OPERATOR'S MANUAL

VOLT-OHM-MILLIAMMETER

"THE HAMMETER"

SIMPSON MODEL 240

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SIMPSON ELECTRIC COMPANY

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Figure 1. Simpson Model 240 Hammeter.

SECTION I

GENERAL DESCRIPTION

THE SIMPSON MODEL 240 VOLT-OHM-MILLIAMMETER, as shown in figure 1, is popularly known as the *"HAMMETER".* This is true because it was designed to serve the needs of *Hams* (Amateur Radio Operators) when they check the circuits in their *transmitters and receivers.* The same types of measurement and ranges which you get with this instrument make it also fit the requirements of *many other applications,* such as *aircraft* and *marine maintenance, telephone,* and *teletype servicing, line voltage checking,* and many others.

There are convenient ranges for measuring *DC voltage, current,* and *resistance,* and *AC voltage.* All the ranges and circuits are arranged easily and quickly with the range switch at the bottom of the front panel. The test leads connect into circuit jacks on the front panel, and are used to contact the source of electrical characteristics which you will measure.

THE MODEL 240 HAMMETER can measure *higher voltage,* both DC and AC, than any other *pocket size portable* Volt-Ohm-Milliammeter. This is one of the reasons why it is especially adapted to the needs of an amateur radio operator; he will have high voltages, both DC and AC, in his transmitter which he will have to test periodically. It is a convenience for him to be able to use the same instrument for this special application as will also help him with all his other *test and service applications.* It is especially convenient when he has all the components for the high voltage circuits present *inside the case* of the instrument rather than in an *accessory* which is hard to find when it is needed. The *HAMMETER* is entirely *self contained,* and does not require any such *external accessory* for high voltage measurements.

1. PHYSICAL DESCRIPTION

The *MODEL 240* measures only 3" wide by 5-7/8" high by 2-1/2" deep. It is furnished complete with a pair of test leads, one red and the other black for easy polarity identification. The net weight is only 1-1/4 pounds.

The *3 inch indicating meter* is one of the famous *SIMPSON INSTRUMENTS THAT STAY ACCURATE.* It has a sensitivity of *400 microamperes DC,* an internal resistance of *365 ohms,* and a special dial calibrated for all the measuring circuits of the instrument. The meter is *very rugged* and will withstand many years of use without showing any signs of wear. However, the parts are made to fit together with the precision of a fine watch, and they can be *damaged by careless handling.* Be careful to prevent your *MODEL 240 HAMMETER* from receiving *any unnecessary*

shocks. If you treat your instrument with care, it will reward you with many years of *trouble-free service* and *accurate indications* of the values which you measure.

There are two knobs on the front panel. One is for the *RANGE* switch. This has twelve positions, each marked for the circuit and the range which it will set up in the instrument. The second is the *ZERO OHMS* control knob. This operates a continuously variable resistor which will allow you to *compensate for aging of the internal battery* when you are making resistance measurements.

There are four contact jacks on the front panel into which you will connect the test leads. There are *three combinations* of these contact jacks which *set up the circuits* which you will require according to their use. The combinations are as follows:

1. For either DC or AC voltage up to 750 volts, and for DC current, use the two contacts at the *left hand side* of the front panel. Connect the *black* test lead in the jack marked *-VOLTS M.A. 3000 V.*, and the *red* test lead in the jack marked *+VOLTS M.A. OHMS.*

2. For either DC or AC voltage between 750 and 3000 volts, use the contact jack on the *lower left* and the one on the *upper right.* Connect the *black* test lead in the jack marked *-VOLTS M.A. 3000 V.*, and the *red* test lead in the jack marked *+3000 V.*

3. For resistance measurements, use the low-

er right contact jack and the *upper left* contact jack.

The test leads are a little over 4 feet long. Each has a special elbow prod on one end which will fit into the contact jacks. On the other end is a crocodile clip termination, covered with a flexible plastic insulator. Either clip the leads to the test points in the circuit which you are measuring, or hold the ends on the test points for momentary contacts.

CAUTION: Do not hold the test leads while you measure high voltage. Connect the leads to the circuit to be measured while the power is turned off; then turn on the power while you measure the voltage. Turn off the power before you reach in to disconnect the leads again.

Inside the *lower half* of the instrument case are all the *resistors*, the *rectifier*, and the *battery*, which make up the circuits for the various ranges. This half of the instrument can be re*moved* for trouble shooting and repair when it is necessary. *Remove the four screws* through the *back of the case* and pull the lower half of the instrument straight out of the case. All the components will come out with the front panel.

Since all repair to the meter portion of the instrument should be *performed only by qualified repairmen* with the proper tools, the top half of the instrument is sealed. This contains the *indicating meter*. Do not attempt to take this part

out of the case. If any repair is necessary, return the entire *MODEL 240* to the repair department at the factory, or to your nearest *Official Simpson Repair Station*. Whenever you return an instrument to a repair station or to the factory, be sure to write a letter to explain exactly what you think is wrong with it and why. This will save *both time and money for you.* also indicate what you want the repair station to do, so they have the necessary authorization from you and can proceed with the repairs.

