measurements the a.c. is rectified by a diode at the end of the probe and then applied to the dividing network. In the standard 203, however, the a.c. is rectified internally in the instrument by one section of the rectifier tube and then applied to the dividing network. In resistance measurements, the unknown is placed in series with an internal source of d.c. voltage and a portion of the divider network depending upon the range used. The voltage drop across the unknown is applied to the grid of the bridge circuit. In capacitance and inductance measurements, the unknown is placed in series with an internal source of a.c. voltage and a portion of the divider network. The a.c. voltage drop across the unknown is applied to a cathode follower, the output of which is rectified by electronic means, and then impressed on the grid of the bridge vacuum tube.

SECTION 2 - THEORY

2.1 GENERAL

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 circuit of this instrument is given. As the principles of operation rather than detailed explanation of the operation is intended, the full schematic, shown in Figure 6.1 or 6.2, is greatly simplified. The power supply incorporated in the unit is of the usual type employing a transformer, full-wave rectifier and a voltage regulator tube, therefore, no explanation of it is given. The milliammeter circuit also needs no detailed explanation as it is simply a meter shunted by a resistance network whose value is determined by the range of the current to be measured.

2.2 BRIDGE CIRCUIT

a. The bridge circuit is common to all measuring circuits except the milliammeter section. Specific application of the bridge is given in the explanation of the type of measurement to be performed, i.e., resistance, capacitance or voltage.

b. The basic circuit of the bridge is similar to the common Wheatstone bridge in operation. Voltage is applied across the bridge; B+ at R13 and B-, through feeder resistor R41, at the junction of R29 and R30. R13 acts as a zero adjustment and is adjusted so that with no voltage input to either grid of the tube, the meter reads zero, indicating balance between the two triodes of the twin triode used as the bridge tube. When making all measurements except capacity measurements the grid of one triode remains at ground potential and the grid of the other triode changes to a potential determined basically by the unknown being measured. Changing the potential of only one of the grids will unbalance the bridge and cause a deflection of the meter in direct proportion to the change in grid potential, as the plate current changes with grid potential. The meter has a calibrated scale which interprets this deflection in terms of volts, ohms, or units of capacity so that, in conjunction with the RANGE switch, the unknown can be evaluated directly from the scale reading. This is basically the action of the bridge and meter. The type of measurement to be made will determine both the input grid to be used and the method of obtaining the input voltage.

2.3 A.C. VOLTMETER

a. In the 203PR the a.c. voltage to be measured is rectified in the a.c. probe by the action of the input condenser C1 and the diode V5. In the standard 203 instrument, this a.c. voltage is applied to the A.C. and GND connections of the instrument and rectified by the action of input condenser C1 and one section of the rectifier tube V1. This resultant d.c. voltage is applied across the input voltage divider network and part of this voltage, as determined by the position of the RANGE control, is fed to the input grid of one of the triodes of the bridge tube causing the bridge circuit to function.

b. A negative contact potential is developed across the rectifier tube before any input voltage is applied due to the normal emission of electrons by the cathode. This negative potential is also across the input voltage divider network and will cause the meter to deflect. To compensate for this undesirable deflection, a positive voltage, equal to the contact potential, is fed to the voltage divider network through a 90 megohm resistor, R37.

2.4 D.C. VOLTMETER

The d.c. input voltage, applied to the D.C. and GND connections of the instrument, is applied directly to the voltage divider network. A part of this voltage, as determined by the position of the RANGE control, is fed to the input grid of one of the triodes of the bridge tube, causing the bridge circuit to function. Deflection of the meter pointer in the wrong direction indicates that the polarity of the voltage being measured is reversed with respect to the polarity of the meter and bridge circuit. A switching arrangement has been incorporated in the instrument, however, which switches the input grids of the bridge tube to permit measurements of either polarity.

2.5 OHMMETER

When an unknown resistance is connected across OHMS-CAP and GND terminals it is placed in series with a portion of the input voltage divider network as determined by the RANGE control and the dry cells incorporated in the instrument.

The voltage applied to the input grid of the bridge tube is the voltage across the unknown resistance caused by the battery current flow. The meter deflection can be calibrated in the terms of resistance.

2.6 CAPACITY AND INDUCTANCE MEASUREMENT

a. Capacity

The theory of the capacity measurement is similar to that of the ohmmeter, with the impedance of the unknown capacitor replacing the unknown resistance. However, as an a.c. voltage is needed to measure the capacitance, and as only d.c. can be applied to the input grid of the bridge tube, some means must be used to rectify the a.c. The a.c. voltage tapped off the voltage divider network is fed to the grid of a cathode follower which is used in the circuit as an impedance matching device. The cathode output is fed to the rectifier circuit which consists of one-half of V1, condenser C2 and resistor R4. The output of the rectifier is fed to the input grid of the bridge tube.

b. Inductance

The theory of the inductance measurements is similar to that of a capacitance measurement with the impedance of the inductance coil replacing the impedance of the capacitor. As the capacity scale is used in making measurements, a chart is given in Figure 3.1 which relates capacity readings to impedances. This impedance, in its affect in the circuit, may be due to either an inductance or a capacitor. A second scale on the chart evaluates the coil directly in henries and may be used if the ohmic resistance of the coil is low.

SECTION 3 - OPERATION

CAUTION

THE HIGH VOLTAGES WHICH CAN BE MEASURED WITH THIS EQUIPMENT MAY BE DANGEROUS TO LIFE. EXTREME CARE SHOULD BE TAKEN TO AVOID BODILY CONTACT WITH EXPOSED HIGH VOLTAGES.

