

OPERATING INSTRUCTIONS



TYPE 1862-C

MEGOHMMETER

G E N E R A L R A D I O C O M P A N Y

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OPERATING INSTRUCTIONS

TYPE 1862-C

MEGOHMMETER

Form 1862-0100-1
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West Concord, Massachusetts, USA

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

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SPECIFICATIONS

Range: 0.5 to 2,000,000 megohms at 500 volts and to 200,000 megohms at 100 volts. There are six decade steps selected by a multiplier switch.

Scale: Each resistance scale up to 500,000 megohms utilizes 90% of the meter scale. Center-scale values are 1, 10, 100, 1000, 10,000, and 100,000 megohms for 500-volt operation.

Accuracy: From $\pm 3\%$ at the low-resistance end of each decade to $\pm 12\%$ (accuracy to which the scale can be read) at the high-resistance end up to 50,000 megohms. There can be an additional $\pm 2\%$ error at the top decade.

Voltage on Unknown: 100 or 500 volts, as selected by switch on front panel. Indicator lamp is lighted when voltage is applied. Current available limited to safe value. Voltage across unknown is 500 volts ± 10 volts, or it is 100 volts ± 4 volts. This voltage source is regulated for operation from 105- to 125- (or 210- to 250-) volt lines.

Terminals: Unknown, ground, and guard terminals. All but the ground terminals are insulated. The voltage is removed from the terminals in the DISCHARGE position of either switch.

Calibration: Switch position is provided for standardizing the calibration at 500 volts.

Power Requirements: 105 to 125 (or 210 to 250) volts, 40 to 60 cps, 25 watts. Instrument will operate satisfactorily on power-supply frequencies up to 400 cps.

Accessories Supplied: Spare fuses, two color-coded test leads.

Cabinet: Flip-Tilt; relay-rack model also is available.

Dimensions: Portable model, case closed width $11\frac{1}{2}$, height $8\frac{1}{4}$, depth $7\frac{1}{2}$, inches (295 by 210 by 190 mm), over-all; rack model panel 19 by $5\frac{1}{4}$ inches (485 by 135 mm); depth behind panel 5 inches (130 mm).

Net Weight: Portable model, 9 pounds (4.1 kg); rack model, 10 pounds (4.6 kg).

Shipping Weight: Portable model, 16 pounds (7.5 kg); rack model, 23 pounds (10.5 kg).

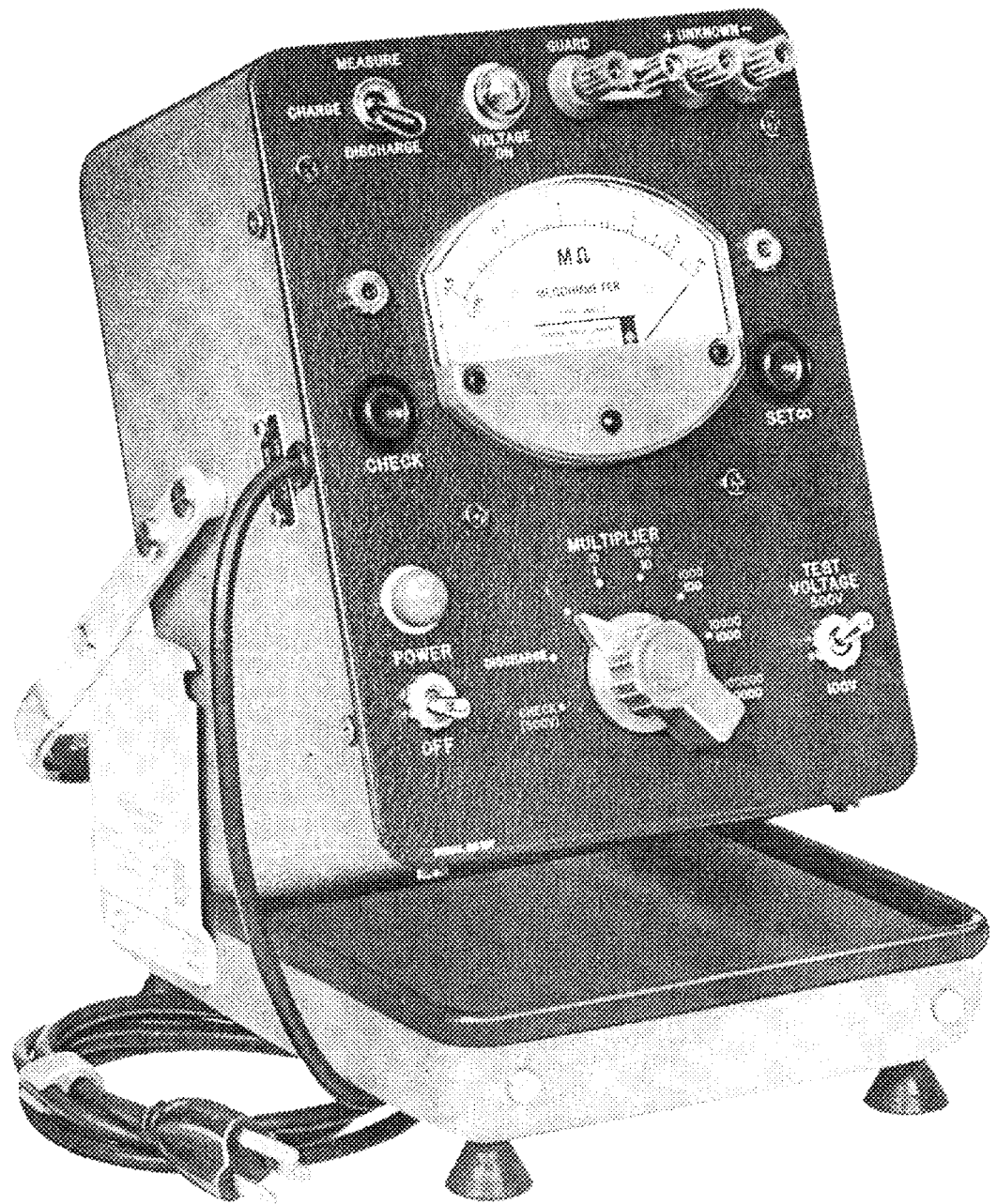


Figure 1-1. Panel view of the Type 1862-C Megohmmeter.

SECTION 1**INTRODUCTION****CAUTION**

HIGH VOLTAGE IS APPLIED TO THE MEASUREMENT TERMINALS OF THE TYPE 1862-C MEGOHMMETER, EXCEPT WHEN ONE OF THE SWITCHES IS SET TO "DISCHARGE" OR "CHECK". WHILE THE CURRENT FROM THE INSTRUMENT IS LIMITED TO A VALUE THAT IS NOT DANGEROUS UNDER MOST CONDITIONS, THE ENERGY STORED IN A CAPACITOR CONNECTED TO THE TERMINALS MAY BE LETHAL. ALWAYS SET EITHER THE FUNCTION OR MULTIPLIER SWITCH TO DISCHARGE WHEN YOU CONNECT OR DISCONNECT THE UNKNOWN.

