HICKOK

HICKOK

INSTRUCTION MANUAL

for

MODEL 455B

VOLT-OHM-MILLIAMMETER

Manual No. 2490-567

THE HICKOK ELECTRICAL INSTRUMENT CO.

VOLT-OHM-MILLIAMMETER
Model 455B

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CABLE — HICKOK, CLEVELAND
WESTERN UNION — KJ

WARRANTY

The Hickok Electrical Instrument Company warrants instruments of its manufacture to be free from defects in material and workmanship for ninety (90) days from the date of original purchase. Any instrument found to be defective during this period may be returned, transportation prepaid, to the factory for repair, or at our option, replaced without charge.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons, or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced or removed. Neither shall the warranty apply where a warranty registration card has not been properly completed and returned to us promptly after purchase. This warranty is in lieu of all other warranties whether expressed or implied.

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, 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. Upon authorization, this equipment should be forwarded directly either to the Hickok factory address at 10626 Leuer Avenue, Cleveland, Ohio, 44108, or to a designated service station in your locality.

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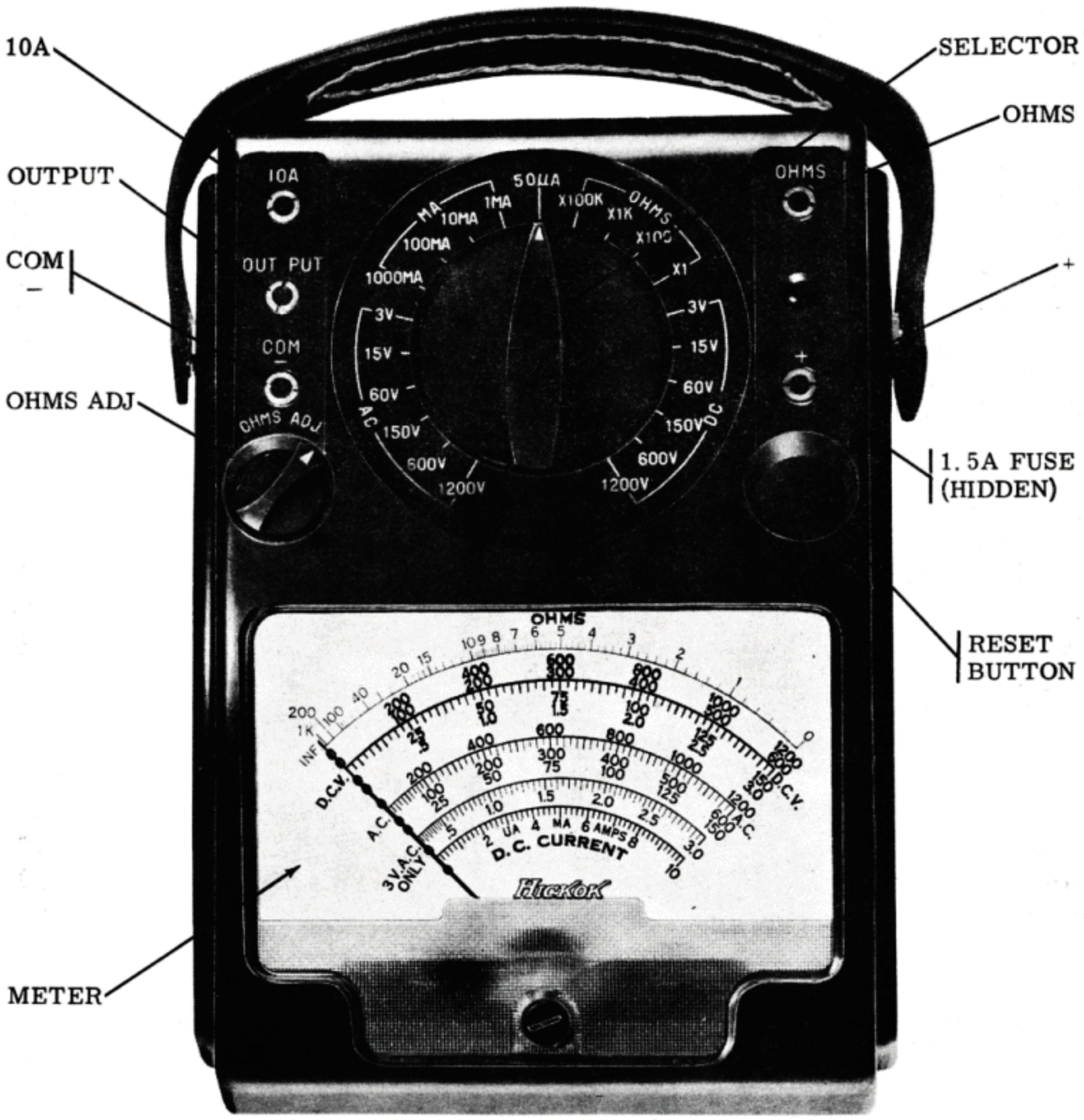