THE PROBE HOUSING IS OPERATED AT THE SAME POTENTIAL AS THE CHASSIS OF THE INSTRUMENT; THEREFORE THE SAME PRECAUTIONS SHOULD BE OBSERVED IN TOUCHING THE PROBE HOUSING WITH RESPECT TO ANY ELECTRICAL CONNECTION THAT WOULD BE OBSERVED IN TOUCHING THE INSTRUMENT ITSELF.

3.1 GENERAL

a. To avoid error in resistance, capacitance and inductance measurements, be sure that the unknown to be measured is isolated from other circuits. In capacity and inductance measurements, it is advisable to remove the unknown from the circuit entirely. In resistance measurements, it is sufficient to free only one terminal of the resistor.

b. Be sure that the instrument is being operated from the correct external power source. It is necessary to allow a two or three minute warm-up period so that stable operation is assured. If the instrument is to be used intermittently over a period of time, it is advisable to keep it turned on to avoid delay.

3.2 A.C. VOLTAGE MEASUREMENTS

DO NOT ATTEMPT TO MEASURE A.C. POTENTIALS OVER 300 VOLTS.

a. Operate the POWER switch to ON.

b. Connect the a.c. probe of the Model 203PR to the panel connector by means of the four-prong connector plug.

c. Connect the black unshielded test lead to the GND jack. If voltages are being measured at frequencies over 100 mc, a braided ground connection should be made from the diode probe to the unit being tested. This lead should be as short as possible.

NOTE

In the case of the standard 203 instrument, the red, shielded a.c. cable with the microphone connector and red test prod would be used in place of the diode probe referred to in paragraph 3.2b.

d. Turn the SELECTOR switch to VOLTS A.C.

e. Turn the RANGE switch to the range which will cover the voltages to be measured. If this is unknown, choose the highest range.

f. Check the meter for zero setting. Adjust to zero with the ZERO ADJUST control. In setting the meter to zero do not touch the prod on the a.c. probe as the stray pickup will deflect the meter.

g. Connect the a.c. probe and the black test lead to the voltage to be measured.

h. Read the numerical value from the scale directly and apply the multiplying factor for the position of the RANGE switch.

3.3 D.C. VOLTAGE MEASUREMENTS

a. Operate the POWER switch to ON.

b. Turn the SELECTOR switch to VOLTS + D.C.

c. Turn the RANGE switch to the range which will cover the voltages to be measured. If an approximate range is unknown, choose the highest range.

d. Check the meter for zero setting at the range at which the measurement is to be made. Adjust to zero with the ZERO ADJUST control.

e. Connect the unknown, using the black ground lead furnished and the shielded cable with the microphone connector.

f. If the meter reads in the wrong direction, operate the SELECTOR switch to VOLTS - D.C.

g. Read the numerical value from the scale directly and apply the multiplying factor for the position of the RANGE control.

3.4 CURRENT MEASUREMENTS

a. To avoid possible injury to the meter, always make measurements using the highest range first.

b. To avoid error due to an inaccurate initial setting of the meter, check the zero reading of the meter before making any measurements. Adjust the zero setting mechanically by means of the screwdriver adjustment in the front of the meter if necessary.

c. Turn the SELECTOR switch to MILS.

d. Turn the RANGE switch to the range which will cover the currents to be measured. If an approximate range is unknown, choose the highest range.

e. Connect the unknown, using the black ground lead for - MILS and the red lead for + MILS.

f. Read the numerical value from the scale directly and apply the multiplying factor for the position of the RANGE control.

3.5 RESISTANCE MEASUREMENTS

a. Operate the POWER switch to ON.

b. Turn the SELECTOR switch to OHMS.

c. Turn the RANGE switch to the range which will cover the resistance to be measured. If it is desired to use the LOW OHMS scale, turn the RANGE switch to the X1 position.

d. Connect the red and black leads to the OHMS-CAP and GND jacks respectively. When using the LOW OHMS scale, connect the leads to the LOW OHMS and GND jacks. Adjust the meter to zero with the ZERO ADJUST control while shorting the test leads together. Open the leads and adjust the meter to full scale with the OHMS-CAPACITY ADJUST control.

e. Connect the unknown resistance between the test leads, making sure that it is isolated from any other circuit components which might introduce error.

f. Read the numerical value from the scale directly and apply the multiplying factor for the position of the RANGE switch. NOTE: When measuring LOW OHMS, read the numerical value from the scale and divide the reading by 10.

CAUTION

DO NOT SHORT THE LOW OHMS JACK TO GND UNLESS THE SELECTOR SWITCH IS IN THE OHMS POSITION, AS THERE IS A POSSIBILITY OF PLACING R49, A TEN OHM RESISTOR, ACROSS THE HEATER WINDING OF THE POWER TRANSFORMER.

3.6 CAPACITANCE MEASUREMENTS

a. Operate the POWER switch to ON.

b. Turn the SELECTOR switch to CAP.

c. Turn the RANGE switch to the range which will cover the capacity to be measured.

d. Connect the black and red leads furnished to OHMS-CAP and GND and check the zero setting by shorting the leads together. Adjust to zero with the ZERO ADJUST control. Open the leads and check for full scale deflection. Adjust to full scale with the OHMS-CAPACITY ADJUST control.

NOTE

Since the instrument has as appreciable internal capacity of approximately 20-30 mmf, the meter, when the range switch is turned to the X1 MMF range, will read this capacity. When making adjustment of the instrument to zero with the OHMS-CAPACITY ADJUST control, always turn the RANGE selector switch to some position other than X10 or X1 MMF since in other positions the small internal capacity will have no effect. In cases where it is necessary to make measurements in the X1 or X10 range, the true capacity will always be the difference between the reading obtained with the unknown capacity connected to the input and the initial reading obtained with no external capacity connected.

e. Connect to the unknown, using the black and red leads furnished. The capacitor should be removed from its associated circuits in making this measurement.

