RCA Ultra-Sensitive DC MICROAMMETER

Type WV-84A

- Specifications
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- Applications
- Maintenance

RADIO CORPORATION of AMERICA

TEST AND MEASURING EQUIPMENT — HARRISON, N. J.

Safety Precautions

The metal case of this instrument is connected to the ground of the internal circuit. Wherever it is practical, the LOW terminal should be connected to the ground of the circuit under test. If it should be necessary to connect the LOW terminal to a point other than ground potential, the case of the instrument will be at the same potential as the LOW terminal. Extreme caution should be observed to prevent contact between the case of the instrument and a ground point.

An important point to remember is that there is always danger inherent in working with electrical circuits which operate at hazardous voltages. Therefore, the operator should thoroughly familiarize himself with the circuit under test, bearing in mind that high voltages may appear at unexpected points in defective equipment. Additional precautions which the operator should observe are listed below.

1. It is good practice to remove power before connecting test leads to high-voltage points. If this is impractical, be *especially careful* to avoid accidental contact with equipment racks and other objects which can provide a ground. Working with one hand in your pocket and standing on a properly insulated floor lessens the danger of shock.

2. Filter capacitors may store a charge large enough to be hazardous. Therefore, discharge filter capacitors before attaching test leads.

3. Remember that leads with broken insulation provide the additional hazard of high voltages appearing at exposed points along the leads. Check test leads for frayed or broken insulation before working with them.

4. To lessen the danger of accidental shock, disconnect test leads immediately after test is completed.

5. Remember that the risk of severe shock is only one of the possible hazards. Even a minor shock can place the operator in hazard of more serious risks such as a bad fall or contact with a source of higher voltage.

6. The experienced operator continuously guards against injury and does not work on hazardous circuits unless another person is available to assist in case of accident.

ITEMS

Supplied with WV-84A

1 Resistor, 50 megohms, ±1%, 2 W.....Stock No. 97181
1 Resistor, 950 megohms, ±2%, 6 W.....Stock No. 57977
1 Warranty Certificate
1 Registration Card
1 Instruction Book
2 RCA-3S4 tubes

Battery Complement
Required but not supplied

2 RCA-VS106 1½ Volts
2 RCA-VS102 22½ Volts

Instr. WV-84A (2) 2-53
Photolithographed
in U. S. A.

General Description

The RCA Ultra-Sensitive Microammeter is a battery operated vacuum-tube microammeter designed for measuring minute currents. When used with the external multiplier resistors which are supplied with the instrument, the WV-84A may be used as a high-resistance voltmeter with an input resistance of at least 100 megohms per volt. The instrument may also be used as a megohmmeter which will measure resistances from 900 to 90000 megohms.

Circuit features of the WV-84A include, negligible loading of the circuit under test, with only a ½-volt drop required for full scale deflection of the meter; and an amplifier which limits the current flow through the meter. This feature protects the meter against burnout. In addition, the self contained power supply makes the instrument completely portable. The use of low-drain filament tubes, and a circuit designed to use low plate current, makes for long battery life.

The WV-84A is an extremely useful instrument which has wide applications in research laboratories in many fields. Experiments involving feeble currents in the fields of electronics, chemistry, biology and nucleonics, as well as manufacturing and servicing, will be facilitated by this versatile instrument. The WV-84A when used as a voltmeter, is particularly suited to measurements where circuit loading is a critical factor. As an ohmmeter, extremely high resistances, such as leakage and insulation resistance, are quickly and accurately measured.

Specifications

Electrical

DC Microammeter:

Ranges, six ..... 0 to 0.01, 0.1, 1, 10, 100, 1000 μa

Input Resistance

X.01 μa Range	50 megohms
X0.1 μa Range	5 megohms
X1.0 μa Range	0.5 megohms
X10 μa Range	50000 ohms
X100 μa Range	5000 ohms
X1000 μa Range	500 ohms

Over-all Accuracy

On X.01 Range	±5% of full scale
On all other ranges	±4% of full scale

Voltage drop on all ranges ..... 0.5 volts

DC Voltmeter:

(When used with external multiplier resistors supplied with the instrument.)