2. MEASUREMENT RANGES AVAILABLE.

a. DC Voltage

Range		Sensitivity
0-15	volts	1000 ohms per volt sensitivity
0-75	volts	
0-300	volts	
0-750	volts	
0-3000	volts	

b. AC Voltage (RMS Values)

Range		Sensitivity
0-15	volts	1000 ohms per volt sensitivity
0-150	volts	
0-750	volts	
0-3000	volts	

c. DC Resistance (M=1000)

0-3000 ohms (30 ohms center)
0-300,000 ohms (3,000 ohms center)

d. DC Current

0-15 milliamperes
0-150 milliamperes
0-750 milliamperes

SECTION II

OPERATING INSTRUCTIONS

CAUTION: When you measure voltages, as a protection to yourself, form the habit of turning off all power in the circuit where you wish to measure the voltage, connect the test leads in the circuit, and then turn on the power while you make the measurement. Then turn off the power before you disconnect the test leads again. Do not touch the leads while voltage is applied.

1. ZERO ADJUSTMENT

Before you make any measurements with your *MODEL 240 HAMMETER*, check to see that its *pointer indicates zero* with the instrument in its operating position. If the pointer is off zero, *adjust the screw* located in the bakelite meter case just below the center of the dial, as shown in figure 1. Use a *small screwdriver* to turn this screw either clockwise or counterclockwise until the pointer rests over the zero indications at the *left hand* side of the meter dial.

2. DC VOLTAGE MEASUREMENTS, UP TO 750 VOLTS.

a. Rotate the *range selector* knob at the bottom of the front panel until it indicates the range desired. These positions are marked *15 V.D.C.*, *75 V.D.C.*, *300 V.D.C.*, and *750 V.D.C.* The last

named position is also marked *3000 V.D.C.;* disregard this 3000 volt range for these instructions. *WHEN IN DOUBT OF THE VOLTAGE PRESENT, ALWAYS USE THE HIGHEST RANGE AS A PROTECTION TO THE INSTRUMENT.* After you observe the *first reading* to determine that a *lower range* may be used, set the range selector for the lower range.

b. Plug the elbow prod for the *black* test lead into the jack marked *–VOLTS M.A. 3000 V.* Plug the elbow prod for the *red* test lead in the jack marked *+ VOLTS M.A. OHMS.*

c. Connect the crocodile clip end of the *black* test lead to the *negative* side of the circuit which you are going to measure. Connect the crocodile clip for the *red* test lead to the *positive* side of the circuit.

d. *Turn on the power* in the circuit to be measured. If the pointer of the meter *deflects to the left of zero,* the lead *connections are reversed* with respect to the polarity of voltage which you expected. *Turn off the power, reverse the connection* of the test probes in the circuit, and then *turn on the power* again while you make the measurement.

e. Read the voltage indicated on the divisions of the *black arc marked D.C.* For the 15, 75, and 300 volt ranges, use the figures 0-15, 0-75, and 0-300 respectively, and *disregard* the red zeros. For the 750 volt range, use both *black and red* markings for the figures 0 to 750.

f. *Turn off the power* before you disconnect the test leads.

3. DC VOLTAGE MEASUREMENTS, 3000 VOLT RANGE.

a. Set the *range switch* at the position marked *3000 V.D.C.* This is also marked 750 V.D.C.; disregard the 750 volt range for these instructions.

b. Plug the elbow prod for the *black* test lead into the jack marked *–VOLTS M.A. 3000 V.* Plug the elbow prod for the *red* test lead into the jack *+3000 V.*

c. Connect the crocodile clip end of the *black* test lead to the *negative* side of the circuit which you are going to measure. Connect the crocodile clip for the *red* test lead to the *positive* side of the circuit.

d. *Without touching the meter or the leads,* turn on the power in the circuit which you are going to measure. If the pointer of the meter *deflects to the left,* the circuit polarity is opposite to that which you expected. *Turn off the power, reverse the test leads,* and then turn on the power again.

e. Read the voltage indicated on the divisions of the *black arc marked D.C.* Use both the black and the red figures for the range 0 to 3000.

f. *Turn off the power* to remove the voltage before you reach in and disconnect the test leads.

4. AC VOLTAGE MEASUREMENTS, UP TO 750 VOLTS.

a. Rotate the *range selector* knob at the bottom of the front panel until it indicates the range desired. These positions are marked *15 V.A.C., 150 V.A.C.,* and *750 V.A.C.* The 750 V.A.C.

position is also marked *3000 V.A.C.*; disregard the 3000 volt range for these instructions. *WHEN IN DOUBT OF THE VOLTAGE PRESENT, ALWAYS USE THE HIGHEST RANGE AS A PROTECTION TO THE INSTRUMENT.* After you observe the *first reading* to determine that a *lower range* may be used, set the range selector for the lower range.

b. Plug the elbow prod for the *black* test lead in the jack marked *– VOLTS M.A. 3000 V.* Plug the elbow prod for the *red* test lead in the jack marked *+ VOLTS M.A. OHMS.*

c. Connect the crocodile clips for the test leads to the *two sides of the circuit* which you wish to measure. For AC voltage measurements, you will not be concerned about the *polarity* of the test leads.

d. *Turn on the power* in the circuit which is to be measured.

e. Read the voltage indicated on the division of the *red arc marked A.C.* For the *15 volt range,* use the figures 0 *to 15*, and disregard the red zeros. For the *150 and 750 volt ranges,* use both the black and the red figures to get *0 to 150* and *0 to 750* respectively.

f. *Turn off all power* before you reach in to disconnect the test leads.