IMPORTANT

Since the capacity measuring circuit is exceedingly sensitive on the two lowest capacity ranges (X1 and X10 MMF), the test leads will pick up any stray a.c. voltage fields near the leads. This will generally cause the meter to read off scale on the right which results in erratic readings. It is therefore advisable to connect the capacitor under test directly to the OHMS-CAP and GND jacks when using either of these two ranges.

f. Multiply the numerical value indicated on the scale by the multiplying factor indicated by the RANGE control. In cases where it is necessary to use the X1 and X10 MMF ranges, the true value of the unknown will be the difference between the meter reading with and without the capacitor connected.

3.7 INDUCTANCE MEASUREMENTS

a. Operate the POWER switch to ON.

b. Turn the SELECTOR switch to CAP.

c. Turn the RANGE switch to any position other than X1 MMF.

d. Insert the red and black test leads into the jacks marked OHMS-CAP and GND and check the zero setting by shorting the leads together. Adjust the meter to zero with the ZERO ADJUST control.

e. Open the leads and adjust the meter to full scale with the OHMS-CAPACITY ADJUST control.

f. Insert the inductance to be measured between the test leads. If the meter reads zero on any of the MMF positions, the inductance is too small to be read on the Model 203.

g. Rotate the RANGE switch clockwise until a suitable reading can be obtained from the meter. The numerical value of capacity is noted and applied in the formula:

$$L = \frac{7.04}{C} \text{ henries}$$

where C is in MFD. NOTE: This formula is accurate only if the ohmic resistance of the inductance is negligible with respect to the inductive reactance at 60 cycles. The accuracy of calculation is greater than 1% if the product of the ohmic resistance and the capacity reading in MFD is less than 370 ($RC<370$).

h. If the ohmic resistance is appreciable, proceed to calculate the inductance as follows:

(1) Read the numerical value of the capacity directly from the scale. Find the associated impedance on the graph given in Figure 3.1. This value is Z_L in the formula which is given in (3) below.

(2) Determine the resistance of the inductance by means of an ohmmeter. This value is R_L in the same formula.

(3) Knowing Z_L and R_L, we can determine the inductance from the formula:

$$L = \frac{\sqrt{Z_L^2 - R_L^2}}{377} \text{ henries}$$

i. EXAMPLE: It is desired to find the inductance of a coil whose resistance, when measured by an ohmmeter, is 100 ohms. The capacity reading obtained from the Model 203 is 8.8 MFD.

RC = 8.8 x 100 880.
RC is greater than 370.

Therefore, the error due to the resistance is greater than 1%. Referring to the graph in Figure 3.1, we find that the impedance for a capacity reading of 8.8 MFD is 300 ohms. Substituting in the formula, we have:

$$L = \frac{\sqrt{Z_L^2 - R_L^2}}{377} = \frac{\sqrt{90{,}000 - 10{,}000}}{377}$$

or

$$L = \frac{282}{377} = .748 \text{ henries.}$$

3.8 DECIBEL MEASUREMENTS

a. The decibel scale can be used to determine the power level based on 0 DB = 6 mw. The operation of the Model 203 is the same for making decibel measurements as that under paragraph 3.2, A.C. voltage measurements. The ranges used for the various scales are clearly marked on the meter dial with the minus values indicated in red and the plus values in black.

b. The following formula can be used to convert the DB reading to watts, provided the reading is taken across a 500 ohm load.