Ranges, three ..... 0 to 1, 10, 100 volts

Input Resistance

0 to 1-Volt Range	100 megohms
0 to 10-Volt Range	1000 megohms
0 to 100-Volt Range	1005 megohms

Megohmmeter:

(When used with two RCA-VSO55 batteries, not supplied with instrument.)

Ranges, two ..... 900 to 9000, 9000 to 90000 megohms
Tube Complement ..... Two RCA-3S4
Battery Complement (Not supplied with instrument)
"A" Battery ..... 2 RCA-VS106 1½ volts
"B" Battery ..... 2 RCA-VS102 22½ volts

Mechanical

Over-all Dimensions

Height ..... 9½ inches
Width ..... 6¼ inches
Depth ..... 5-11/16 inches
Weight ..... 9½ pounds (including batteries)
Finish ..... Blue-grey hammeroid case
Satin-aluminum panel

Functions of Controls and Terminals

SELECTOR switch—Has two functions; turns the power off in the "OFF" position, provides a means of reversing the meter connection.

RANGE switch—Permits the choice of the range for the desired current measurement.

ZERO ADJ control—Used to position the meter pointer at the zero mark on the meter scale.

HIGH terminal—The point of higher potential of the circuit to be measured should be connected to this terminal, by means of any convenient lead.

LOW terminal—Is connected to the chassis and case of the instrument. If the LOW terminal is not connected to a ground point in the circuit under test it is necessary to observe caution as the case of the WV-84A will not be at ground potential. (See "Safety Precautions," page 2.)

Operation and Applications

Preliminary Adjustment

1. Set the RANGE switch to "X 1000" and the SELECTOR switch to "+".
2. Adjust the ZERO ADJ control until the meter reads zero.
3. Rotate the SELECTOR switch to "—". If the pointer moves away from zero, refer to the Maintenance section for corrective measures. Return switch to "+" position.

The instrument is now ready for use.

Direct-Current Measurements

1. Remove power from the equipment in which the measurement is to be made.
2. Break the circuit to be measured at a convenient point. Connect the LOW terminal of the instrument to the point of lower potential, and the HIGH terminal to the other point. (See "Safety Precautions' page 2.) The WV-84A should now be in series with the circuit to be measured.

3. Apply power and observe the reading.

4. If necessary, switch the RANGE control so that the reading is nearest to full-scale deflection of the pointer.

Microammeter Applications

The RCA Ultra-Sensitive DC Microammeter is useful in applications where exceedingly small dc currents must be measured. Applications include weak-current measurements in the iconoscope, the image orthicon, electron multipliers, transistors, and similar devices.

The WV-84A has a wide variety of uses in research laboratories conducting experiments in chemistry, biology, medicine, electronics, and radiation. It is useful in calculating contact potentials and in pH measurements. As a precision measuring instrument, it also serves for checking currents in light meters, in ultra-violet and infra-red detectors, and in photospectrometric devices. Because of its high degree of accuracy and its easy to read meter, it can often replace the galvanometer in bridge circuits.

DC Voltage Measurements

When used with the external multiplier resistors which are supplied with the instrument, the WV-84A can be used as a dc voltmeter with an input resistance of 100 megohms on the 1-volt range, 1000 megohms on the 10-volt range, and 1005 megohms on the 100-volt range. The sensitivity of the instrument is 100 megohms per volt on the 1 and 10-volt range, and 10 megohms per volt on the 100-volt range.

1-Volt Range

1. Connect the 50-megohm Multiplier Resistor (Stock No. 97181) in series with the input of the HIGH terminal, as shown in Figure 1.

2. Set RANGE switch to "X.01".

3. Connect a lead from the LOW terminal to the low side of the voltage to be measured. (See "Safety Precautions" on page 2.)

4. Touch or connect the lead from the HIGH terminal to the point at which the voltage is to be measured.

5. Read the voltage directly from the meter scale. Do not use the RANGE factor. Thus, a reading of .5 on the meter scale indicates one-half volt.