5. AC VOLTAGE MEASUREMENTS, 3000 VOLT RANGE.

a. Set the *range switch* at the position marked *3000 V.A.C.* This is also marked 750 V.A.C.; disregard the 750 volt range for these instructions.

b. Plug the elbow prod for the *black* test lead in the jack marked *– VOLTS M.A. 3000 V.* Plug the elbow prod for the *red* test lead in the jack marked + *3000 V.*

c. Connect the crocodile clips for the test leads to the *two sides of the circuit* which you are going to measure.

d. *Turn on the power* in the circuit which is to be measured *without touching* the meter or the test leads.

e. Read the voltage indicated on the divisions of the *red arc marked A.C.* Use both the *black and the red figures* for the range *0 to 3000.*

f. *Turn off the power* to remove voltage from the circuit before you reach in to disconnect the test leads.

6. DC RESISTANCE MEASUREMENTS.

CAUTION: Before you make any resistance measurements in an electrical or electronic circuit, be sure the power is off and all capacitors are discharged, so no voltage exists in the circuit. Otherwise you may damage the meter circuits.

a. Rotate the *range selector* switch knob at the bottom of the front panel until it indicates the range desired for resistance measurement. These ranges are marked *R.* and *R×100.*

b. Plug the elbow prod for the *black* test lead in the jack marked – *OHMS.* Plug the elbow prod for the *red* test lead in the jack marked + *VOLTS M. A. OHMS.*

c. *Short the crocodile clips* to each other. While they are *connected together,* rotate the *ZERO OHMS* knob in the center of the instrument above the range switch. The pointer will move back and forth as you rotate the knob. Set it for a *zero ohms* indication, at the *right hand* end of the dial.

d. Separate the test leads and connect them across the resistance or the portion of a circuit which is to be measured. The *more accurate* resistance indication is given on the range which provides a reading nearest center scale.

e. Read the value indicated on the *black arc* at the top of the dial, which is marked *OHMS.* Note that this scale *increases from right to left.* For the *R.* range, read the resistance directly on the *OHMS* arc (M=1000). For the *R×100* range, read the indication on the OHMS arc and *multiply the reading by 100* (add two zeros).

See instructions in Section V for measuring resistances *greater than 300,000 ohms.*

7. DC CURRENT MEASUREMENTS.

CAUTION: Never connect the test leads directly across any source voltage when your MODEL 240 is set for current measurements. This will damage the instrument. Always connect the meter in series with the load across a source of voltage.

a. Rotate the *range selector* knob at the bottom of the front panel until it indicates the *range desired* for current measurements. These positions are marked *15 M.A., 150 M.A.,* and *750 M.A. WHEN IN DOUBT OF THE CURRENT PRESENT, ALWAYS USE THE HIGHEST RANGE AS A PROTECTION TO THE INSTRUMENT.* After you have observed the *first reading* to determine that a *lower range* may be used, set the range switch for the lower range.

b. Plug the elbow prod for the *black* test lead into the jack marked – *VOLTS M.A. 3000 V.* Plug the elbow prod for the *red* test lead in the jack marked + *VOLTS M.A. OHMS.*

c. *Open the circuit* in which the current is to be measured. Connect the *MODEL 240 in series* with the circuit. Connect the *red* test probe on the *positive* side of the circuit and the *black* test probe on the *negative* side.

d. *Turn on the power* in the circuit which is to be measured. If the pointer of the meter is deflected *to the left,* circuit current is flowing in the *opposite direction* to which you expected. *Turn off* the power, *reverse* the lead connections, and then *turn on the power* again.

e. Read the current values on the *black arc* of the meter marked *D.C.* For the *15 milliamperes* range, use the figures *0 to 15* and disregard the red zeros. For the *150 and 750 milliamperes* ranges, use both the *black and the red* figures.

f. *Turn off the power* before you disconnect the test leads.

g. *Connect the circuit together* where you have opened it to make the current measurement.

SECTION III

FUNCTIONING OF PARTS

The complete schematic diagram for the *MODEL 240 HAMMETER* is shown in figure 7. The *simplified sections* which are used for each of the four types of measuring circuits which you can set up with the *HAMMETER* are shown in figures 2 through 5.