FORMULA: $DB = 20 \log_{10} \frac{P}{.006}$

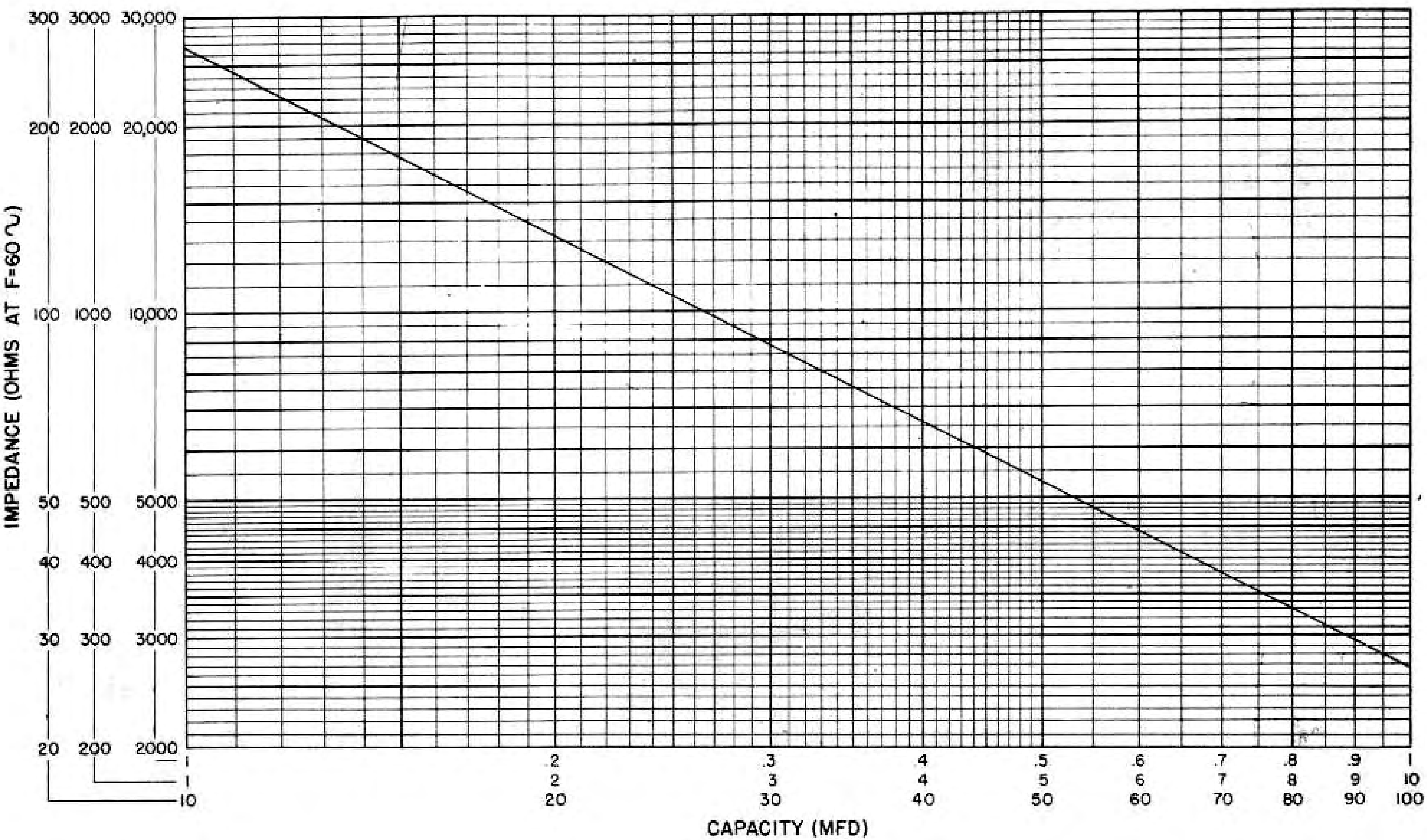

FIGURE 3.1 - IMPEDANCE CHART

SECTION 4 - APPLICATION

4.1 GENERAL

The following applications are very general in nature as it is always advisable to consult the instructions pertinent to the instrument under test to obtain the actual procedures in making a test. The Hickok Electronic Volt-Ohm-Capacity-Milliammeter, Model 203PR, may of course, be used in making all measurements common to an instrument of its type. These applications given here will give more specialized use of which the user may not be aware.

4.2 D.C. VOLTMETER

a. The input impedance in the vacuum tube voltmeter is constant at approximately 10 megohms for all ranges. As the result of this high input impedance, it can, in general, be used to measure d.c. voltages in any electrical circuit without appreciably loading down the d.c. circuit and, consequently, the voltage as indicated will be essentially the voltage which would be found under normal operating conditions. In the conventional low impedance type of voltmeter the loading caused by the meter is often sufficiently great to cause extreme error when measurements are made in high impedance circuits.

b. RF-IF Circuits

As a result of the incorporation of an isolating resistor of one megohm in the d.c. probe, this voltmeter can also be used to measure voltages in oscillating or r-f circuits without loading these circuits from a capacitive or resistive standpoint. This feature makes it possible to measure a-v-c voltages at such places as the control grids of r-f and i-f stages without disturbing the normal operation of those circuits.

c. Oscillation Check

Determination of the condition of oscillation or non-oscillation of the oscillator sections in receivers is another application of the voltmeter. An immediate check is obtained on the oscillator section by connecting the voltmeter so as to measure the voltage at the grid of the oscillator tube and tuning from one end of the band to the other. Note the grid voltage throughout the entire range. Normally a negative voltage of from 5 to 30 volts will be found at the grid of the oscillator tube when the oscillator section is operating properly. Dead spots on one or more of the tuning ranges may be located by this test.

d. Discriminator Circuit Alignment

Service instructions for the alignment of frequency modulated receivers often call for the insertion of a zero center microammeter in the discriminator circuit. Misalignment is indicated by any reading, either positive or negative, on the meter and alignment is indicated by a zero reading. The d.c. voltmeter section of the Model 203 may be much more conveniently used to make such alignments. Merely connect it across the discriminator load resistance and advance the zero adjust control to bring the normal position of the pointer of the meter to some arbitrary position on the scale where swings, either positive or negative, may be noted. Make the necessary alignment which will bring the meter back to the position at which it had been set prior to the connection to the discriminator load resistance. Thus a satisfactory alignment can be made without the necessity of breaking the circuit to insert the microammeter.

4.3 A.C. VOLTMETER

a. The a.c. voltmeter impedance in the Model 203PR has a constant resistive component of approximately 11 megohms and a capacitive component of approximately 6 mmf. The low shunting capacity is attained by the use of the diode probe, and consequently, measurements of voltages over 100 mc. are possible. The range can further be extended by using a braided connection from the ground post of the diode head to the chassis of the unit under test. This lead should be as short as possible to reduce the possibility of standing waves being present along the lead. At high frequencies, the shunt capacity, although it is only about 6 mmf, will have a low reactance and may introduce some error in the reading obtained. This error is dependent upon the impedance from which the voltage is measured, and increases as the impedance increases. Also, at these frequencies the loading imposed by the capacity input may detune a tuned radio frequency circuit.

In the standard 203 instrument, the a.c. voltmeter has a constant a.c. input impedance of approximately 11 megohms which is shunted by the capacity of the lead and associated capacitors in the circuit which amounts to approximately 100 mmf. Throughout the audio frequency range a shunt of this capacity will not seriously load the circuit under test. The a.c. voltmeter may be used up to the frequency of 10 to 15 mc. with no appreciable error in the voltage determination although the loading imposed by the capacity input will probably seriously detune the tuned radio frequency circuits.

b. The a.c. input circuit of the 203PR includes a blocking condenser between the test prod and the diode circuit so that any d.c. components present in the circuit under test are ineffective and only the a.c. components are measured. In the standard 203 instrument, this blocking condenser is located between the test lead and the internal circuit of the instrument.

c. When the a.c. voltmeter is used to measure voltages of supply line frequency, for example, the common 60 cycle supply, small discrepancies in the readings may occur if the polarity of the test leads is reversed -- that is, if the grounded test lead changes in position with respect to the a.c. voltage being measured. The actual voltage in such cases should be taken as the average of the two readings obtained.