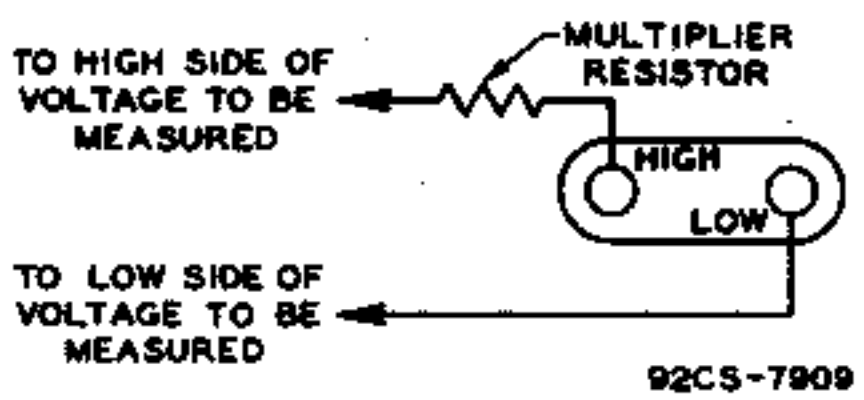

Figure 1. Connection for use as a voltmeter

10-Volt Range

1. Connect the 950-megohm Multiplier Resistor (Stock No. 57977) in series with the input of the HIGH terminal, as shown in Figure 1.

2. Set RANGE switch to "X.01".

3. Connect a lead from the LOW terminal to the low side of the voltage to be measured. (See "Safety Precautions" on page 2.)

4. Touch or connect the lead from the HIGH terminal to the point at which the voltage is to be measured.

5. The meter scale will indicate one-tenth of the voltage under test. Therefore, the scale reading must be multiplied by 10.

100-Volt Range

1. Connect both Multiplier Resistors (Stock Nos. 97181 and 57977) in series with the input of the HIGH terminal, as shown in Figure 1.

2. Set RANGE switch to "X.1".

3. Connect a lead from the LOW terminal to the low side of the voltage to be measured. (See "Safety Precautions" on page 2.)

4. Touch or connect a lead from the HIGH terminal to the point at which the voltage is to be measured.

5. The meter scale will indicate one-hundredth of the voltage under test. Therefore, the scale reading must be multiplied by 100.

Voltmeter Application

The WV-84A is useful in voltmeter applications because it provides a very high input resistance. This characteristic makes the instrument particularly suited for measurements where circuit loading is a critical factor, such as voltage measurements across phototube load resistors. The resistance of such loads may range as high as 2.5 megohms in conventional phototube circuits. The WV-84A, on the 1-volt range, reduces the value of a 2.5 megohm load by 2.4 percent; on the 10-volt range, and on the 100-volt range (which is the range normally used for phototube voltage measurements) the loading error is entirely negligible. A high-quality service voltmeter, however, with an input resistance of 10 megohms, would reduce the value of a 2.5 megohm load by 20 percent.

The WV-84A makes possible more accurate measurement of avc, bias-cell, and other high-resistance-source voltages. Accordingly, this instrument is useful in the service shop as well as in the laboratory. Because the WV-84A does not require an ac power outlet for operation, it finds applications in aircraft, boats, trains, taxis and patrol cars, submarines, and in rural areas.

Resistance Measurements

900 to 9000 megohms

1. Connect a 90-volt battery (two VS055) in series with the resistance under test, as shown in Figure 2.

2. Set Range switch to "X.1".

3. Turn Selector switch to "+".

4. Note scale reading, and find the resistance value from the chart shown in Figure 3.

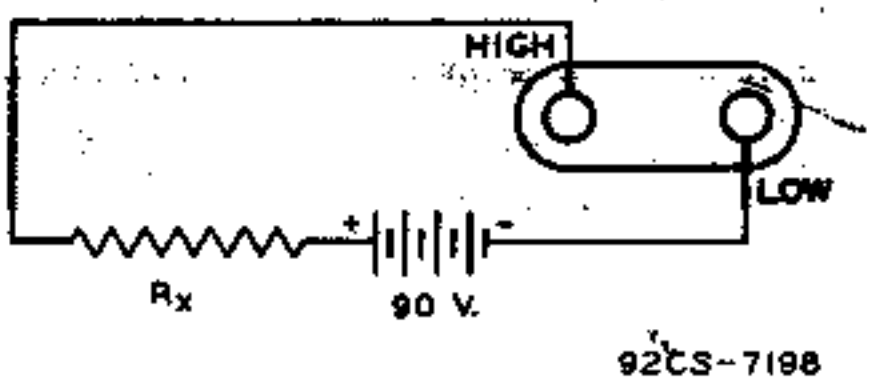

Figure 2. Connection for use as an ohmmeter

9000 to 90000 megohms

1. Connect a 90-volt battery (two VS055) in series with the resistance under test, as shown in Figure 2.
2. Set RANGE switch to "X.01".
3. Turn SELECTOR switch to "+".
4. Note the scale reading, and find the resistance value from the chart shown in Figure 3.