1.1 DESCRIPTION.

The Type 1862-C Megohmmeter (Figure 1-1) indicates directly on the panel meter any resistance from 0.5 to 2,000,000 megohms. This range is suitable for leakage-resistance measurements of most types of insulation used in electrical machinery, electronic devices and components, etc. The voltage applied to the unknown is either 100 volts or 500 volts, as selected by a switch on the panel.



1.2 CONTROLS AND CONNECTORS.

Table 1 lists the controls and connectors on the panel of the Type 1862-C Megohmmeter.

TABLE 1 CONTROLS AND CONNECTORS

NAME	TYPE	FUNCTION
Function	3-position toggle switch	Selects measure, charge, or discharge function.
CHECK	Thumbset rotary control	Adjusts low-resistance end of meter range (voltmeter gain).
SET ∞	Thumbset rotary control	Adjusts high-resistance end of meter range (voltmeter zero).
POWER	2-position toggle switch	Turns power on and off.
MULTIPLIER	8-position selector switch	Selects resistance range or discharge or check functions.
TEST VOLTAGE	2-position toggle switch	Selects test voltage of 100 or 500 volts.
UNKNOWN + and -	Pair of insulated binding posts	For connection of the unknown.
Ground	Uninsulated binding post	For grounding the unknown.
GUARD	Insulated binding post	For guarded measurements (refer to paragraph 3.5).

1.3 SYMBOLS.

This instrument indicates the resistance of the unknown in megohms (millions of ohms). The relationship between ohms (Ω), kilohms ($k\Omega$), megohms ($M\Omega$), gigaohms ($G\Omega$), and teraohms ($T\Omega$) is shown below.

$$1 M\Omega = 10^6 \Omega = 10^3 k\Omega$$

$$1 G\Omega = 10^9 \Omega = 10^6 k\Omega = 10^3 M\Omega$$

$$1 T\Omega = 10^{12} \Omega = 10^9 k\Omega = 10^6 M\Omega = 10^3 G\Omega$$

SECTION 2

OPERATING PROCEDURE

2.1 INSTALLATION.

2.1.1 OPENING AND TILTING THE CABINET. Unwrap the power cord from around the feet of the instrument and open the case following the directions given on the handle support of the instrument. Once open, the instrument may be tilted to any convenient angle. The angle should be chosen to give the best view of the panel meter and the most comfortable access to the controls.

The instrument may be locked fully open by the same slide pins that are used to lock the instrument closed. Thus, the instrument can be carried in the open position with the cover firmly in place.

The cover of the instrument forms a convenient storage place for the instruction manual and any test data that should be kept with the instrument.

2.1.2 POWER CONNECTIONS. Connect the instrument to a suitable power source as indicated on the plate on the side of the instrument where the power cord is attached (115 v or 230 v, 50 to 60 cps). A three-wire power cord is supplied. If a three-wire power connection is not used, connect the panel of the instrument (uninsulated binding post) to a good ground.

2.2 CALIBRATION.

2.2.1 METER. To check the calibration of the meter, proceed as follows:

- a. Turn the instrument on and allow a minute or two for warm-up.
- b. Set the MULTIPLIER switch to DISCHARGE and the TEST VOLTAGE switch to 500 v. Adjust the SET ∞ control for a meter reading of ∞ .
- c. Set the MULTIPLIER switch to CHECK and adjust the CHECK control for a meter reading of 0.5.

The SET ∞ control should be reset whenever the meter does not indicate ∞ with either the function switch or the MULTIPLIER switch set to DISCHARGE. A more complete calibration procedure is described in paragraph 5.4.

2.2.2 GRID-CURRENT ADJUSTMENT. Set the function switch to DISCHARGE and the MULTIPLIER switch to the highest range (10,000 or 100,000). If, after warmup, the meter does not read ∞ , adjust R104 (in the hole at the right-hand side of the meter) with a screwdriver for a meter indication of ∞ .



Leakage across the binding posts may affect this measurement. Clean the binding posts and use ungrounded unknown terminals (if possible) on humid days (refer to paragraph 3.7).

2.3 MEASUREMENT SETUP

2.3.1 CONNECTION OF GROUND LINK. The grounding link connected to the uninsulated, grounded binding post, may be connected from this ground terminal GUARD or the + UNKNOWN terminal (see Figure 2-1). The ground link should be connected to the GUARD terminal if the sample to be measured is a small, separate component or if it is a component mounted in an enclosure that should be guarded (refer to paragraph 3.5). However, if one terminal of the unknown must be grounded, then the link should tie the + UNKNOWN terminal to the instrument case.

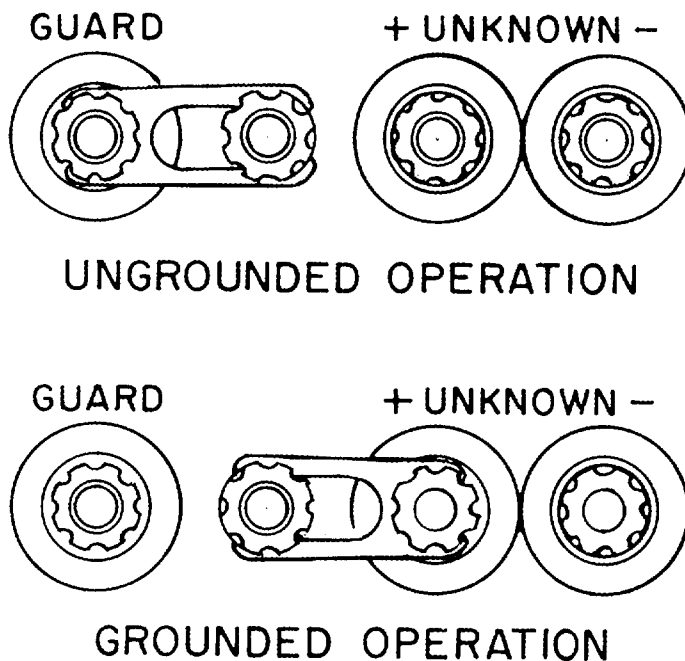


Figure 2-1. The ground link connected to the GUARD terminal (top) and to the + UNKNOWN terminal (bottom).

2.3.2 SELECTION OF TEST VOLTAGE. The TEST VOLTAGE switch should be set to either 100 v or 500 v, as desired.

2.4 MEASUREMENT PROCEDURE.

2.4.1 GENERAL. Either of two measurement procedures is used, depending on whether or not the correct resistance-multiplier range is known. If the range is not known, the search procedure (paragraph 2.4.2) should be followed. If repetitive measurements are to be made on a given range (eg., if similar components are to be sorted), the sort procedure (paragraph 2.4.3) should be used.

2.4.2 SEARCH PROCEDURE. When the approximate resistance of the sample to be measured is not known, proceed as follows:

- a. Set the MULTIPLIER switch to DISCHARGE and the function switch to MEASURE.
- b. Connect the unknown between the UNKNOWN + and - terminals.

c. Rotate the MULTIPLIER switch clockwise until the meter gives a reading below 5.

d. The resistance of the unknown in megohms is the meter reading multiplied by the MULTIPLIER switch indication that is the same color as the indication of the TEST VOLTAGE switch setting.