Figure 1. Top Panel Controls and Connectors

GENERAL INFORMATION

DESCRIPTION

The Model 455B Volt-Ohm-Milliammeter is an accurate and rugged test instrument, especially designed around the requirements of the industrial and electronic technician or engineer. It is light in weight and styled with a low silhouette to give stability in crowded work areas. The slanted meter dial contributes to faster and more accurate readings.

ADDITIONAL FEATURES

The Model 455B incorporates an exclusive and patented POSITIVE OVERLOAD PROTECTION (POP); it has a simplified function and range selector switch that is coded to the meter dial; it has an easy to read wide vision meter dial; and it has battery and fuse compartments readily available without opening the instrument case.

QUICK REFERENCE DATA

1. RANGES
   a. AC volts: 0-3, 0-15, 0-60, 0-150, 0-600, and 0-1200
   b. DC volts: 0-3, 0-15, 0-60, 0-150, 0-600, and 0-1200
   c. OHMS: 1-100 megohms (4 ranges)
   d. MICROAMPERES: 0-50
   e. MILLIAMPERES: 0-1, 0-10, 0-100, and 0-1000
   f. AMPERES: 0-10
2. SENSITIVITY
   a. AC volts: 20,000 ohms per volt
   b. DC volts: 20,000 ohms per volt
   c. METER: 38 microamperes

3. DIMENSIONS: 6" wide, by 8" deep, by 3-1/4" high.

4. WEIGHT: 3-3/4 pounds.

TOP PANEL CONTROLS AND CONNECTORS

Efficient operation of the Model 455B, Volt-Ohm-Milliammeter requires familiarity with the instrument's controls and connectors. The following explains their purpose and function. See figure 1.

OHMS ADJ - A continuously variable adjustment - provides a zero reference for use in connection with the OHMS scale.

COM & — (minus) - A banana jack - accepts the black or common test lead.

OUTPUT - A banana jack - permits the measurement of AC signal component of a modulated DC source.

10A - A banana jack - for measuring DC current from 0 to 10 amps range - indicated on lowest scale of meter dial.

SELECTOR - 21 position rotary switch - selects function and scale to correspond to that part of the meter dial to be used.

OHMS - A banana jack - used for resistance measurements from 0 to 100 megohms - indicated on the topmost scale of meter dial.

+ (plus) - A banana jack - to accept the positive (red) test lead to complete a test circuit in combination with black lead.

RESET BUTTON - mechanical, spring loaded - an integral part of the Positive-Overload-Protection circuitry. See Circuit Description.

BOTTOM PLATE FEATURES

Additional features of the Model 455B which appear on the bottom plate of the unit are as follows:

NAME PLATE - The name plate on the bottom of the unit provides battery information and access to the batteries, as well as, the spare fuses.

PROTECTION CIRCUIT TEST - Access hole to relay switch that provides Positive - Overload - Protection (POP). See Circuit Description.

1/2A. FUSE - Access hole for removal (for testing) or replacement of the 1/2 amp fuse.

OPERATING INSTRUCTIONS

POSITIVE-OVERLOAD-PROTECTION (POP)

The Model 455B has Positive-Overload-Protection (POP) which is divided into two phases, i. e., the conventional fuses (0. 5 amp and 1. 5 amp) together with an exclusive and patented circuit. This circuitry, as explained in detail in the section of this manual titled "Circuit Description", is dependent upon the 30 volt battery to trip the red RESET BUTTON and open the circuit. Opening the circuit removes the overload, thus protecting both the Model 455B and the circuit being tested.

CAUTION

If the red RESET BUTTON pops up, determine that the SELECTOR is properly positioned for the intended measurement before further testing.