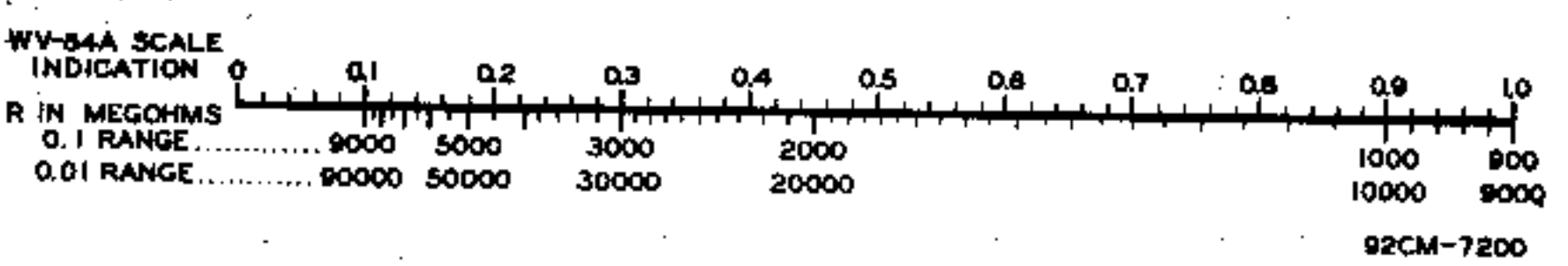

Figure 3. Chart for conversion of scale indication to resistance value

Note 1: The usefulness of the chart shown in Figure 3 depends upon the voltage of the external battery. If this voltage is higher or lower than 90 volts, the value of the resistance under test must be calculated from Ohm's law; necessary data are given in the "Specifications" section.

Note 2: Resistance values below 900 megohms are usually measured with the VoltOhmyst*. The WV-84A can be used for this purpose, however, if desired. For example, when the RANGE switch is set to the "X1" position, divide the chart value obtained from the "0.1" scale (Figure 3) by 10. Similarly, if the "X10" range is used, divide the chart value obtained from the "0.1" scale by 100.

Ohmmeter Applications

The WV-84A is useful in ohmmeter application because it supplements the resistance-measuring ranges of conventional instruments and makes it possible to measure the resistance of paper and mica capacitors, insulation resistance of tube sockets and switches, insulation resistance of cables, and other very high resistance values.

Circuit Description

A schematic diagram of the WV-84A is shown in Figure 4. The circuit is essentially a battery-operated dc vacuum-tube microammeter.

The operation can perhaps be better understood by reference to the simplified diagram of Figure 5. Batteries E_3, E_4, are arranged with V_1, V_2 to form a bridge circuit. The ZERO ADJ control acts to balance the bridge; zero potential existing across the meter when balance is obtained. The HIGH and LOW terminals are connected in series with the current to be measured.

The potential drop across the shunt, R, (selected by the RANGE switch) is applied to the grid of V_1 and changes the resistance of the tube in a direction which depends upon the direction of applied current flow. This change unbalances the bridge, and causes current to flow through the meter. By suitable circuit design, the grid current of the input tube has been reduced to the point where it is small

* Trade Mark—Reg. U. S. Pat. Off.