4.4 OHMMETER

a. The ohmmeter section of the Model 203 uses only 3 volts d.c. for all resistance measurements. Many resistors, especially of the composition type, have what is known as a voltage coefficient, that is, the actual value of the resistance varies with the voltage placed across the resistors. This is especially true at resistance values above one megohm. As an example of this, a resistor measured with 3 volts, as in the Model 203, to be 5 megohms might differ from 5 megohms if it were measured with several hundred volts. This difference would depend upon the voltage coefficient of the resistor.

b. On the lower ranges the internal shunt resistance between the test leads used in resistance measurements is relatively low. It is advisable, therefore, never to connect the test leads across a voltage which could possibly damage or destroy these resistors. To avoid this, be sure that the resistor being measured is not connected to an active circuit when measurements are being made.

4.5 CAPACITY MEASUREMENTS

In conventional capacitance measuring devices it is necessary to use very high voltages for measuring capacitors of low capacity with a resultant hazard to the operator. This hazard has been completely eliminated in the Model 203 and capacity test leads may be handled without fear of electrical shock as the electronic circuit utilized permits capacity measurements throughout the wide range of from approximately 1 mmf to 1000 mfd with the use of only 6 volts a.c.

SECTION 5 - MAINTENANCE

5.1 GENERAL

As the Model 203 has been built under the high standards of workmanship of a Hickok instrument, no maintenance other than routine replacement of tubes or batteries should be necessary. It is suggested that, should the instrument need maintenance other than routine replacements, the factory be contacted with regard to the nature of the trouble, and if necessary, the instrument be shipped to the factory or an authorized Hickok repair station for inspection and service. A schematic, shown in Figure 6.1 or 6.2, and a chassis view, shown in Figure 5.1, are given to aid in maintenance work.

5.2 VACUUM TUBES

All vacuum tubes are operated at, or below, their normal rating to insure long life and uniform service. To check the tubes, remove the chassis from the case by removing the eight screws around the edge of the panel and lifting the panel from the case.

5.3 DRY CELLS

Two dry cells are operated in series as a source of d.c. in making ohmmeter measurements. If it is impossible to bring the meter to full scale deflection on any scale it is probable that one or both of the dry cells are low. To replace these, remove the chassis from the case as given in paragraph 5.2, and remove the dry cells. It will be necessary to remove the clamp holding the cells in place before removing the cells from their clip holders.

NOTE

IF THE METER POINTER MOVES VIOLENTLY TO THE LEFT WITH THE SELECTOR SWITCH IN THE OHMS POSITION, REMOVE THE MODEL 203 FROM ITS CASE AND CHECK THE ELECTRICAL CONTACTS OF THE BATTERIES.

5.4 CAPACITY AND RESISTANCE MEASUREMENTS

When making capacity or resistance measurements with the Model 203 or 203FR, a condition is often encountered which is very confusing unless explained. This is caused by stray A.C. pickup of the test leads reacting to cause the meter pointer's inability to be properly adjusted to full scale. This stray field is almost always present whereever there is 110 volt wiring and especially prevalent where fluorescent lamps are used.

When using the most sensitive ranges of these instruments, the following procedure should be used.

Turn the range selector switch to one of the higher, or preferably the highest range, X1 ohm or X100 mfd. Short the test leads together and adjust the zero control to zero ohms or infinity capacity. Open up the test leads and adjust the OHMS CAP. ADJUST control to bring the meter up to 0 mmf. or Inf. ohms. Disconnect the red lead from the OHMS CAP. jack and rotate the range control to the desired range. If capacity measurements are being made with the range control operated to the MMF X1 range, the meter pointer will probably deflect back to about 30 or 40 mmf, indicating the internal stray capacities in the instrument.

On resistance ranges, however, the pointer will probably not drop back to very much below the "Inf." position. If it does come down below this, readjust the ohms capacity adjust to bring the indicator up to the "Inf." position. In capacity measurements, however, this control should not be readjusted.

If reinserting the red lead in the OHMS CAP. jack affects the reading under these conditions, then the capacity or resistance being measured should preferably be connected directly between the OHMS CAP. jack and the black, or ground, test lead.

In capacity measurements, of course, the actual reading of capacitors when measured in this way, will be the sum of the capacity being measured and the internal capacity. Therefore, the stray or internal capacity should be deducted numerically from the reading to give actual capacity being measured.