After the test conditions have been verified, depress the red RESET BUTTON. This restores the POP circuit and its accompaning protection. In making measurements, it is usually desirable to have readings in the upper three-quarters of the particular scale being used. When subjected to severe overloads on the high mils ranges, the 1. 5 amp fuse in the "+" banana jack may be blown. To test this fuse, rotate the SELECTOR to the X100K Ohms position. With the two leads, short the COM & — (minus) jack and the + (plug) jack. See figure 1. If the 1. 5 amp fuse is not blown, the METER indicator can be adjusted to zero OHMS by means of the OHMS ADJ control. In making the test be sure that the red RESET BUTTON is down. When the X1 OHMS range is subjected to severe overloads, the 0. 5 amp fuse located in the bottom plate of the unit may blow. To check this fuse, remove the fuse from its holder and check for continuity by use of the X100 OHMS range.

AC VOLTAGE MEASUREMENTS

To make AC voltage measurements, observe the following:

a. Range of scales available for selection are 0 to 3, to 15, to 60, to 150, to 600, or to 1200 volts. All are read directly on the meter dial except the 0 to 15 volt scale which is read on the 0 to 150 volt scale, then divided by ten; and the 0 to 60 volt scale which is read on the 0 to 600 volt scale, then also divided by ten.

b. Rotate the SELECTOR to the AC function and to the highest scale (1200 volts). In general, for greater accuracy, it is desirable to start on the highest range of all scales, and drop down, in successive steps until the reading is in the upper half of the scale. This also avoids excessive tripping of the overload relay (K1).

c. Plug the red test lead into the + (Plus) jack and the black test lead into the COM or — (minus) jack. See figure 1.

d. Apply the test probes to the points to be measured.

e. Read the AC voltage on the appropriate scale.

f. If the protective circuit activates the relay (K1) and pops up the red RESET BUTTON, see the first paragraph of this section titled Positive-Overload-Protection".

DC VOLTAGE MEASUREMENTS

To make DC voltage measurements, observe the following:

a. Range of scales available for selection are 0 to 3, to 15, to 60, to 150, to 600, or to 1200 volts. All are read directly on the meter dial except the 0 to 15 volt scale which is read on the 0 to 150 volt scale, then divided by ten; and the 0 to 60 volt scale which is read on the 0 to 600 volt scale, then also divided by ten.

b. Rotate the SELECTOR to the DC function and to the highest scale (1200 volts). In general, for greater accuracy, it is desirable to start on the highest range of all scales, and drop down, in successive steps until the reading is in the upper half of the scale. This also avoids excessive tripping of the overload relay (K1).

c. Plug the red test lead into the + (plus) jack and the black test lead into the COM or — (minus) jack. See figure 1. The color of the leads are significant and quite important only when working with DC, but it is an excellent practice to always be consious of the polarity of the leads. The red lead usually indicates the "hot" or plus side of a circuit, while the black lead usually indicates the negative, common, or ground side of a circuit.

d. Apply the test probes to the points to be measured, and in this case matching the polarities.

e. Read the DC voltage on the appropriate scale.

f. If the protective circuit activates the relay (K1) and pops up the red RESET BUTTON, see the first paragraph of this section titled "Positive-Overload-Protection".

RESISTANCE MEASUREMENTS (OHMS)

To make resistance measurements, observe the following:

a. The OHMS scale is a direct reading single scale with multipliers of X1, X100, X1K, and X100K, according to the position of the SELECTOR.

b. Rotate the SELECTOR to the OHMS quadrant.

c. Check that which is to be measured to be sure it is de-energized. NO VOLTAGE PRESENT.

d. Plug the red test lead into the COM or — (minus) jack and the black test lead into the OHMS jack. See figure 1.

e. Check calibration by shorting leads and adjust indicator to zero by means of the OHMS ADJ control.

f. Apply the test probes to the points to be measured.

g. Take reading. If necessary, rotate the SELECTOR to a multiple in the OHMS range, which gives approximately a mid-scale reading for greatest accuracy.

h. If the portective circuit is activated or it is possible that a fuse has "blown", see the first paragraph of this section titled "Positive-Overload-Protection".