2.4.3 SORT PROCEDURE. When the approximate resistance of the sample to be measured is known, proceed as follows:

a. Set the function switch to DISCHARGE and the MULTIPLIER switch to the desired range.

b. Connect the unknown between the UNKNOWN + and - terminals.

c. Set the function switch to MEASURE.

d. The resistance of the unknown in megohms is the meter reading multiplied by the MULTIPLIER switch indication that is the same color as the indication of the TEST VOLTAGE switch setting. For go-no-go checks, it is often useful to draw a limit line on the outside of the meter with a wax pencil.

CAUTION

DO NOT MAINTAIN A SHORT CIRCUIT AT THE UNKNOWN TERMINALS AS THIS WILL SHORTEN THE LIFE OF THE RECTIFIER AND THE REGULATOR TUBE. A MOMENTARY SHORT WILL DO NO DAMAGE.

2.5 SHOCK HAZARD

Every precaution has been taken in the design of the Type 1862-C Megohmmeter to reduce the possibility of shock. However, high voltage must be present at the terminals to make measurements at the required voltage levels and the operator should be aware of the dangers involved.

The current delivered by the Type 1862-C under short-circuit conditions is approximately 10 ma at 500 volts and 2 ma at 100 volts. The 10-ma current is not lethal to most persons but may be lethal to those with poor hearts, and it is painful to all. The actual current that will flow through a person depends on the resistance of the part of the body that makes contact with the terminals. This resistance can be as low as 300 ohms. Note that any of the three insulated binding posts may be at high voltage, depending on the position of the connecting link.

When capacitors are tested there is an especially dangerous condition because a charged capacitor can easily have enough energy to cause heart fibrillation and death. The capacitor should always be shunted before connection to the Megohmmeter, and either the function switch or the MULTIPLIER switch should be set to DISCHARGE for a few seconds before the capacitor is disconnected.

We strongly recommend that additional precautions, such as rubber gloves and insulated bench tops, chairs, and shoes, should be used for



anyone making repetitive measurements with the Megohmmeter, particularly measurements on capacitors. These precautions should not take the place of careful discharge of the capacitors before and after measurement, but should be used as an additional safety measure.

2.6 TEST LEADS.

Two 36-inch, rubber-covered test leads, one black and one red, are supplied with the instrument. Each lead has a banana plug at one end (for connection to the Megohmmeter) and an alligator clip at the other end. These leads are adequate for most measurements. However, measurements of very high resistances may require shorter or rigid leads or even shielded leads, depending on the size of the component under test and the ambient conditions. Leakage between these leads shunts the unknown (refer also to paragraph 3.6).

CAUTION

REMEMBER THAT THERE MAY BE
500 VOLTS BETWEEN THE TEST
LEADS, AND FROM ONE OF THEM
TO GROUND.

SECTION 3

APPLICATIONS

3.1 INSULATION TESTING.

The insulation resistance of electrical machinery, transducers, etc, is one of several parameters that may indicate the condition of the insulation. Routine measurement of capacitance, dissipation factor, and leakage resistance provides useful data for monitoring the condition of the insulation and for guarding against incipient breakdown.

A routine test that has been widely adopted for insulation testing calls for the measurement of the apparent leakage resistance after a test voltage has been applied for one minute and again after the test voltage has been applied for 10 minutes. The ratio of the indicated resistances, sometimes referred to as the Polarization Index (refer to paragraph 3.2), can have some relation to the condition of the insulation. The results of such a measure-

ment are apt to be more dependent on the dielectric absorption of the insulator than on its true leakage resistance measured at equilibrium. A complete charge-current-vs-time plot will provide more useful information.

The Type 1862-C Megohmmeter can be used for either true leakage measurements or for measurements at one- or 10-minute intervals following the operating procedure described in Section 2. On large machinery, one terminal must usually be grounded, so the grounding strap should be connected between the ground terminal and the + UNKNOWN terminal.

To determine the charge current, divide the test voltage by the indicated resistance. At the start of a charge-current-vs-time plot, the meter will be off scale. The resistance in series with the insulator is the product of the red engraving of the MULTIPLIER switch indication and 2000 ohms.

3.2 LEAKAGE RESISTANCE OF CAPACITORS.

3.2.1 GENERAL. The leakage resistance of capacitors is measured by either the search or sort method (refer to paragraphs 2.4.2 and 2.4.3) used for resistors, except that some consideration must be given to the charge and discharge currents.

WARNING

CAPACITORS BEING MEASURED MAY BE CHARGED AND CONTAIN LETHAL ENERGY. ALWAYS SET EITHER THE FUNCTION OR MULTIPLIER SWITCH TO DISCHARGE BEFORE YOU CONNECT OR DISCONNECT THE CAPACITOR UNDER TEST.

3.2.2 CHARGING TIME. The charging time for a capacitor is determined by the maximum current then may be drawn from the power supply (approximately 10 ma at 500 volts and 2 ma at 100 volts) and by the resistance in series with the capacitor. With the function switch set at CHARGE, the series resistance is 4.7 kilohms and is independent of the MULTIPLIER switch setting (see Figure 4-2). With the function switch set at MEASURE, the series resistance is equal to 2000 ohms multiplied by the red engraving of the MULTIPLIER switch indication. This becomes very large on the highest ranges. For measurement of high-valued, low-leakage capacitors, the MULTIPLIER switch should be left on the lowest range (search method) or the function switch should be left at CHARGE (sort method) until the capacitor is charged. A couple of seconds per hundred microfarads is sufficient time for units with low dielectric absorption.

Dielectric absorption (dipole and interfacial polarization) is present in many capacitors and insulators, especially those with a laminated structure. When voltage is applied to such material, the charge slowly diffuses throughout the volume and several minutes, hours, or even days, are required for equilibrium in order to make the charging current small compared with the true leakage current. A measure of this effect, called the Polarization Index,



is the ratio of the resistance measured after 10 minutes of charging to that measured after 1 minute of charging. Often, the measured resistance after 1 minute of charging is called the insulation resistance even though the charging current may be much larger than the true leakage current.

3.2.3 DISCHARGE TIME. With either the function or MULTIPLIER switch set at DISCHARGE, the unknown terminals are connected through 4.7 kilohms and the discharge time is approximately $0.005 \times C \mu\text{sec}$, where C is in microfarads. The VOLTAGE ON lamp is powered by the actual voltage on the terminals so that for large capacitors it will not be immediately extinguished when either switch is set at DISCHARGE.

Capacitors with high dielectric absorption may have a residual charge even after they are shunted and must be repeatedly shunted to be completely discharged.

3.2.4 METER FLUCTUATIONS DURING CAPACITOR-LEAKAGE MEASUREMENTS. Line-voltage fluctuations will cause meter fluctuation when capacitors are tested unless the test-voltage supply is very well regulated. Refer to paragraph 5.4.1 for this adjustment.

3.3 RESISTANCE MEASUREMENTS.

The recommended test voltage is 100 volts for fixed composition resistors, film resistors, and wire-wound resistors above $100\text{k}\Omega$. (Refer to EIA Standards RS172, RS196, and REC 117.) These resistors can be measured easily on the Megohmmeter as long as the accuracy of the instrument is adequate. If the resistors are separate, we suggest that they be measured ungrounded (with the grounding link connected to the GUARD terminal).