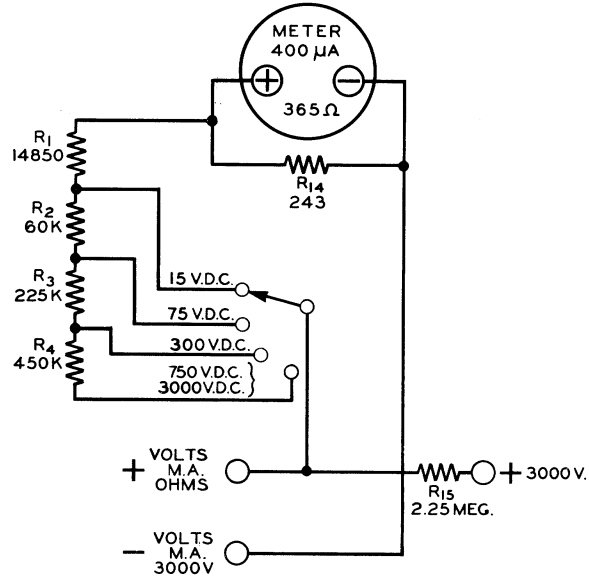

Figure 2. Simplified DC Voltmeter Circuit.

Figure 2 shows the portion of the *internal components* of the *MODEL 240* which you will use for *DC voltage* measurements. Only the four positions of the range switch which connect the DC voltage measuring circuits are shown. The switch is in the *15 V.D.C.* position. Voltage which is to be measured is applied to the + *and* – *VOLTS jacks* through the test leads, and to the complete circuit through the meter and resistor R1 in series. Resistor R14, in parallel with the meter, adjusts the circuit sensitivity to 1 milliampere DC. The total circuit resistance for the *15 V.D.C.* range is *15,000 ohms.* If 15 volts is applied to the circuit between the test leads, there will be *1 milliampere of current* through the circuit. This will cause full scale deflection of the meter, and is interpreted as 15 volts. If some *fractional part of 15 volts* is applied, a proportional *fraction of full scale deflection* will result from the proportional amount of current which will flow. The *black* division markings on the *D.C. arc* of the meter will help you read the amount of voltage which is causing the deflection.

When the range switch is set at *any other V.D.C.* position, more resistance is added in series with the meter, so that *more voltage is required* for the same deflection. For each range, the total circuit resistance is *1000 ohms per volt,* and *1 milliampere* of circuit current will cause full scale meter deflection when the applied voltage is equal to the value of the range. *Fractional parts* of applied voltage will cause *proportional deflections.*

For the *3000 volt* range, the range switch is set at *750 V.D.C., 3000 V.D.C.,* and the *red* test lead is plugged into the jack marked *+ 3000 V.* Resistor *R15* is then in series with *R4, R3, R2, R1,* and the *meter* circuit. The total circuit resistance is *3 megohms.*

Figure 3 shows the portion of the *internal parts* which are used for *AC voltage* measurements. Only the three positions of the range switch which connect the circuit for AC voltage measurements are shown in this diagram. The switch is shown in the *15 V.A.C.* position. Voltage which is to be measured is applied through the test leads to the *+ and − VOLTS jacks.* The rectifier is connected

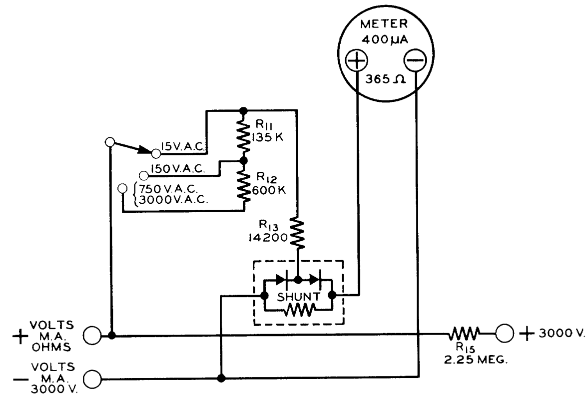

Figure 3. Simplified AC Voltmeter Circuit.

so that it will allow current to flow *only one direction* through the meter, but *both directions* through the instrument circuit. When an AC voltage is applied to the test leads, current will flow during *both halves of each cycle,* but it will flow through the meter on *one half cycle* and through the bypass circuit around the meter on the *other half cycle.* The pointer will be deflected by the *average* amount of current during the *half cycle* when it flows *through the meter.* The amount of deflection indicates the RMS value of applied voltage, assuming that the input is a *sine wave.*

The resistor which is marked *SHUNT* in figures 3 and 8 is a value which *matches the characteristics* of each individual *rectifier.* Since its value varies through a wide range, no attempt is made to give a typical value. Collectively, the resistance of the *AC voltage* circuit is *1000 ohms per volt.*

For the *3000 volt* range, the range selector switch is set at *750 V.A.C., 3000 V.A.C.,* and the *red* test lead is connected in the + *3000 V. jack.* Resistor *R15* is then in series with the rest of the meter circuit, the *rectifier,* and multipliers *R11, R12, and R13.*

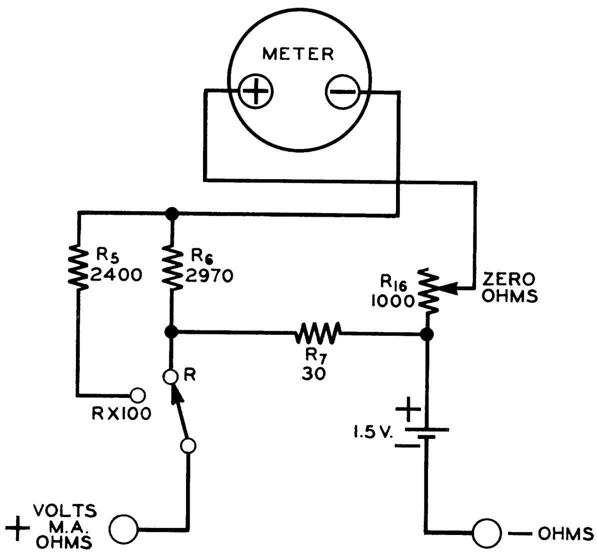

Figure 4. Simplified Ohmmeter Circuit.