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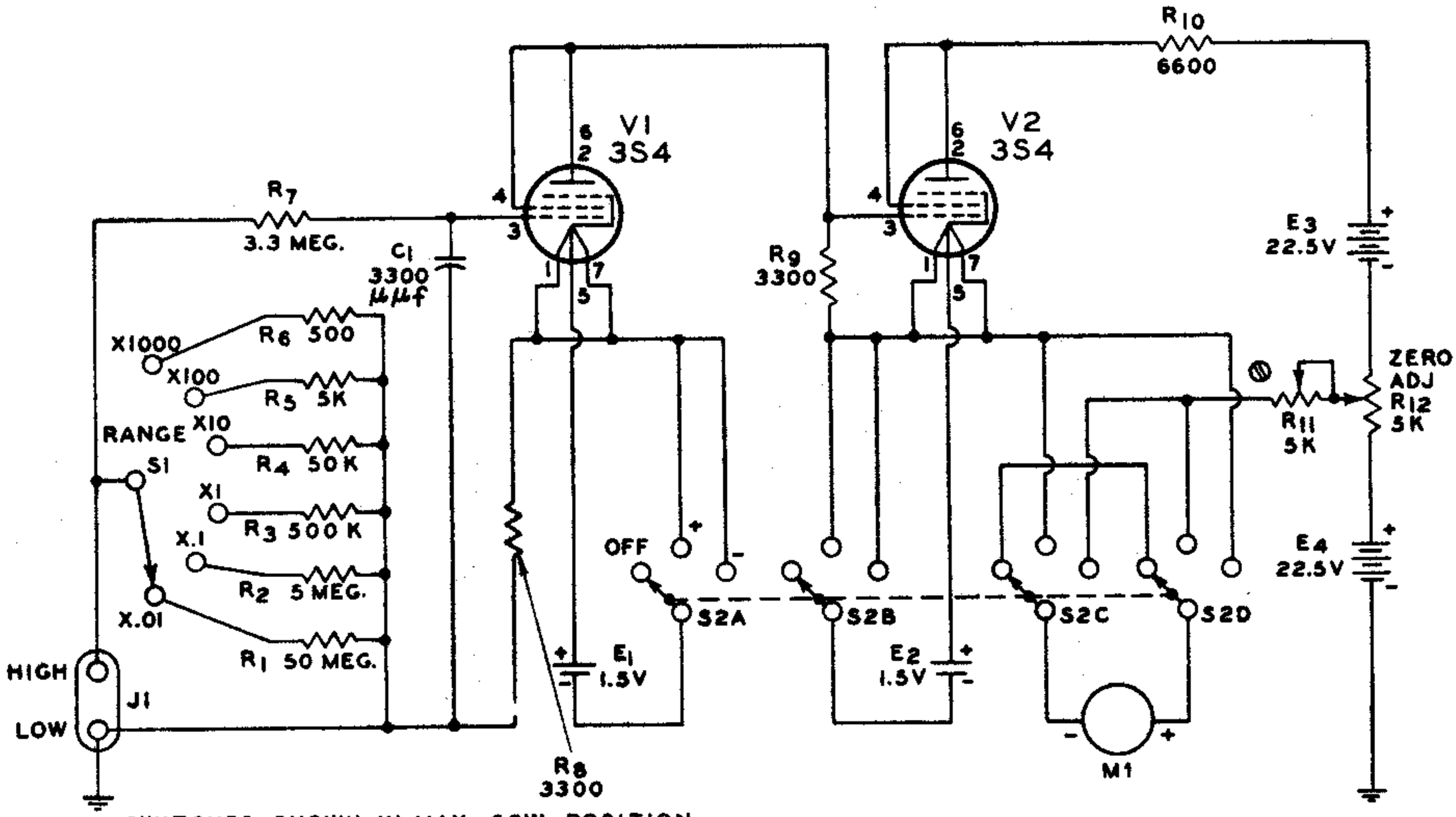

SWITCHES SHOWN IN MAX. CCW POSITION.
RESISTANCE VALUES IN OHMS UNLESS OTHERWISE NOTED. K=1000
⊘ = SCREW-DRIVER ADJUSTMENT.