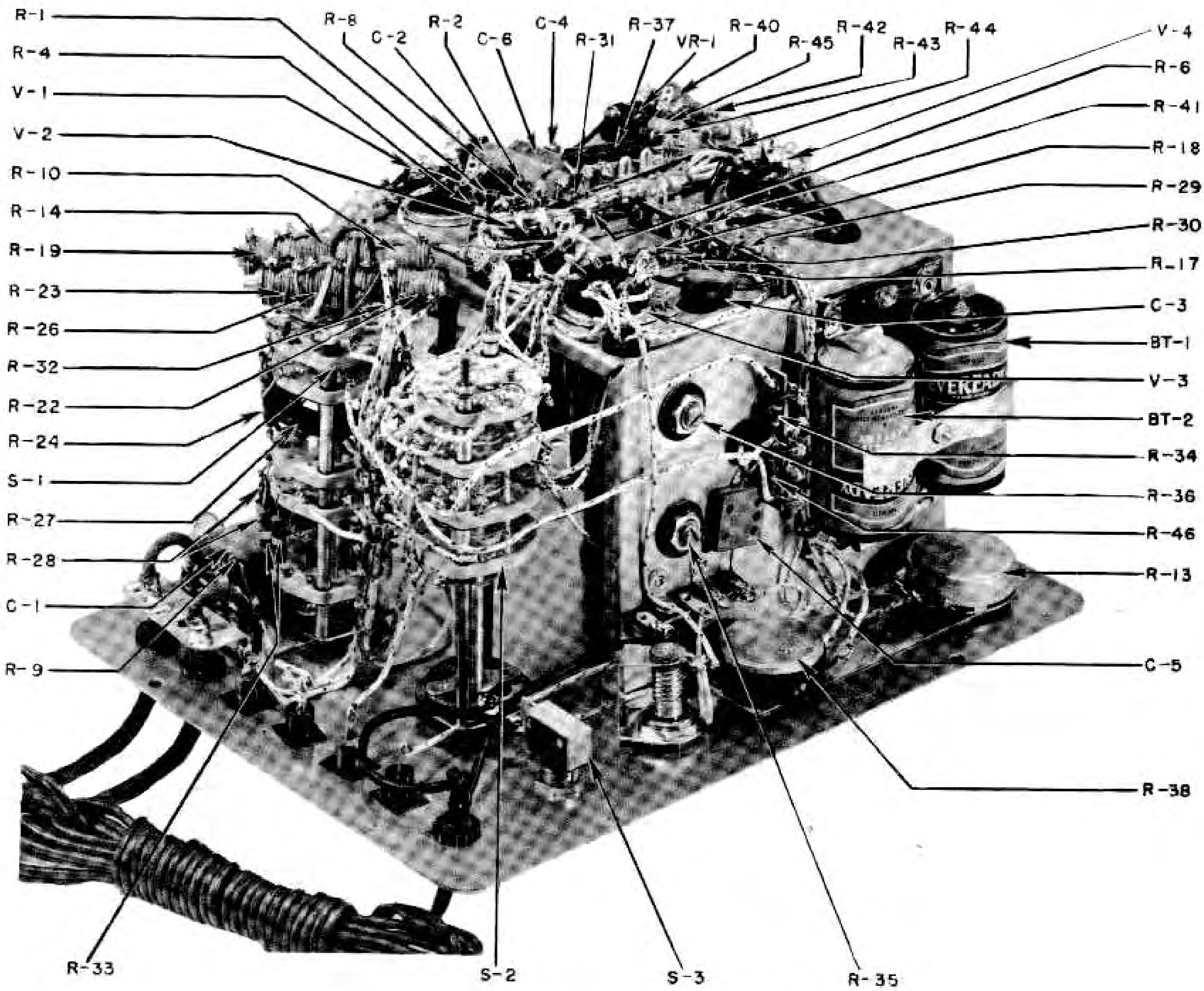

FIGURE 5.1 - CHASSIS VIEW, MODEL 203 OR 203PR

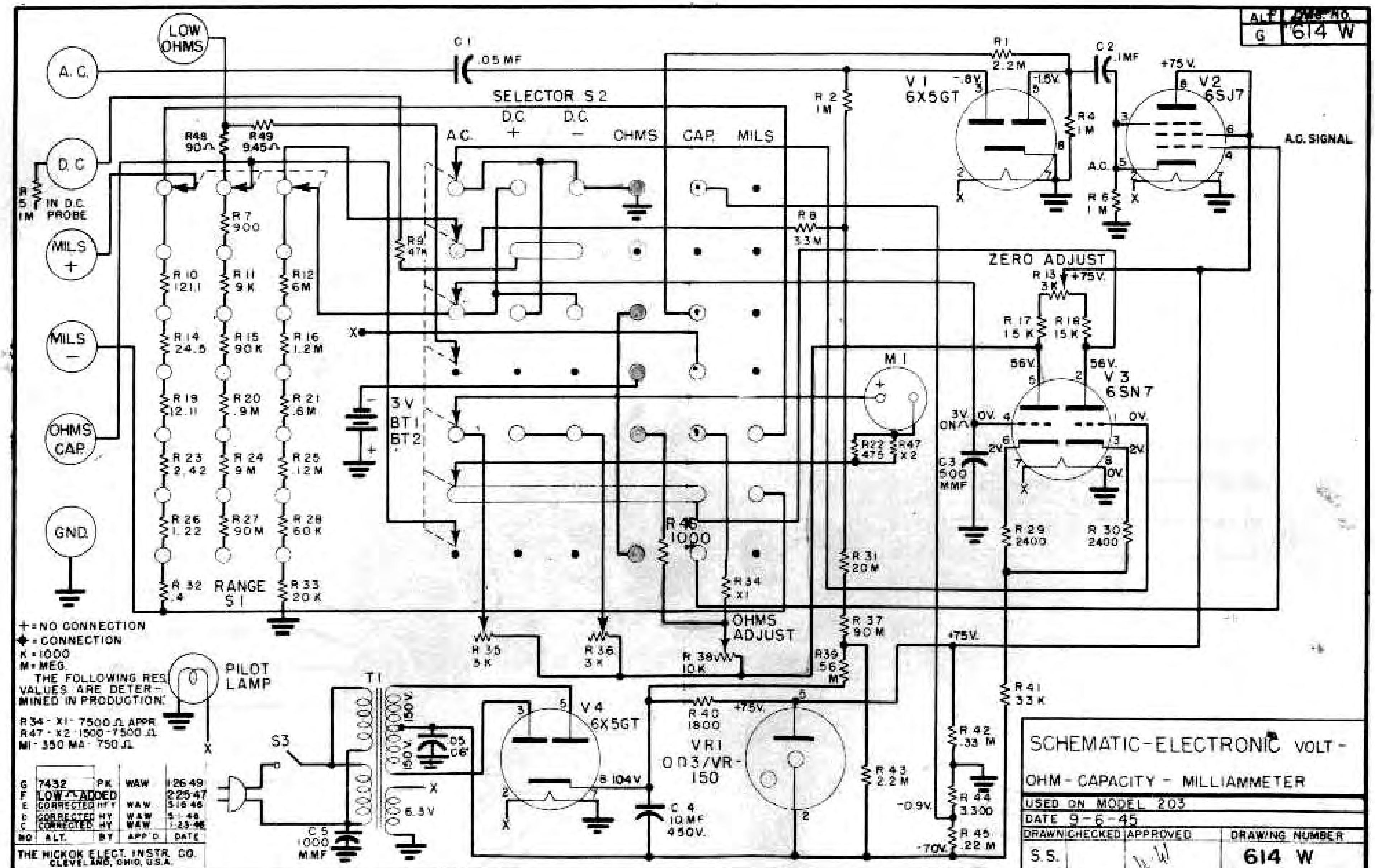

FIGURE 6.1 - SCHEMATIC, MODEL 203