3.4 MEASUREMENT OF VOLTAGE COEFFICIENT.

The Type 1862-C Megohmmeter may be used to measure voltage coefficient as long as its accuracy is adequate. The voltage coefficient of a resistance is defined as:

$$\frac{R_1 - R_2}{R_2(V_1 - V_2)} \times 100\%$$

where $V_1 > V_2$

R_1 is the resistance at V_1

R_2 is the resistance at V_2

With the Megohmmeter, $V_1 = 500 \text{ v}$ and $V_2 = 100 \text{ v}$, so that:

$$\begin{aligned} \text{Voltage Coefficient} &= \frac{R_{500\text{v}} - R_{100\text{v}}}{(400) R_{100\text{v}}} \times 100\% \\ &= \frac{1}{4} \frac{\Delta R}{R_{100\text{v}}} \% \end{aligned}$$

This voltage coefficient is usually negative.

3.5 GUARDED-3-TERMINAL MEASUREMENTS.

In many cases it is necessary to measure the resistance between two points in the presence of resistance from each of these points to a third point. This third point can often be guarded to avoid error caused by the extraneous resistances.

This situation can be shown diagrammatically as a three-terminal resistor (see Figure 3-1). Here, R_X is the quantity to be measured in the presence of R_A and R_B . If the junction of R_A and R_B is tied to a guard, R_A is placed across the power supply and has no effect if it is greater than 500 k Ω . R_B shunts R_S and causes a much smaller error than that which would be present if no guard were used. The error is approximately $-R_S/R_B \times 100\%$, where R_S equals 2000 Ω times the red engraving on the MULTIPLIER switch indication. If a choice is possible, the higher of the two stray resistances should be connected as R_B .

The guard terminal may be used whether the GUARD or the + UNKNOWN terminal is grounded, but note that if the + UNKNOWN terminal is grounded, the GUARD terminal will be at a high (negative) voltage level. Often the terminal to be guarded is a large chassis and it is, therefore, safer to ground the GUARD terminal. If this third terminal is true ground then the GUARD terminal must be grounded.

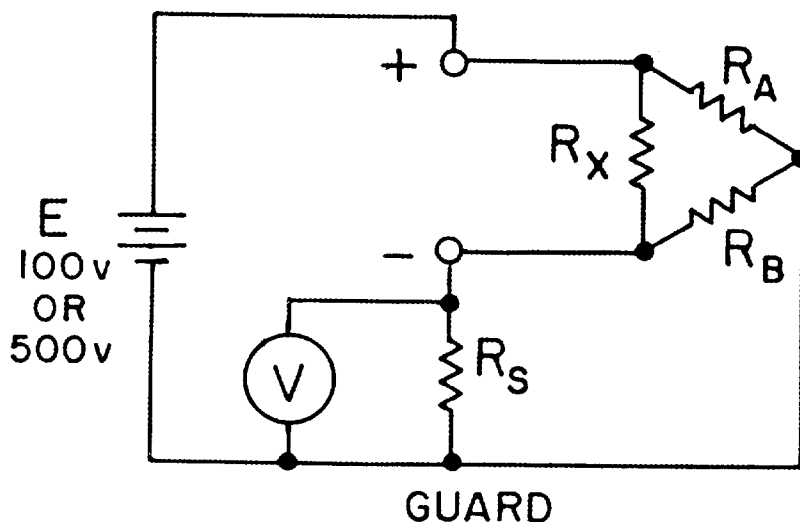


Figure 3-1. Guarded measurement of a three-terminal resistor.

3.6 REMOTE MEASUREMENTS.

Measurements may be made on components that are some distance from the instrument if care is used to prevent leakage between the connecting leads and to avoid shock hazard. A convenient way to do this is to use a shielded cable. If the unknown may be measured ungrounded, make the connection to the + UNKNOWN terminal with the shielded lead, tie the shield to the GUARD terminal, and connect the GUARD terminal to the panel ground with the connecting link. If one side of the unknown must be grounded, connect the grounding link to the + UNKNOWN terminal, shield the + UNKNOWN terminal, and tie the shield to the GUARD terminal. In this instance, the shield is not at ground potential and should be insulated.



3.7 MEASUREMENTS UNDER HUMID CONDITIONS.

The Type 1862-C Megohmmeter has been designed to operate under conditions of high humidity but, nevertheless, a few simple precautions should be taken to ensure accurate measurements. These precautions are:

1. Allow several minutes warmup (internal heat will reduce humidity inside the instrument).
2. Clean the binding-post insulation with a dry, clean cloth.
3. Use ungrounded operation (tie the GUARD terminal to the panel ground).

To determine the presence of errors due to humidity, measure the resistance between the binding posts with no external connections. Note that with the + UNKNOWN terminal grounded, breathing on the terminals will cause a meter deflection because leakage from the insulator of the - UNKNOWN terminal to the panel is measured.

Actually, this problem is somewhat academic because the unknown to be measured is usually much more severely affected by humidity than is the Megohmmeter.

3.8 ALTERNATE TEST VOLTAGES.

Test voltages of 100 volts and 500 volts are provided in the Type 1862-C Megohmmeter. Measurements at other voltages between 0 and 500 volts may be made with a suitable external power supply. The procedure is as follows:

- a. Remove V501, a type 6AB4 tube (see Figure 5-1).
- b. Set the TEST VOLTAGE switch to 500 v.
- c. Set the function switch to MEASURE.
- d. Set the MULTIPLIER switch to the desired range.

CAUTION

DO NOT CHANGE THE POSITION OF EITHER THE FUNCTION SWITCH OR MULTIPLIER SWITCH AS THIS WILL SHUNT THE EXTERNAL POWER SUPPLY.

- e. Connect the external power supply between the GUARD (minus) and the + UNKNOWN terminals.
- f. Set the external power supply to the desired voltage.
- g. The unknown resistance, R_X , is:

$$\frac{E}{500} R_M - R_S$$

where E is the applied voltage

R_M is the resistance indicated by megohmmeter.

R_S is the red engraving on the MULTIPLIER switch setting multiplied by 0.002 MΩ.

SECTION 4

PRINCIPLES OF OPERATION

The Type 1862-C Megohmmeter consists of a regulated dc power supply of 100 or 500 volts, a set of precision resistors ranging in value from 2 kΩ to 200 MΩ, and a vacuum-tube voltmeter connected as shown in Figure 4-1. The voltage appearing on the voltmeter is

$$E \frac{R_S}{R_X + R_S}$$

If $R_X \gg R_S$, then the voltmeter reading is inversely proportional to the resistance of the unknown and the scale is so calibrated. The meter has a right-hand zero (labeled ∞) so that this inverse scale increases from left to right for easier interpolation.