Figure 4 shows the portion of the *internal parts* of the *MODEL 240* which are used for measuring *DC resistance.* Only the two range switch positions which are used for resistance measurements are shown, and the switch is in the *R. position.* For this position, values of resistance in ohms are read *directly on the meter* dial.

There is a *1.5 volt battery* inside the case of the instrument which furnishes power for resistance measurements. When the test leads, connected in the + *VOLTS M.A. OHMS* and the −*OHMS* jacks, are connected across any continuous circuit, the battery will send current through the the circuit. Part of the current will also pass *through the meter* to cause deflection.

In the circuit shown in figure 4, the meter, in series with resistors *R6 and R16,* is in parallel with *R7.* The *total resistance between the test leads* is 30 ohms. When you short the test leads together, the battery sends enough current through the meter to cause *full scale deflection.* Resistor R16, *ZERO OHMS,* will compensate for *normal variations* due to *battery aging.* Now if you connect the test leads across *any amount of resistance* the total circuit current is less, and the current through the meter is less. This will cause *less deflection,* which indicates the *number of ohms added* between the test leads when you read the *OHMS* scale on the dial. For example, if you add 30 ohms between the test leads, the total circuit *resistance is doubled,* and current flowing through the circuit is *half as great.* With half as much current flowing, you get half as much pointer deflection. When the pointer is at half scale, it indicates 30 ohms.

When you set the range switch at *R×100,* you connect an internal circuit with a resistance of *3000 ohms.* The meter can still be set for full scale deflection when you short the test leads together. Use the *ZERO OHMS* control for this. Now it is necessary to connect the test leads across *3000 ohms of external resistance* in order to reduce the meter current to half as much, and to get *half scale deflection.*

Other resistances added between the test leads will regulate the meter current to allow an indication of the amount of resistance for each measurement. Whenever the pointer remains at the left hand side of the dial, where the *OHMS* scale is marked ∞, this indicates an *open circuit.* The marking is *"infinity".*

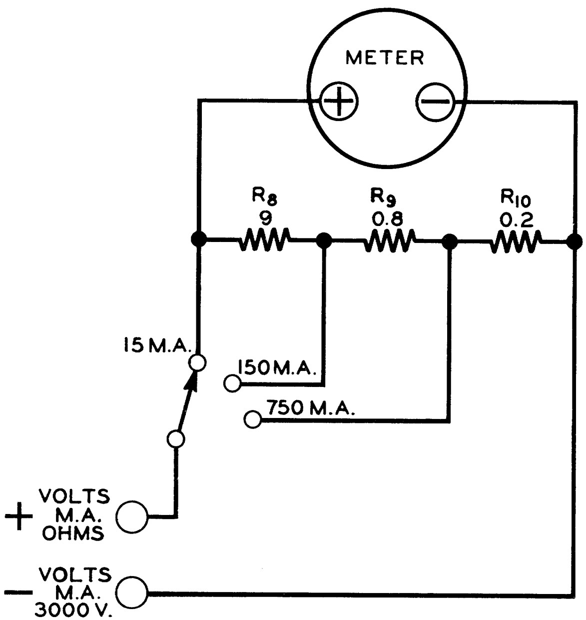

Figure 5. Simplified DC Milliammeter Circuit.

Figure 5 shows the *portion of the circuit* which is used for all *DC current* measurements. Only the three switch positions which are used for measuring DC currents are shown in this diagram.

Resistors *R8, R9,* and *R10* form a *ring shunt* in parallel with the meter movement. Some *proportional part* of the current through the circuit between the test leads will pass *through the meter.* Pointer deflection is proportional to the amount of current which passes through the meter, and this is in turn proportional to the current through the entire circuit. The amount of *circuit current* is indicated on the *meter dial.*

SECTION IV

MAINTENANCE

1. PLACEMENT OF COMPONENT PARTS.

All the component parts of the circuits in the *MODEL 240 HAMMETER,* except the meter, are available when you *remove the lower half* of the instrument from the case as shown in figure 6. Remove the *four mounting screws* through the back of the case and then pull the lower half of the instrument straight forward out of the case. Note the two *spring contacts* on the lower side of the meter portion of the instrument inside the case. When the removable portion is in place within the case, these connect the *mated contacts* on the edge of the *terminal board,* and make the two connections for the meter circuit.