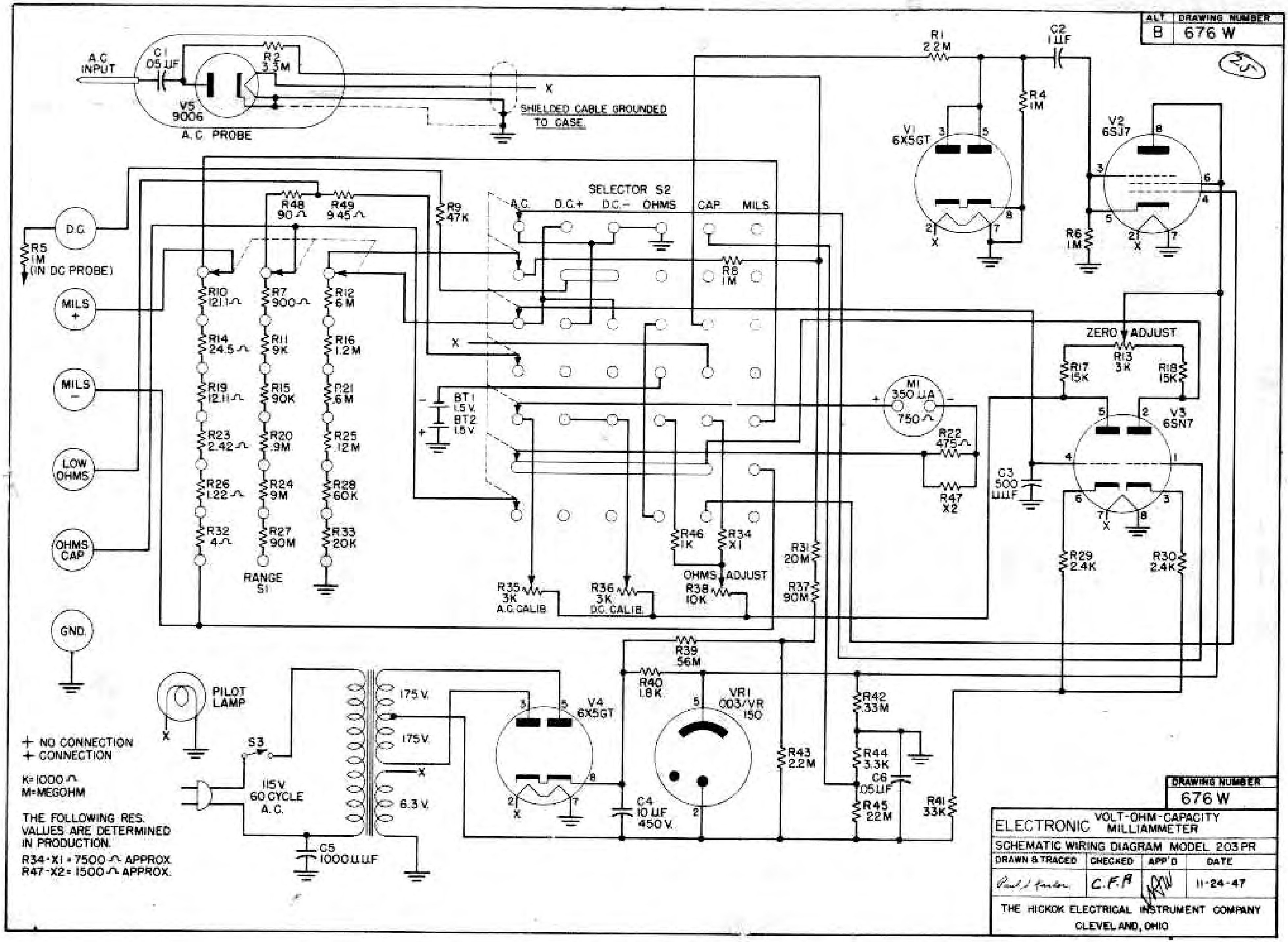

FIGURE 6.2 - SCHEMATIC, MODEL 203PR

SECTION 6 - PARTS LIST

MODEL 203 - 203PR

NOTE: There is a minimum charge of $1.50 for the shipment of any one order.