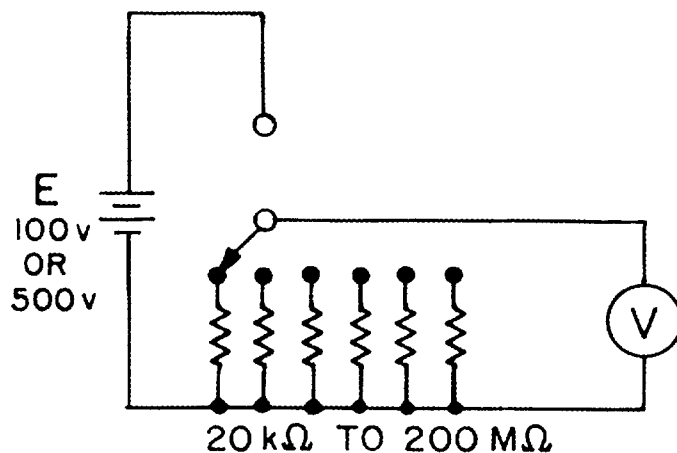


Figure 4-1. VTVM connection in the Type 1862-C.



On the 500-volt range R_x is always greater than 250 R_s so that the above approximation is well within the instrument accuracy. On the 100-volt range, this ratio is as low as 25, which would result in a 4% error. When the 100-volt test voltage is used, a diode is inserted in the voltmeter circuit to compensate for this nonlinearity of scale.

The voltage across the unknown varies by 2 volts over each range with the 500-volt test voltage and by 4 volts with the 100-volt test voltage. The voltages are set to give the nominal voltage at midscale.

The power supply uses a rather conventional series regulator with a gas reference tube. The 500-volt output is adjustable, as is the 100-volt output which is tapped off of the output divider. Note that, because the 100-volt tap is a higher voltage than the voltage compared with the reference, this output is also regulated and has a low output impedance. The degree of regulation can be adjusted by variation of the screen voltage on the amplifier tube.

The voltmeter is a differential type using a premium double triode with low grid current. Its plate supply is regulated, and it has both zero and gain controls (the SET ∞ and CHECK panel controls, respectively). An extra zero adjustment, R104, compensates for the voltage caused by grid current flowing into the 200-M Ω standard on the highest resistance range.

The MULTIPLIER switch selects the standard resistor, R_s , used for the measurement and provides DISCHARGE and CHECK positions. (See Figure 4-2.) In the CHECK position a precision resistor is substituted for the unknown so that the gain control (CHECK adjustment) may be set. The separate function switch facilitates rapid repetitive measurements. The component is discharged by 4.7 k Ω if either the function switch or the MULTIPLIER switch is set to DISCHARGE. Voltage is applied only when the function switch is set to MEASURE and the MULTIPLIER switch is set to a multiplier position (see Figure 4-2). The neon lamp adjacent to the GUARD terminal lights when voltage appears across the UNKNOWN terminals. The lamp is dim when 100 volts is applied and quite bright when the more dangerous 500 volts is applied.

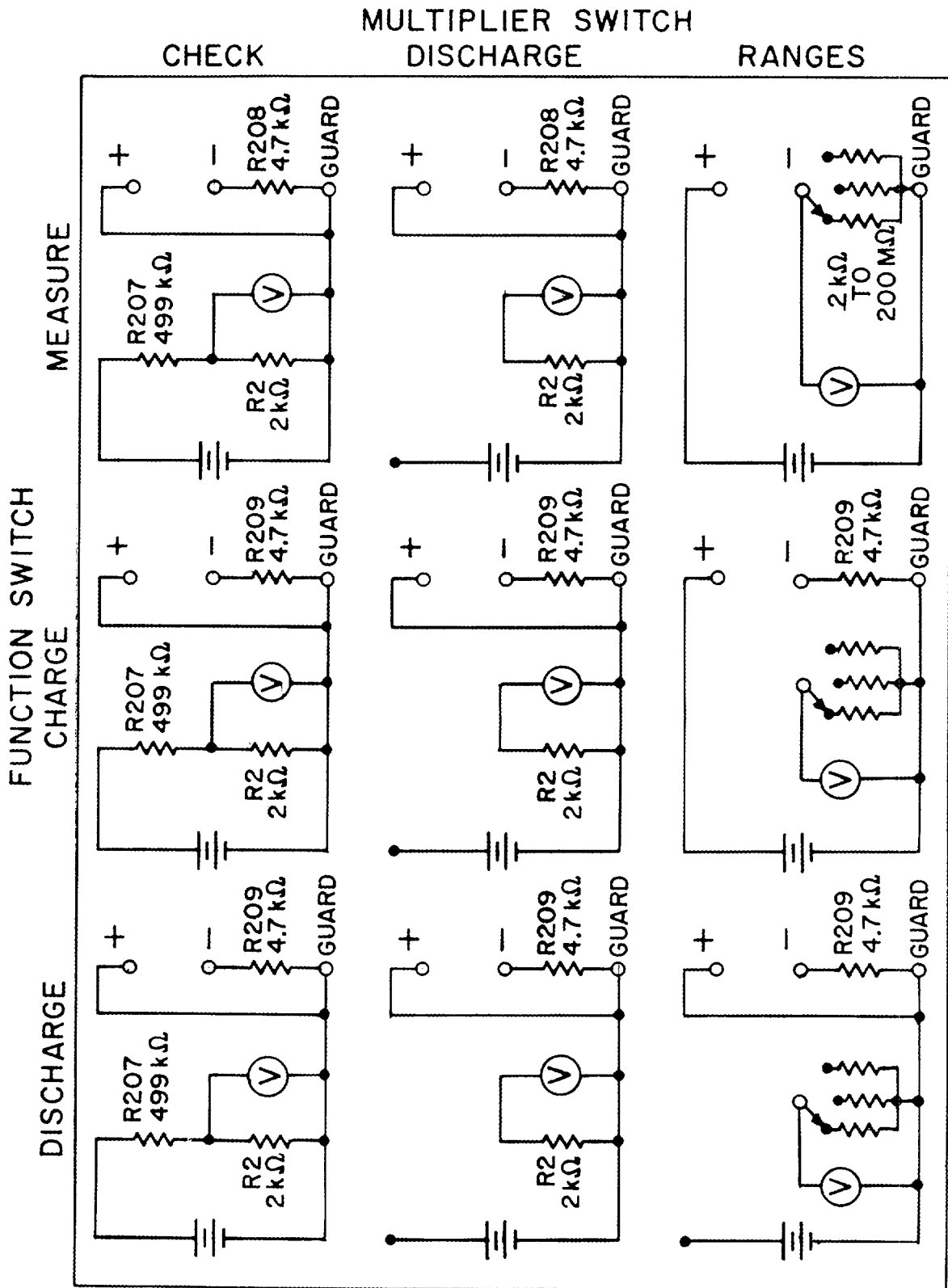


Figure 4-2. Circuit diagram of the Megohmmeter for each position of the MULTIPLIER and Function switches.

**SECTION 5****SERVICE AND MAINTENANCE****5.1 WARRANTY.**

We warrant that each new instrument sold by us is free from defects in material and workmanship, and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two year period not to meet these standards after examination by our factory, district office, or authorized repair agency personnel, will be repaired, or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

5.2 SERVICE.

The two year warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department (see rear cover), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest district office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

5.3 REMOVAL FROM CABINET.

To remove the instrument from the cabinet, remove the four screws near the panel on the sides of the instrument and pull the instrument up out of the cabinet.