DC MEASUREMENTS - MILLIAMPERES

To make milliampere measurements, observe the following:

a. The milliampere (MA) scale is a direct reading single scale from 0 to 10 with values of 1 MA, 10 MA, 100 MA, and 1000 MA per full scale reading, according to the setting of the SELECTOR.

b. Rotate the SELECTOR to the MA quadrant. If possible, select a setting which will result in a reading in the upper half of the scale.

c. Plug the red test lead into the + (plus) jack and the black test lead into the COM or — (minus) jack. See figure 1.

d. Apply the test probes to the points to be measured.

e. Take reading. If necessary, rotate the SELECTOR to a setting for the most satisfactory reading.

f. If the protective circuit is activated or it is possible that a fuse has "blown", see the first paragraph of this section titled "Positive-Overload-Protection.

DC MEASUREMENTS - MICROAMPERES

To make microampere measurements, observe the following:

a. The same DC CURRENT scale as used in the "DC MEASUREMENTS-MILLIAMPERES" is used in measuring microamperes: i. e., 0 to 10.

b. Rotate the SELECTOR to the 50μA setting.

c. Plug the red test lead into the + (plus) jack and the black test lead into the COM or — (minus) jack. See figure 1.

d. Apply the test probes to the points to be measured.

e. Take the reading and <u>multiply</u> by 5.

f. If the protective circuit is activated or it is possible that a fuse has "blown", see the first paragraph of this section, titled "Positive-Overload-Protection".

DC MEASUREMENTS - AMPERES

To make ampere measurements, observe the following:

a. The same DC CURRENT scale as used in the "DC MEASUREMENTS-MILLIAMPERES" is used in measuring amperes; i. e., 0 to 10.

b. Rotate the SELECTOR to the MA function and the 1000 MA setting.

c. Plug the red test lead into the 10A jack and the black test lead into the COM or — (minus) jack. See figure 1.

d. Apply the test probes to the points to be measured.

e. Read directly in amperes on the DC CURRENT scale, 0 to 10.

f. If the protective circuit is activated or it is possible that a fuse has "blown", see the first paragraph of this section, titled "Positive-Overload-Protection".

CIRCUIT DESCRIPTION

INTRODUCTION

In the interest of simplicity, the circuit description is divided into functional units which are described and discussed separately. Each functional unit has its own simplified schematic wiring diagram.