REF. SYMBOL	HICKOK PART NUMBER	NAME AND DESCRIPTION	FUNCTION
BT1	2210-2	BATTERY: 1½ volt, size D	
BT2		BATTERY: Same as BT1	
C1	3105-56	CAPACITOR: .05 mfd, 1000 V (203 only)	
C1	3105-103	CAPACITOR: .05 mfd, 400 V, Solite (203PR only)	
C2	3105-24	CAPACITOR: .1 mfd, 400 V, paper	
C3	3095-8	CAPACITOR: 470 mmf, 500 V, mica	
C4	3085-25	CAPACITOR: 10 mfd, 450 V, electrolytic	
C5	3095-9	CAPACITOR: .001 mfd, 500 V, mica	
C6	3105-9	CAPACITOR: .05 mfd, 400 V, paper	
R13	16925-11	POTENTIOMETER: 3000 ohms, linear, carbon	ZERO ADJUST
R35	16925-12	POTENTIOMETER: 3000 ohms, linear, wire wound	A.C. CALIBRATION
R36		POTENTIOMETER: Same as R35	D.C. CALIBRATION
R38	16925-27	POTENTIOMETER: 10,000 ohms, linear, carbon	OHMS ADJUST
R1	18415-222	RESISTOR: 2.2 meg, ½ W, 10%	
R2	18415-332	RESISTOR: 3.3 meg, ½ W, 10%	
R4	18415-102	RESISTOR: 1 meg, ½ W, 10%	
R5		RESISTOR: Same as R4	
R6		RESISTOR: Same as R4	
R7	18525-20	RESISTOR: 900 ohms, ½ W, 2%, paired	
R8		RESISTOR: Same as R4	
R9	18413-472	RESISTOR: 47,000 ohms, ½ W, 10%	
R10	18670-417	RESISTOR: spool, 121.1 ohms	
R11	18525-37	RESISTOR: 9000 ohms, ½ W, 2%, paired	
R12	18525-207	RESISTOR: 6 meg, ½ W, 2%, paired	
R14	18670-408	RESISTOR: spool, 24.25 ohms	
R15	18525-61	RESISTOR: 90,000 ohms, ½ W, 2%, paired	
R16	18525-142	RESISTOR: 1.2 meg, ½ W, 2%, paired	
R17	18413-151	RESISTOR: 15,000 ohms, ½ W, 5%	
R18		RESISTOR: Same as R17	
R19	18670-106	RESISTOR: spool, 12.11 ohms	
R20	18525-263	RESISTOR: 900,000 ohms, ½ W, 2%, paired	
R21	18525-141	RESISTOR: 600,000 ohms, ½ W, 2%, paired	
R22	18670-123	RESISTOR: spool, 475 ohms	
R23	18670-102	RESISTOR: spool, 2.42 ohms	
R24	18525-264	RESISTOR: 9 meg, ½ W, 2%, paired	
R25	18525-147	RESISTOR: 120,000 ohms, ½ W, 2%, paired	
R26	18670-102	RESISTOR: spool, 1.22 ohms	
R27	18550-71	RESISTOR: 90 meg, 1 W, 10%	
R28	18525-57	RESISTOR: 60,000 ohms, ½ W, 2%, paired	
R29	18412-271	RESISTOR: 2700 ohms, ½ W, 5%	
R30		RESISTOR: Same as R29	
R31	18416-201	RESISTOR: 20 meg, ½ W, 5%	
R32	18670-101	RESISTOR: spool, .4 ohms	
R33	18525-45	RESISTOR: 20,000 ohms, ½ W, 2%, paired	
R34		RESISTOR: 7500 ohms, appx.	
R37		RESISTOR: Same as R27	
R39	18414-562	RESISTOR: 560,000 ohms, ½ W, 10%	
R40	18432-182	RESISTOR: 1800 ohms, 2 W, 10%	
R41	18413-332	RESISTOR: 33,000 ohms, ½ W, 10%	
R42	18424-332	RESISTOR: 330,000 ohms, 1 W, 10%	
R43		RESISTOR: Same as R1	
R44	18412-332	RESISTOR: 3300 ohms, ½ W, 10%	
R45	18424-222	RESISTOR: 220,000 ohms, 1 W, 10%	
R46	18412-102	RESISTOR: 1000 ohms, ½ W, 10%	
R47		RESISTOR: 1500 ohms, appx.	
R48	18525-8	RESISTOR: 90 ohms, ½ W, 2%, paired	
R49	18525-2	RESISTOR: 9.45 ohms, ½ W, 2%, paired	
S1	19912-95	SWITCH: 5 section, 7 position, 3 pole, rotary, ceramic	RANGE
S2	19912-94	SWITCH: 4 section, 6 position, 7 pole, rotary	SELECTOR
S3	19911-9	SWITCH: S.P.S.T., toggle	ON-OFF

SECTION 6 - PARTS LIST

MODEL 203 - 203PR

NOTE: There is a minimum charge of $1.50 for the shipment of any one order.

REF. SYMBOL	HICKOK PART NUMBER	NAME AND DESCRIPTION	FUNCTION
T1	20800-59	TRANSFORMER: power	
V1	20875-22	TUBE: 6X5GT	A.C. INPUT RECT.
V2	20875-17	TUBE: 6SJ7	CATHODE FOLLOWER
V3	20875-19	TUBE: 6SN7GT	BRIDGE
V4		TUBE: Same as V1	POWER SUPPLY RECT.
V5	20875-46	TUBE: 9006 (203PR only)	RECTIFIER
VR1	20875-39	TUBE: OD3/VR150	VOLTAGE REGULATOR
	3030-29	CABLE, Assembly: 48" shielded	D.C. TEST LEAD
	3030-38	CABLE, Assembly: 48" shielded (203 only)	A.C. TEST LEAD
	16970-12	CABLE, Assembly: 48" shielded cable and probe assembly (203PR only)	A.C. TEST LEAD
	4160-12	DIAL, Assembly: with knob	SELECTOR
	4160-13	DIAL, Assembly: with knob	RANGE
	12450-93	LEAD, Assembly: 48" unshielded, red	OHMS & MILS
	12450-99	LEAD, Assembly: 48" unshielded, black	GND & - MILS
	12270-5	LAMP: #40 Mazda, 6-8 V, 15 amp.	PILOT

HICKOK

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