WARNING

BE CAREFUL WHEN TROUBLE-SHOOTING THE INSTRUMENT WHEN IT IS OUT OF ITS CASE AND CONNECTED TO THE POWER LINE. DANGEROUS VOLTAGES ARE PRESENT, PARTICULARLY AT THE TRANSFORMER TERMINALS. CONNECT THE GROUND STRAP BETWEEN THE GUARD AND GROUND TERMINALS TO KEEP THE VOLTMETER CIRCUITRY NEAR GROUND POTENTIAL.

5.4 CALIBRATION PROCEDURE.

5.4.1 GENERAL. The simple calibration check (refer to paragraph 2.2), which checks the gain of the voltmeter, should be made after warmup and several times a day during use. A more complete calibration should be made at least once every six months, or whenever the measurements are in doubt.

5.4.2 REGULATOR ADJUSTMENT. Good regulation is particularly important for leakage measurements on capacitors where a variation on the test voltage is capacitively coupled to the voltmeter input and thus causes meter fluctuations.

To set the regulator adjustment, vary the line voltage from 105 to 125 volts with a Variac[®] adjustable autotransformer while you measure a mica capacitor of approximately 0.01 μf on the highest range of the Megohmmeter. Adjust R503, located on the rear of the internal shelf, to give the smallest fluctuations. This adjustment should be repeated whenever components in the regulator circuit are replaced or when excess fluctuation is noticed.

5.4.3 VOLTAGE ADJUSTMENTS. The voltage between the + UNKNOWN terminal and the GUARD terminal should be set to 501 volts for the 500-volt test voltage and to 102 volts for the 100-volt test voltage. The 500-volt adjustment, R510, is available on the panel (see Figure 5-1) and the 100-volt adjustment, R512, is located at the rear of the internal shelf. A very accurate voltmeter is required. Note that an error in the setting of the 500-volt supply does not directly cause an error in resistance measurements at 500 volts because the CHECK adjustment calibrates the meter at the actual voltage. Also, 100-volt measurements will be correct if the ratio between the two voltages is correct.

5.4.4 RANGE CALIBRATION. The Megohmmeter is calibrated against the internal standard by the procedure described in paragraph 2.2. However, this procedure does not check the standard resistors used on all ranges. Moreover, the high-valued resistors required to make calibration checks on the upper ranges are usually not too stable and often show a sizable voltage coefficient. However, if suitable standards are available, they may be used to check each range.

Another method of calibration is to measure each of the six standard resistors on a suitable bridge. These resistors should be measured at low voltage levels because, when the Megohmmeter is in use, the maximum voltage applied to the resistors is 4 volts. With a General Radio Type 1644-A Megohm Bridge, these measurements can be made to 1%. When measuring the standard resistors, disconnect the Type 1862-C from the power line, set the function switch to MEASURE, and the MULTIPLIER switch to each of the six ranges in turn. Measure the resistance from the GUARD terminal to the - UNKNOWN terminals. The value of the resistance should be 2000 Ω multiplied by the red engraving on the MULTIPLIER switch indication $\pm 1\%$, except on the highest range where it is $\pm 2\%$.

5.4.5 LINEARITY. The linearity of the scale may be easily checked with a decade box that has 100-k Ω and 1-M Ω steps (General Radio Type 1432-Y or 1432-Z). Connect the decade box across the UNKNOWN terminals. Set the TEST VOLTAGE switch to either 500 v or 100 v and set the MULTIPLIER



switch to 1. Adjust the decade box for readings over the entire scale. The accuracy should be $\pm 3\%$ at full-scale (left-hand) end. If the full-scale (left-hand) reading is made exact with the CHECK adjustment, the remaining readings should track to an accuracy which is proportional to the scale reading and is $\pm 3\%$ of the reading at a reading of 1.

5.5 TROUBLE-SHOOTING.

5.5.1 GENERAL An understanding of the operation of this instrument (refer to Section 4) makes the instrument easy to trouble-shoot because the difficulty can usually be located quickly in either the voltage regulator or in the meter circuit. Both of these circuits are of straightforward design. Failure of a vacuum tube can be located quickly by a check of the vacuum-tube-socket voltages (correct values are given in paragraph 5.5.2).

If the instrument is completely inoperative, be sure to check the power-line connection and the fuses (located internally on top of the power transformer).

5.5.2 VACUUM-TUBE DATA. The Table 2 gives dc voltages measured from each tube-socket pin to ground as measured with a 20,000 Ω /volt instrument. The Megohmmeter was set to the following operating conditions: 115-volt, 60-cycle line; ground terminal strapped to GUARD terminal; MULTIPLIER switch set to 1; TEST VOLTAGE switch set to 500 v; and the CHECK and SET ∞ controls set as for measurement (refer to paragraph 2.2).

TABLE 2 TUBE VOLTAGES

TUBE (TYPE)	DC VOLTS TO GROUND FROM SOCKET-PIN NUMBER									FUNCTION
	1	2	3	4	5	6	7	8	9	
V101 (6189)	+55	0	+3	--	--	+55	0	+3	--	VTVM
V501 (6AB4)	+900	0	--	--	0	+490	+500	--	--	Series Regulator
V502 (6AU6)	+80	+83	--	--	+490	+160	+83	--	--	Regulator Amplifier
V503 (5651)	+83	0	--	0	+83	--	0	--	--	Reference Voltage
V551 (0A2)	+55	-90	--	-90	+55	--	-90	--	--	Power-Supply Regulator