92CS-7915

Figure 4. Schematic diagram of WV-84A

Replacement Parts List

When ordering Replacement Parts, please state Serial Number and Code Number of instrument

Symbol No.	Description	Stock No.
C 1	Capacitor — Fixed mica, 3300 mmf. ±20%	39664
J 1	Post—Binding post	95732
M 1	Meter—Microammeter	55879
	Resistors	
R 1	Fixed composition, 50 megohms ±1%, 2 watts	97181
R 2	Fixed composition, 5 megohms ±1%, ½ watt	55881
R 3	Fixed composition, 500,000 ohms ±1%, ½ watt	52819
R 4	Fixed composition, 50,000 ohms ±1%, ½ watt	55861
R 5	Fixed composition, 5000 ohms ±1%, ½ watt	55855
R 6	Fixed composition, 500 ohms ±1%, ½ watt	55857
R 7	Fixed composition, 3.3 megohms ±10%, ½ watt	503533
R 8	Fixed composition, 3300	
R 9	ohms, ±1%, ½ watt	55885
R 10	Fixed composition, 6600 ohms ±1%, ½ watt	55886
R 11	Variable, wire wound 5000 ohms ±10%, slotted shaft (Calibration Control)	55887
R 12	Variable, wire wound, 5000 ohms ±10% (ZERO ADJ.)	55888
S 1	Switch—RANGE, rotary, 6 position, 1 pole, shorting	54573
S 2	Switch — SELECTOR, rotary, 3 position, 4 pole, shorting	30919
	Miscellaneous	
	Foot—Rubber foot	51583
	Handle—Carrying handle	44091
	Insulators—Binding post (1 pair) (Part of J-1)	48268
	Knob—RANGE and SELECTOR switch	34950
	Knob—ZERO ADJUSTMENT—control	4323
	Panel—Front panel	55877
	Socket—Tube, miniature, 7 contact	55878

compared to the lowest reading of the instrument's range. The current through the input terminals required to give full-scale deflection is dependent, therefore, only on the resistance of the internal shunts. On the "X.01" range, the shunt is 50 meg-ohms. On succeeding ranges the shunt resistance is reduced in 10-to-1 steps until

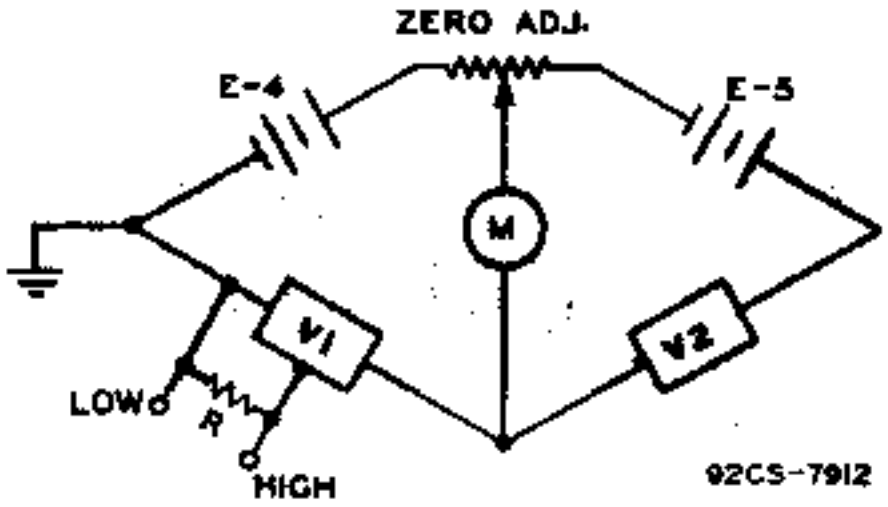

Figure 5. Simplified diagram of WV-84A

it is 500 ohms on the "X1000" range. A calibrating resistance (R-11) is included in the circuit of the WV-84. This is an internal screw-driver adjustment and is set at the factory. This adjustment should not be disturbed unless tubes or components of the instrument are charged. If it should be necessary to adjust R-11, refer to "Calibration Adjustment," in the "Maintenance" section.

Maintenance

General

The performance of the instrument is dependent upon the quality and tolerances of the components used. If it becomes necessary to replace a component part, the stock number may be found in the Replacements Parts list. Only RCA replacement parts, or parts which have equivalent specifications should be used.

The equipment may be removed from its case by removing the six screws from the front panel.

Since this instrument is used to measure extremely small currents, small amounts of leakage can cause considerable error. The insulator of J 1, switch S 1, and the socket and tube base of V 1 should be kept free of dust and moisture. Care should be taken not to touch any of the components associated with the input circuit unless the hands are clean and free of perspiration. The parts mentioned above may be cleaned when necessary with a soft, clean cloth, or with cleansing tissue. Leakage is indicated if the pointer deviates from zero when the SELECTOR switch is rotated from "+" to "—".