All the component parts of the circuit except resistor *R15* and *ZERO OHMS* control *R16* are mounted on the back of the terminal board as shown in figure 6. They are attached to the terminal board with their wire leads. The *rectifier* is

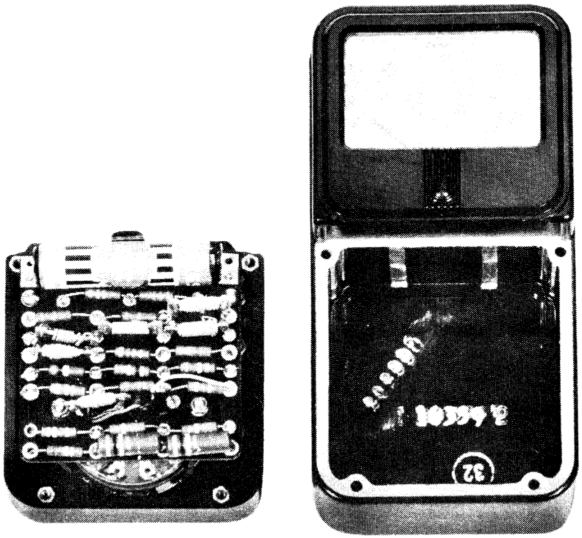

Figure 6. Model 240 with Case Opened to Show Internal Components.

also attached to this *terminal board.* Resistors *R7, R8, R9, R10,* and the *SHUNT* are all *wire wound* bobbins. The other resistors are all fixed value commercial types with *very close tolerances* to assist in *maintaining the accuracy* of the instrument for all its measuring ranges and circuits.

If the *SHUNT* resistor or the rectifier needs to be replaced, *both items must be replaced as a unit.* Each *rectifier* has its own *forward* and *reverse* resistance, and the shunt resistor *is matched* to the individual requirements of each rectifier.

2. BATTERY REPLACEMENT.

The *1.5 volt dry cell* inside the case of the *MODEL 240* is used for *resistance* measurements. It is shown in figure 6, and is attached to the inside of the case in a *battery clip with spring terminals.* During its normal use-life, the battery will *gradually increase* its internal resistance. This will result in a *decrease of terminal voltage* under normal load. The *variable resistance* in series with the meter for resistance measurements, called *ZERO OHMS,* will adjust the meter sensitivity through a wide range to *compensate for aging of the battery.* When you can no longer bring the pointer to zero at the right hand end of the dial, the *battery must be replaced* with a new one.

Remove the *lower half* of the instrument from the case, as shown in figure 6. *Note the polarity* of the old battery to be sure that the new battery is placed in position for the *same polarity connections.* Pull the old battery out of the clip and place a fresh No. Z, 1.5 volt cell in the same position in the clip. *Be sure that its positive post contacts the spring terminal at the right* *hand side* (as you view the clip from the rear), and that the *negative end* of the case presses against the spring terminal at the *left hand side.* Replace the bottom half of the instrument in the case and fasten it with the four screws through the case back.

3. PARTS LIST.

	DESCRIPTION	SIMPSON PART NO.
R1	Resistor, 14,850 ohms, 2%	1-112522
R2	Resistor, 60,000 ohms, 2%	1-112523
R3	Resistor, 225,000 ohms, 2%	1-112524
R4	Resistor, 450,000 ohms, 2%	1-112525
R5	Resistor, 2400 ohms, 2%	1-112521
R6	Resistor, 2970 ohms, 2%	1-112520
R7	Resistor, 30 ohms, bobbin	0-008082
R8	Resistor, 9 ohms, bobbin	0-008068
R9	Resistor, 0.8 ohm, bobbin	0-008054
R10	Resistor, 0.2 ohm, bobbin	0-008050
R11	Resistor, 135,000 ohms, 2%	1-112519
R12	Resistor, 600,000 ohms, 2%	1-112518
R13	Resistor, 14,200 ohms, 2%	1-112526
R14	Resistor, 243 ohms, bobbin	0-008096
R15	Resistor, 2.25 megohms, 2%	1-111651
R16	Potentiometer, 1000 ohms, ZERO OHMS	1-112588
	Battery (Everyready or Burgess No. Z Cell)	1-111802
	Knob for Zero Ohms control	1-114949
	Knob for range switch	3-262871
	Rectifier assembly (with shunt resistor)	0-008580
	Test leads, pair	0-008375

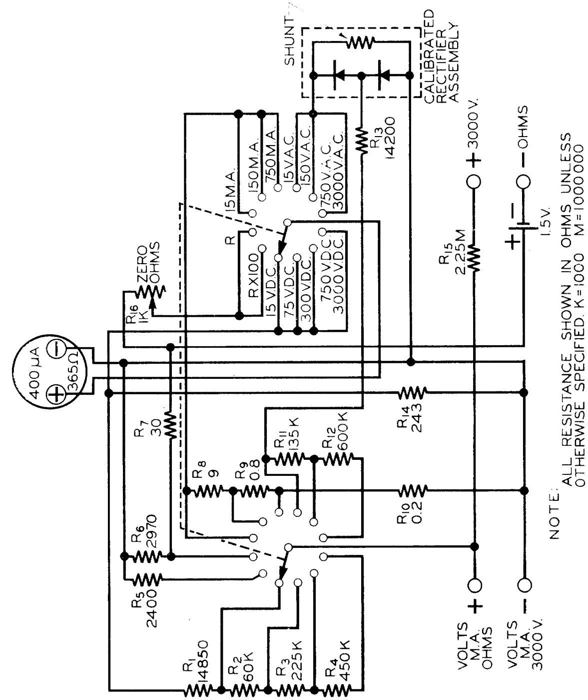

Figure 7. Model 240 Hammeter, Overall Schematic Diagram.