POSITIVE-OVERLOAD-PROTECTION (POP) CIRCUIT

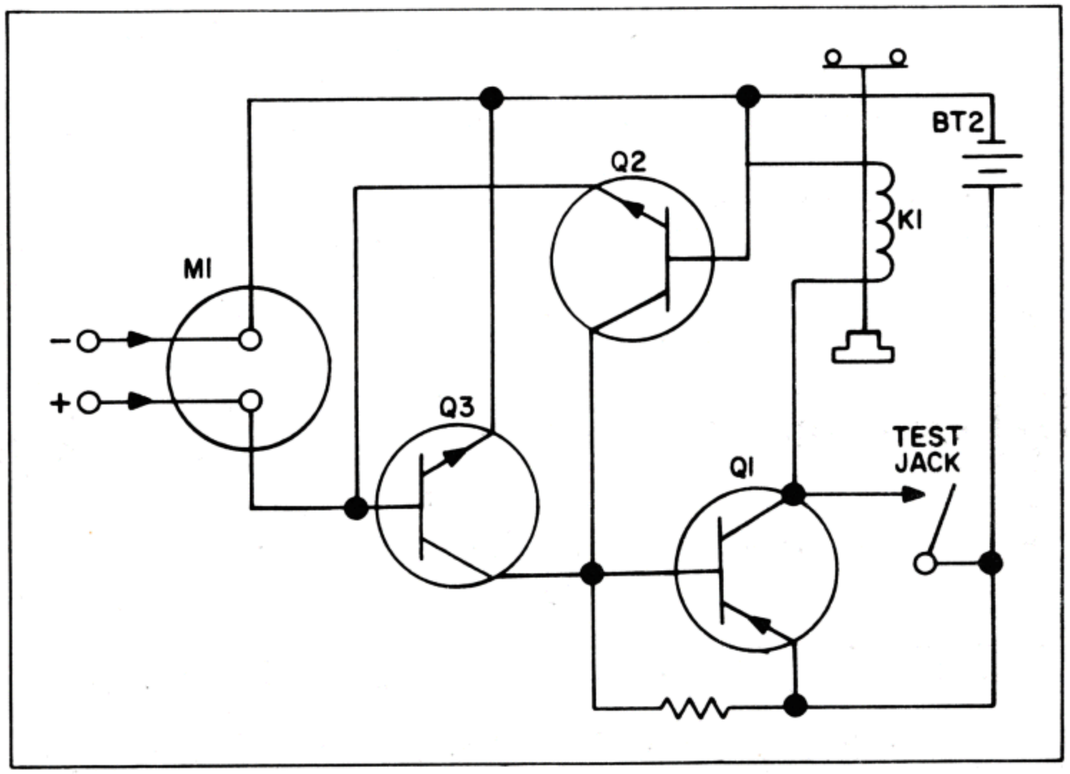

Figure 2. Simplified Schematic Diagram of the "POP" Circuit

The Model 455B has a unique circuit designed solely and exclusively to protect it against harm from an accidental overload. See figure 2. The new circuit includes three transistors, two of which (Q2 and Q3) are used for bi-directional sensing of the METER (M1) terminal voltage. These, in turn, are used to trigger the third transistor (Q1) that is used as a switch to actuate the relay (K1) and thus open the circuit across the METER. <u>After</u> the overload has been removed, the METER is restored to service by depressing the red RESET BUTTON.

The operation of the relay (K1) is dependent upon adequate energy in the 30 volt battery (BT2). Failure of this battery could damage the unit

under overload conditions. For this reason, periodic checks dependant upon period of time and frequency of use, must be made. This test is both easy and fast with the PROTECTION CIRCUIT TEST switch on the bottom plate of the unit. Simply insert the end of a probe or some similar object, to close the contacts of this test switch, thus actuating the relay (K1) and making the red RESET BUTTON pop up. This action proves that the 30 volt battery (BT2) has sufficient energy to operate the overload protection circuit. Depressing the red RESET BUTTON restores the unit to service.

CAUTION

Should the red RESET BUTTON not pop up when the PROTECTION CIRCUIT TEST switch is activated, do not use the unit until the 30 volt battery has been replaced with a fresh battery. See Maintenance Section.

DC MILLIAMMETER CIRCUIT

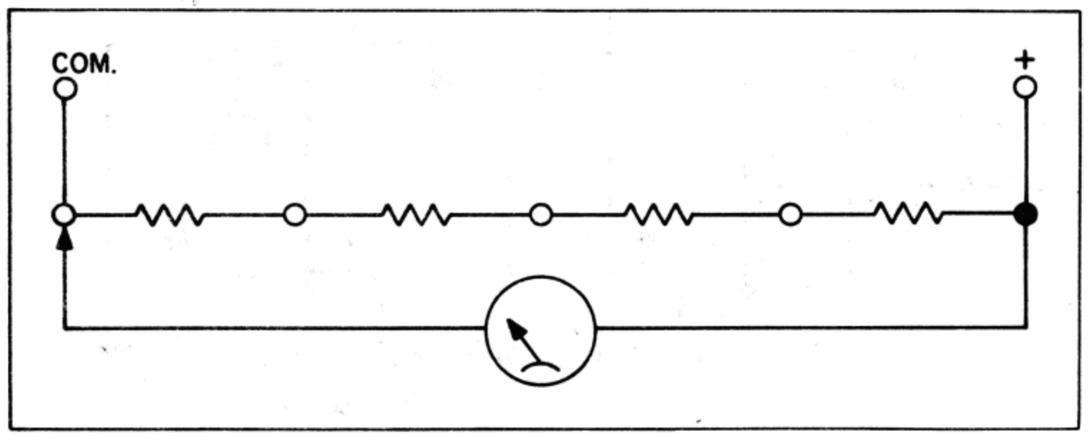

Figure 3. Simplified Schematic Diagram of a Milliammeter Circuit

Basically, a milliammeter is a meter shunted by resistance. See figure 3. The value of the resistance is such that the total current for a given range is the sum of the current through the meter and the resistance. To change the range, the value of the parallel resistor is changed by the selector switch.

OHMMETER CIRCUIT

In essence, an ohmmeter is a battery in series with a known resistance which is in a circuit with a meter. See figure 4. When the input is shorted, the full voltage of the battery is developed across the known resistor and the meter is adjusted to indicate zero ohms.