Tubes

The WV-84A employs two RCA-3S4 tubes. Because of the low operating voltages, the tube life will be unusually long. However, when replacement becomes necessary, care should be taken to see that the two type 3S4 tubes are approximately balanced. If they are unbalanced, it will be impossible to bring the pointer to zero within the middle third of the range of the ZERO ADJ control. If this should happen, the tubes should be interchanged and the adjustment tried again. If it is still impossible to get a proper balance, the tubes have different characteristics and each one should be matched with another tube in order to obtain a balanced pair. When the tubes are matched, it will be possible to bring the pointer to zero within the middle third of the range of the ZERO ADJ control.

An appreciable change in the zero position of the pointer when the RANGE switch is rotated from "X1000" to "X.01" indicates excessive grid current is

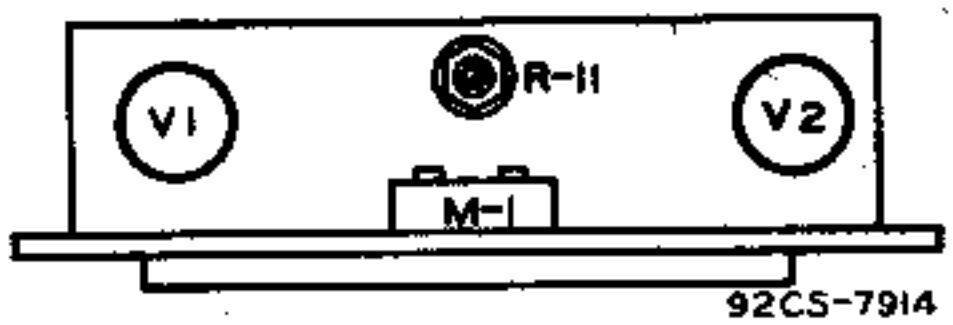

Figure 6. Locations of tubes and R-11

being drawn by the tube in the V1 position. If this is the case, interchange V1 and V2. If the condition remains, replace V1. Tubes which draw grid current may operate satisfactorily in the V2 position, but cannot be used in the V1 position.

Calibration Adjustment

The instrument is provided with one internal adjustment, R-11 (Figure 6). to compensate for variations in circuit constants. This adjustment is set at the factory and need be changed only upon replacement of tubes or other components. When readjustment is necessary, proceed as follows:

1. Check the mechanical zero of the meter.
2. Set the SELECTOR switch to the "+" position and the RANGE switch to the position marked "X.01".
3. Connect an input of exactly +½ volt dc to the WV-84A
4. Adjust R-11 until the meter of the WV-84A reads exactly full scale.
5. Reverse the input to the WV-84A and put the SELECTOR to "—". The meter should again read full scale. If the meter does not read exactly full scale, the error can be split between the "+" and "—" positions by a slight readjustment of R-11. The maximum error must not be greater than ½ small scale division on either "+" or "—".

Mechanical Zero Adjustment

The pointer should rest at "0" when the power is off. If the pointer should come to rest at a deflected position when the Selector switch is turned to "OFF", adjust the pointer position mechanically, as follows:

1. Unscrew the meter-adjustment screw plug.
2. Insert a scriber or similar tool to engage the zero-adjustment lever, and move the lever laterally as required to bring the pointer to "0".

Caution: Extreme care must be taken to prevent insertion of the tool to a depth which will injure the pointer spring. The meter warranty does not cover such damage.

3. Replace the meter-adjustment screw plug.

If the difficulty remains, vigorously wipe the outside surface of the meter-case window with a clean, soft, dry cloth. If the pointer moves away from its initial position and remains at another off-zero position for several minutes, the anti-static coating on the inside surface of the window is no longer effective. Requests for anti-static solution should be addressed to Radio Corporation of America, Order Service, Building 60, Camden, New Jersey. A 1-ounce bottle with instructions for use will be sent free to WV-84A users whose warranties are on file at the Camden RCA office.

Resistance and Continuity

The schematic diagram, Figure 4, contains such information as will be needed to locate causes of defective operation if it should develop. Suspected faulty circuits or parts may be checked and their resistances compared with the values given on the schematic diagram.