SECTION V

SPECIAL APPLICATIONS

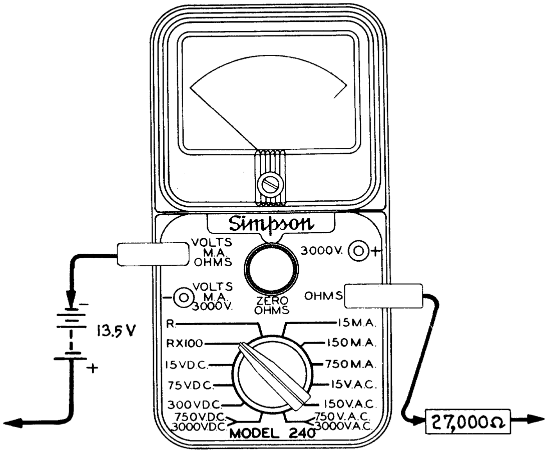

Figure 8. Increasing the Resistance Ranges.

1. MEASURING HIGH RESISTANCE.

With the aid of a circuit such as shown in figure 8, you can measure *resistance values* up to *3 megohms.* Set the range switch at *R×100.* The range which you set up will be *R×1000,* so multiply the reading which you get on the *OHMS* scale of the dial by *1000* (add three zeros). Use whatever combination you may have available to make up *13.5 volts,* which is *9 cells in series.* One combination would be three 4.5 volt batteries in series. Another would be two 6 volt batteries and one 1.5 volt cell all in series. Still another way to get it is to use two bias batteries with five cells each, which have taps at each 1.5 volts; use the entire 7.5 volts from one battery and four cells (6 volts) from the second, *connected in series.*

The resistance is indicated as *27,000 ohms,* and any value close to that amount will provide satisfactory indications with your ohmmeter. The closer you get to 27,000 ohms, the *more accurate* your values will be, but that is not usually necessary for resistance readings. This does not have to be a single resistor, but can be *any combination* which will produce a series resistance of 27,000 ohms.

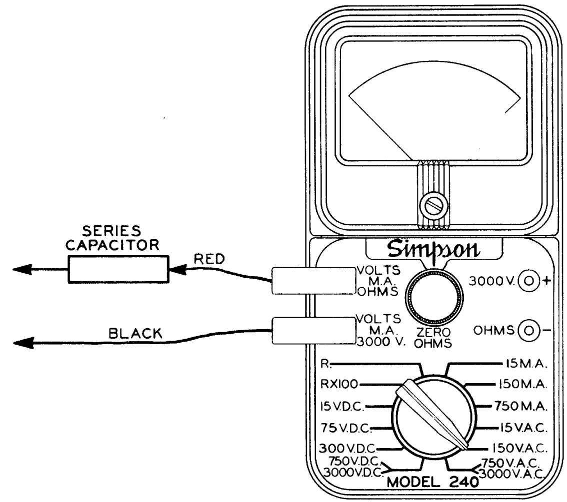

Figure 9. Circuit for Measuring Output Voltages.

2. MEASURING OUTPUT VOLTAGES.

Output voltage is the name given to the AC portion of mixed *AC and DC voltages.* It is the signal voltage at the *plates of amplifier tubes,* and the *ripple voltage* on the DC power supply. To measure the AC portion separately, connect a *blocking capacitor* as shown in figure 9, and set the *HAMMETER* for A.C. voltage measurements. Use a capacitor with a value of *0.25 or 0.5 microfarad,* and with a working voltage equal to or greater than the combined DC and AC values.

The capacitor will *block the DC voltage,* but will allow the AC voltage to send a current through the measuring circuits of the *HAMMETER.* This is measured the same as *AC voltage;* use the instructions in Section II.

3. THE RADIO AMATEUR AND HIS VOLT-OHM-MILLIAMMETER.

There are many operations which can and should be performed around the radio amateur's transmitter, receiver, and associated equipment, but are not. The *HAMMETER* will furnish the *necessary tool* for many of these jobs. By using it to its fullest advantage, a more satisfactory degree of *efficiency can be achieved.*

For *trouble shooting and repair,* standard procedures require that you check *voltages, currents,* and *resistances* in your circuits, and compare them to the expected amounts for known good operating circuits. The manufacturer of a *commercial receiver or transmitter* includes, as a standard part of his operating and maintenance instructions, a set of *expected voltages* and *resistances* at tube socket pins and at various other critical points in his circuit. If you have built your own equipment, it is very wise to make such a *tabulation of the values* in your own set. Do this while it is in good working order; then there will be information on which you can rely *for future servicing.*

To use the trouble shooting information, *measure the voltages* and *resistances* at points in the

circuit where you have *reference information.* When you find some *difference* between the amount which exists and the amount which you should have, you have located a *possible source of trouble.* The kind of trouble and the type of indication will dictate your next move. Almost every possible trouble in your *transmitter, receiver,* or *other associated equipment* can be identified with the ranges and measuring circuits of your *MODEL 240.*

Use your *HAMMETER* to determine the *power output* of your final amplifier stage in your transmitter. If you have a plate current meter for this stage, use it to measure the current. If there is no plate current meter in the transmitter, use your *MODEL 240* to measure this current. Open the lead to the final amplifier plate, and *insert the MODEL 240* in series with this lead. Set up the *MODEL 240 for current measurements* according to the instructions in Section II. Connect the *black* test lead to the *plate* of the tube and the *red* test lead to the *lead* which you disconnected from the plate circuit.