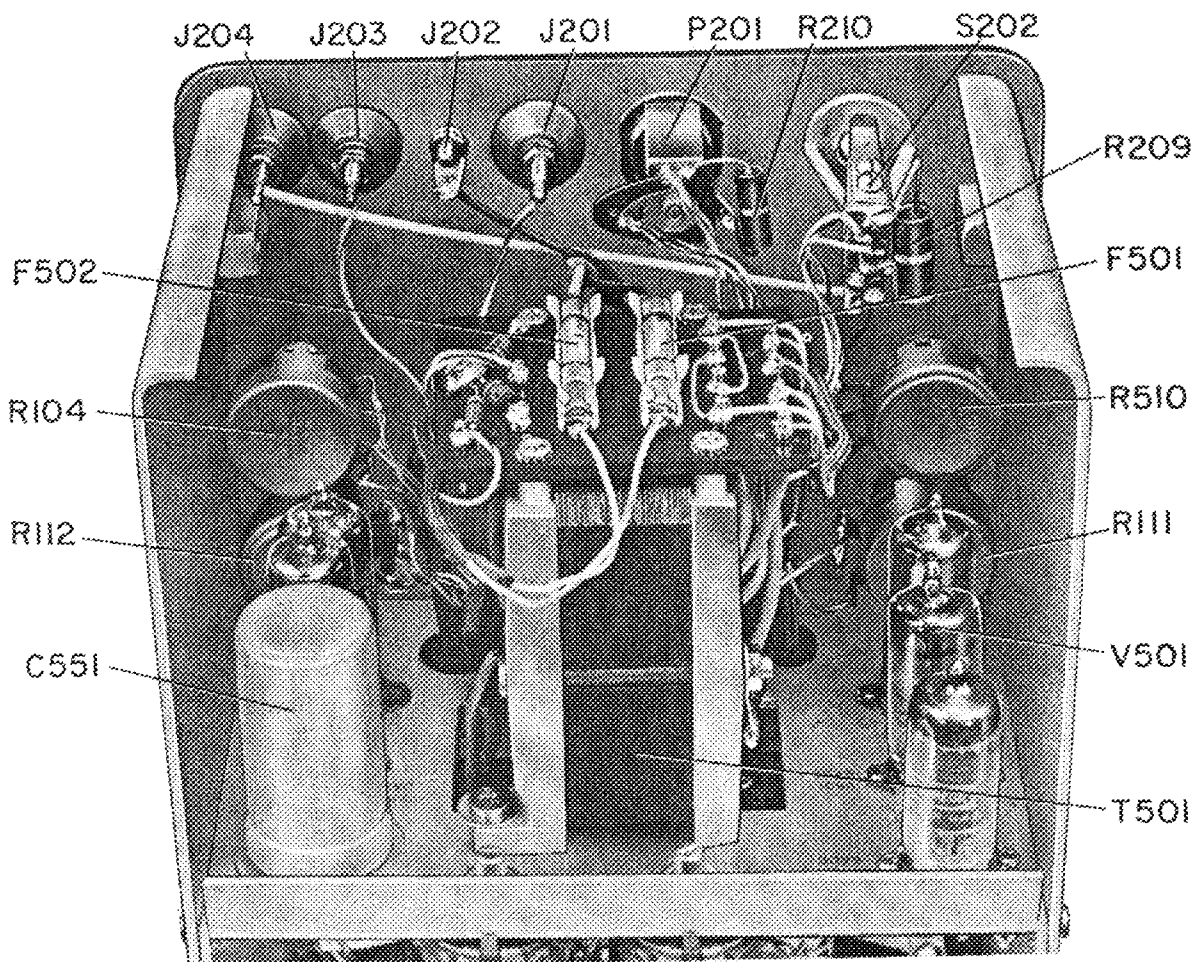


Figure 5-1. Top interior view of the Type 1862-C.

PARTS LIST

REF NO.	DESCRIPTION	PART NO.
R101	RESISTOR, Composition 2.2M Ω \pm 10% 1w	6110-5229
R102	RESISTOR, Composition 39k Ω \pm 5% 1/2w	6100-3395
R103	RESISTOR, Composition 22k Ω \pm 5% 1/2w	6100-3225
R104	POTENTIOMETER, Wire-Wound 500 Ω \pm 10%	6050-1100
R105	RESISTOR, Composition 22k Ω \pm 5% 1/2w	6100-3225
R106	RESISTOR, Composition 62k Ω \pm 5% 1/2w	6100-3625
R107	RESISTOR, Composition 100k Ω \pm 5% 1/2w	6100-4105
R108	RESISTOR, Film 10k Ω \pm 1% 1/4w	6350-2100
R109	RESISTOR, Composition 75k Ω \pm 5% 1/2w	6100-3755
R110	RESISTOR, Composition 4.3k Ω \pm 5% 1/2w	6100-2435
R111	POTENTIOMETER, Wire-Wound 5k Ω \pm 10%	6050-1700
R112	POTENTIOMETER, Composition 250k Ω \pm 10%	6010-2000
R113	RESISTOR, Composition 100k Ω \pm 5% 1/2w	6100-4105
R114	RESISTOR, Composition 10M Ω \pm 5% 1/2w	6100-6105

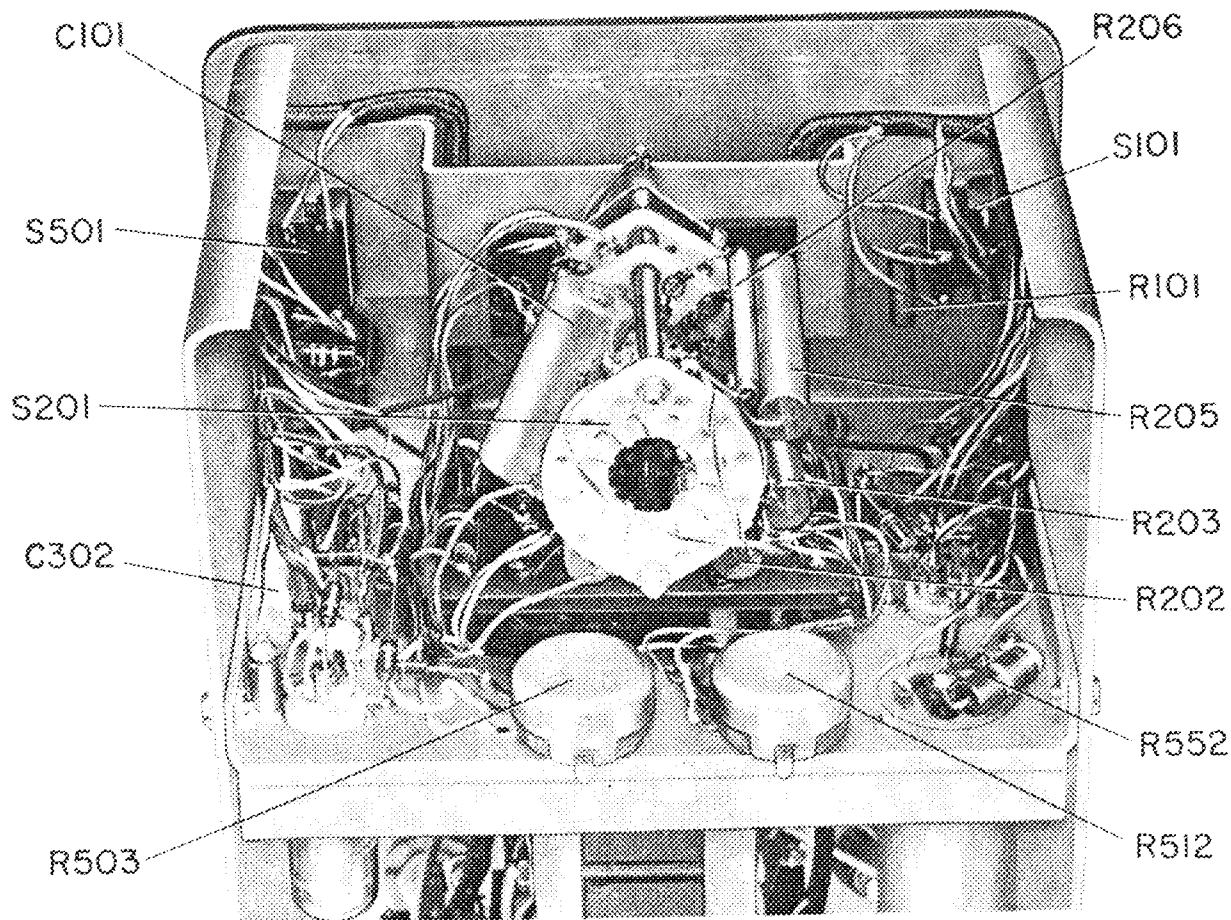


Figure 3-2. Bottom interior view of the Type 1862-C.