After setting the meter to zero, any unknown resistor placed across

the input will divide the voltage across the known resistor in direct proportion to the value of the known and unknown resistors. The meter is then calibrated in terms of the value of the unknown resistor.

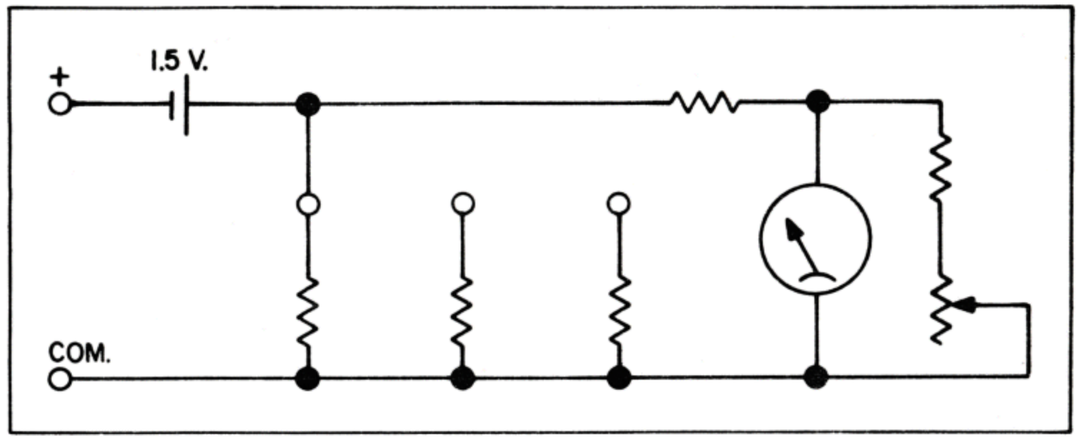

Figure 4. Simplified Schematic Diagram of an Ohmmeter Circuit

DC VOLTMETER CIRCUIT

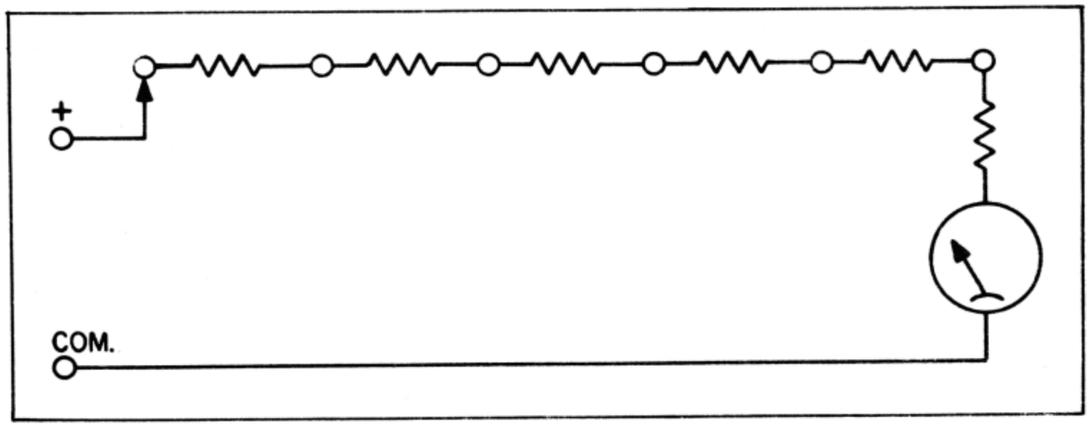

Figure 5. Simplified Schematic Diagram of a DC Voltmeter Circuit

A DC voltmeter circuit is a series circuit consisting of a meter and associated resistors. See figure 5. The resistors are chosen so that the current in the series circuit is such that full scale deflection of the meter is obtained when the applied voltage is equal to the full scale reading of the meter. To change ranges, the series resistance is changed by the SELECTOR switch.

AC VOLTMETER CIRCUIT

As indicated in figure 6, the function of the AC voltmeter circuit is the same as the DC voltmeter circuit except for the rectification of the AC current to provide DC current to operate the meter. The indicator in the Model 455B is a DC movement and the calibration is based on average AC voltage. If AC voltage were impressed across the input of the meter without rectification, the average current would be zero and the

meter could not respond. However, by rectifying the AC voltage, the current will always flow in one direction and the meter deflection will be a function of the average current flow. The meter scales for the AC ranges are calibrated in terms of RMS values.