> *CAUTION: Be sure that the power is turned off while you make the necessary connections for this current measurement. When the circuit is connected, turn on the power while you read the current WITHOUT TOUCHING THE METER OR THE TEST LEADS. Voltage which is present at the plate of the final amplifier is usually dangerous to touch: it is present in the meter circuit during this measurement. Turn off the power before you disconnect the meter from the transmitter again.*

After you have finished measuring the plate current, be sure to *connect the circuit* as it was again, in order to resume operation.

Next, measure the *plate voltage.* Do this according to the instructions for measuring voltage in Section II. Be sure again to *connect and disconnect the meter leads* while the *power is off.* Your *MODEL 240* will measure any DC voltage up to *3000 volts,* and this is more than enough for all the voltage measurements in average equipment.

When you have both the *current* and *voltage values,* you can calculate the *plate power.* Power, measured in watts, is equal to volts times amperes. Multiply your two values together to get the power *delivered into the plate* of the final amplifier stage of your transmitter.

For maximum efficiency, neutralize the final amplifier stage. Ordinarily, there is a circuit in the transmitter for this purpose, but it needs periodic readjustment. Use your *MODEL 240 HAMMETER* to measure the results of adjusting the neutralizing capacitor. You will need an *accessory* which you will make according to the circuit in *figure 10.* You will need a 1N34 crystal and a 2000 uuf capacitor. This is a simple *detector circuit* with which you will change *RF energy to DC.*

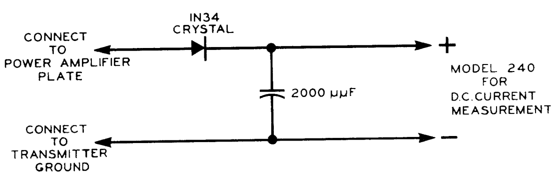

Figure 10. Accessory Detector Circuit for Transmitter Power Amplifier NEUTRALIZATION.

To use the accessory detector, *disconnect the B+* circuit for the final amplifier plate circuit and *connect the leads of the detector* as indicated, to the power amplifier tube plate and to ground in the transmitter. Connect the test leads of your *HAMMETER* across the output shown at the right. Set your *MODEL 240* for its *15 M.A.* range.

Now *turn on the power* for the transmitter. There is no DC voltage for the plate of the final amplifier because you have *disconnected the plate lead.* If the stage is not neutralized, there will be some *RF signal* fed through the *interelectrode capacity* in the tube to the plate. It will cause an indication on the meter if it is strong enough. Your adjustment will reduce this indication to a *minimum amount.* When the indication on the meter shows that the current is *less than 400 microamperes* (each scale division if 500 microamperes for this range), you can *increase the sensitivity* of the meter for the final adjustment. Remove the lower half of the instrument from its case and use the *meter movement alone.* As you look at the inside of the instrument in the position shown in figure 6, the *positive* spring contact for the meter is on the *right hand side.* The *negative* is at the *left.* There is no reading on the dial which corresponds to the 400 microampere range, but you are adjusting the plate neutralization circuit for a *minimum indication,* so the exact value is not necessary.

After you have neutralized the plate circuit, *turn off the power* and connect the lead to the plate again; the transmitter is ready to operate with *improved efficiency.*

There are many operating voltages which *you should check periodically* in your equipment. Set up a schedule for these operational checks and maintain it. You will be able to *detect and pre-*

dict a developing fault, and then you can eliminate it before it causes any expensive damage in your equipment. Use your *MODEL 240* to measure *any and all voltages* for which you do not have meters on the front panels of your equipment.

Tuning procedures require grid and plate current measurements for accuracy. Use your *HAMMETER* for these applications, too.

For the amateur who builds his own transmitter or receiver, there is a *variety of uses for the HAMMETER.* Of course, checking *continuity* and *resistance* of all circuits *before applying any voltage* is an obvious use during construction. When the power is first applied, use your *HAMMETER* to analyze general *circuit operation.*

In short, there are many *special uses* for your *HAMMETER* around your "shack". Its ranges are *ideal for these application.*

WARRANTY

SIMPSON ELECTRIC COMPANY warrants each instrument and other articles of equipment manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any instrument or other article of equipment which shall within 90 days after delivery of such instrument or other article of equipment to the original purchaser be returned intact to it, or to one of its authorized service stations, with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and SIMPSON ELECTRIC COMPANY neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products.

This warranty shall not apply to any instrument or other article of equipment which shall have been repaired or altered outside the SIMPSON ELECTRIC COMPANY factory or authorized service stations, nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation or use not in accord with instructions furnished by the manufacturer.

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