Batteries

To replace batteries, remove the instrument from the case by first removing the six front-panel screws. The filament batteries and those for the plate circuit are mounted on the rear wall of the case. The batteries may be taken out when their retaining clamps are removed.

Make certain battery contacts are bright and clean so that there will be no resistance at the connections.

Batteries should be checked occasionally to insure satisfactory operation. Weak batteries will be indicated by lack of sensitivity of the equipment. In general, the 22½ volt batteries should be discarded whenever the terminal voltage falls below 20 volts and the 1.5 volt batteries when the voltage registers below 1.33 volts (measured with the WV-84A in operation).

CAUTION—Batteries should not be allowed to remain in test equipment after they have been exhausted or in equipment that is to remain idle for a long period of time, as they deteriorate and may damage the instrument.

Figure 7 shows the location of the batteries and the color coding of the battery leads.

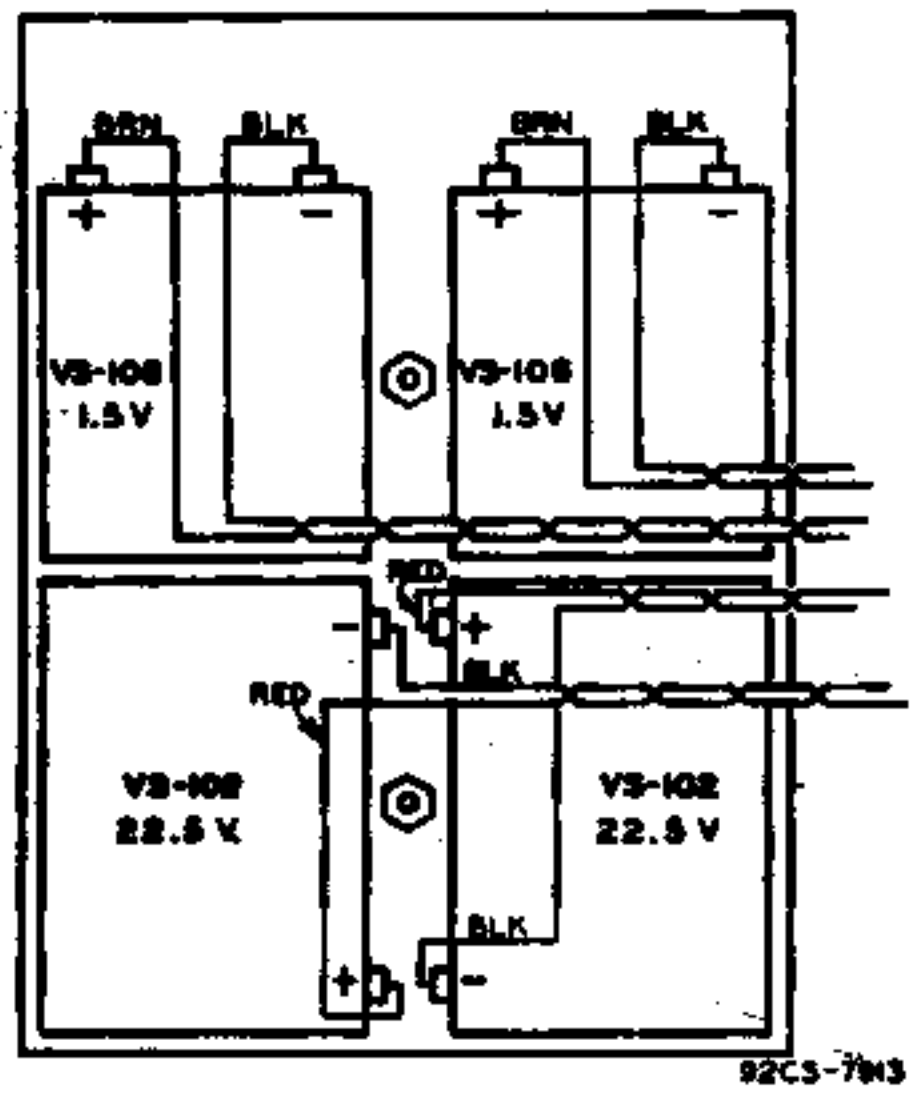

Figure 7. Battery connections