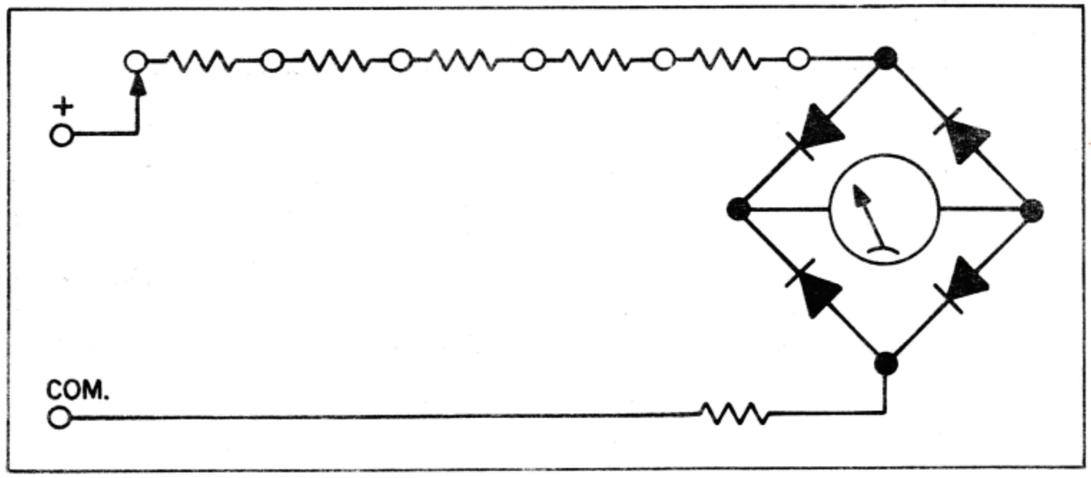

Figure 6. Simplified Schematic Diagram of an AC Voltmeter Circuit

MAINTENANCE

The Model 455B is manufactured to exacting requirements and should require no maintenance or repair other than replacing batteries or fuses and except in the case of physical damage by accident. It is suggested that if the instrument should require repair service, that the factory service department or one of our authorized service stations be contacted for service or advise.

REPLACING DRY CELL OR BATTERY

A dry cell of 1.5 volts (National Carbon Company, No. 950 or equal) and a 30 volt battery (National Carbon Company, No. 413 or equal), are used as the source of DC power in making ohmmeter measurements. If it is impossible to bring the METER to full scale deflection on the X1, X100, or X1K OHMS settings of the SELECTOR, it is probable that the 1.5 volt dry cell is weak. REPLACE IT. See below.

If the red RESET BUTTON does not pop up when the PROTECTION TEST jack is actuated, the 30 volt battery is too low in energy to trip the relay (K1) and therefore, will not protect the METER against possible overload damage. REPLACE IT AT ONCE.

The dry cell or battery may be replaced without opening the case. To replace either of these, remove the four (4) screws holding the name plate on the bottom of the instrument thus exposing both to view. Remove either or both and replace, observing the proper polarity as stamped on the case.

REPLACING FUSES

Two spare fuses, 0.5A and 1.5A, are located under the name plate on the bottom of the instrument. Remove the name plate and select the proper fuse. The 0.5A fuse is replaced by removing the fuse holder in the bottom of the instrument as shown on the bottom. The 1.5A fuse is located beneath the + (plus) jack on the top of the instrument. See figure 1. Unscrew the jack. Turn the case over and the fuse will fall out. Check the new fuse for current rating (1.5A) and replace. Replace jack.

NOTES

PARTS LIST

INTRODUCTION

Reference designations are assigned to identify all parts of the Model 455B, Volt-Ohm-Milliammeter. These designations are used in parts list and the schematic wiring diagram, as well as, in the text. The letter prefix of a reference designation indicates the kind of part — battery, capacitor, transistor, resistor, etc. The number of the reference designation indicates the particular part as shown on the schematic wiring diagram.

Ref. Desig.	Name and Description	Hickok Part No.	Price Each
BT1	BATTERY: 1-1/2V, size D, National Carbon	2210-2	.60
BT2	BATTERY: 30V, #413 Eveready "B" Min. Max.	2210-17	3.10
C1	CAPACITOR, FIXED: .1μF, 600V	3105-207	.63
CR1	SEMI-CONDUCTOR DEVICE, DIODE: SS2	3870-146	1.01
CR2	RECTIFIER: full wave, copper oxide, 3" leads	18150-42	2.46
F1	FUSE: .5 Amp, .9Ω resistance, .2 tol.	6900-23	.60
F2	FUSE: 1.5 Amp	6900-22	.55
K1	RELAY ASSEMBLY	18400-5	10.17
M1	METER	660-175	36.40
MP1	KNOB: molded, selector, black phenolic	11505-75	.66
MP2	KNOB: molded, ohm adjust, black phenolic	11505-76	.63
Q1	TRANSISTOR: 2n3644 PNP high B, high voltage general purpose, silicon	20861-107	1.55
Q2	TRANSISTOR: 2n3566 NPN silicon, general purpose	20861-122	.89
Q3	Same as Q2		
R1	RESISTOR, FIXED, FILM: 240KΩ, 1%, 1/2W	18537-56	1.26
R2	RESISTOR, FIXED, FILM: 900kΩ, 1% 1/2W	18537-53	.66
R3	RESISTOR, FIXED, FILM: 1.8MΩ, 1% 1/2W	18538-1	.66
R4	RESISTOR, FIXED, FILM: 9MΩ, 1%, 1W	18539-6	.95
R5	RESISTOR, FIXED, FILM: 12MΩ, 1%, 2W	18540-1	1.19

Ref. Desig.	Name and Description	Hickok Part No.	Price Each
R6	RESISTOR, METAL FILM: 3.4Ω, 1%, 1W	18550-160	2.02
R7	RESISTOR, FIXED, FILM: 510Ω, 1%, 2W	18540-2	1.01
R8	RESISTOR, FIXED, FILM: 6.325KΩ, 1% 1/2W	18537-3	.66
R9	RESISTOR, FIXED, FILM: 900Ω, 1%, 1/2W	18537-4	.66
R10	RESISTOR, FIXED, FILM: 15.6KΩ, 1% 1/2W	18537-5	.66
R11	RESISTOR, FIXED, COMPOSITION: 22KΩ, 5%, 1/2W	18413-221	.47
R12	Same as R11		
R13	RESISTOR, CARBON FILM: 90Ω, 1% 1W	18550-152	.92
R14	RESISTOR, FIXED, FILM: 19KΩ, 1%, 1/2W	18537-6	.66
R15	Same as R11		
R16	RESISTOR, FIXED, FILM: 498KΩ, 1% 2W	18540-3	1.01
R17	RESISTOR, SPOOL, SMALL: 9Ω, 1%	18670-105	.99
R18	RESISTOR, SPOOL, SMALL: .9Ω, 1%	18670-101	1.20
R19	SHUNT: .1Ω, 10 Amp	19210-79	.88
R20	RESISTOR, FIXED, FILM: 55.6KΩ, 1% 1/2W	18537-7	.66
R21	RESISTOR, FIXED, FILM: 3640Ω, 1%, 1/2W	18537-8	.66
R22	RESISTOR, FIXED, COMPOSITION: 56KΩ, 10%, 1/2W	18413-562	.40
R23	RESISTOR, FIXED, COMPOSITION: 51KΩ, 5%, 1/2W	18413-511	.47
R24	RESISTOR, FIXED, COMPOSITION: 27KΩ, 10%, 1/2W (calibration)	18413-272	.40
R25	RESISTOR, FIXED, COMPOSITION: 1000Ω, 5%, 1/2W	18412-101	.52
R26	RESISTOR, FIXED, COMPOSITION: 3600Ω, 5%, 1/2W	18412-361	.47
R27	RESISTOR, VARIABLE: composition, 50KΩ, linear taper	16925-258	1.40
R28	RESISTOR, VARIABLE: wire wound, 1.5KΩ	16925-266	.58
S1	SWITCH: rotary, 4 section, 21 positions	19912-616	9.00
W1	LEAD ASSEMBLY: black	12450-292	2.53
W2	LEAD ASSEMBLY: red	12450-293	2.56
	BOOKLET: instructions	2490-567	3.00

HICKOK 455B

ALT.	DRAWING NUMBER
B	900-132W