PARTS LIST continued

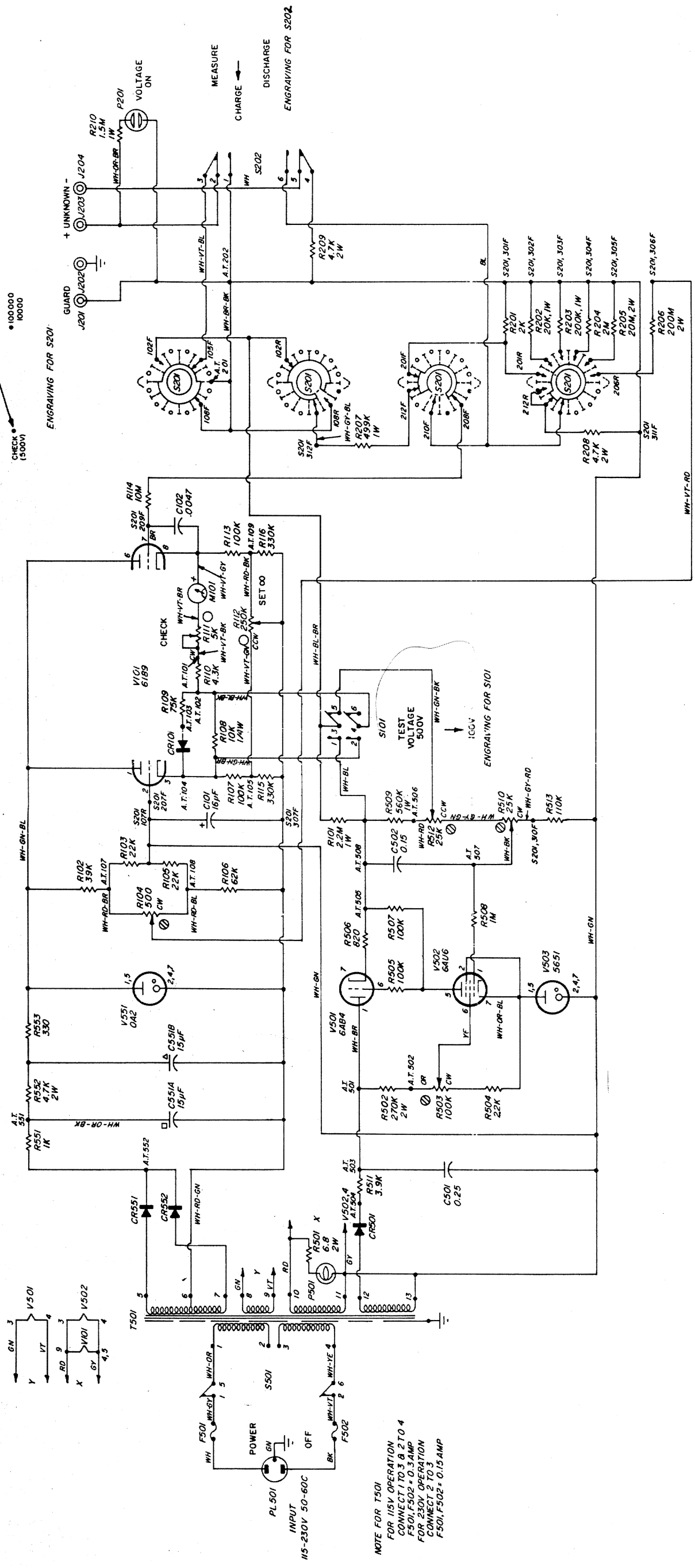
REF NO.	DESCRIPTION	PART NO.	
R115	RESISTOR, Composition $330k\Omega \pm 5\%$ 1/2w	6100-4335	
R116	RESISTOR, Composition $330k\Omega \pm 5\%$ 1/2w	6100-4335	
R201	RESISTOR, Film $2k\Omega \pm 0.5\%$ 1/2w	6193-1200	
R202	RESISTOR, Film $20k\Omega \pm 1\%$ 1w	6550-2200	
R203	RESISTOR, Film $200k\Omega \pm 1\%$ 1w	6550-2300	
R204	RESISTOR, Film $2M\Omega \pm 1\%$ 1/2w	6450-4200	
R205	RESISTOR, Film $20M\Omega \pm 1\%$ 2w	6590-5200	
R206	RESISTOR, Film $200M\Omega \pm 1\%$ 2w	6183-6200	
R207	RESISTOR, Film $499k\Omega \pm 0.5\%$ 1w	6194-3499	
R208	RESISTOR, Composition $4.7k\Omega \pm 10\%$ 2w	6120-2479	
R209	RESISTOR, Composition $4.7k\Omega \pm 10\%$ 2w	6120-2479	
R210	RESISTOR, Composition $1.5M\Omega \pm 10\%$ 1w	6110-5159	
R501	RESISTOR, Wire-Wound $6.8\Omega \pm 10\%$ 2w	Part of 7510-1930	
R502	RESISTOR, Composition $270k\Omega \pm 10\%$ 2w		6120-4279
R503	POTENTIOMETER, Composition $100k\Omega \pm 10\%$		6010-1700

PARTS LIST continued

REF NO.	DESCRIPTION	PART NO.
R504	RESISTOR, Composition 2.2k Ω \pm 5% 1/2w	6100-2225
R505	RESISTOR, Composition 100k Ω \pm 5% 1/2w	6100-4105
R506	RESISTOR, Composition 820 Ω \pm 5% 1/2w	6100-1825
R507	RESISTOR, Composition 100k Ω \pm 5% 1/2w	6100-4105
R508	RESISTOR, Composition 1M Ω \pm 5% 1/2w	6100-5105
R509	RESISTOR, Composition 560k Ω \pm 5% 1w	6110-4565
R510	POTENTIOMETER, Composition 25k Ω \pm 10%	6010-1100
R511	RESISTOR, Composition 3.9k Ω \pm 5% 1/2w	6100-2395
R512	POTENTIOMETER, Composition 25k Ω \pm 10%	6010-1100
R513	RESISTOR, Composition 110k Ω \pm 5% 1/2w	6100-4115
R551	RESISTOR, Composition 1k Ω \pm 5% 1/2w	6100-2105
R552	RESISTOR, Composition 4.7k Ω \pm 10% 2w	6120-2479
R553	RESISTOR, Composition 330 Ω \pm 5% 1/2w	6100-1335
C101	CAPACITOR, Electrolytic 16 μ f +100-10% 150dcwv	4450-0200
C102	CAPACITOR, Ceramic 0.0047 μ f \pm 10% 500v	4400-2479
C501	CAPACITOR, Oil 0.25 μ f \pm 10% 1000dcwv	4510-2300
C502	CAPACITOR, Plastic 0.15 μ f \pm 10% 600v	4860-9400
C551A) C551B)	CAPACITOR, Electrolytic { ¹⁵ μ f ₁₅ μ f} +100-10% 350dcwv	4450-3500
CR101	DIODE, Type 1N645	6082-1016
CR501	DIODE, Type	6080-4001
CR551	DIODE, Type 1N3254	6081-1002
CR552	DIODE, Type 1N3254	6081-1002
F501	FUSE {115v,0.3a 230v,0.15a	5330-0800 5330-0500
F502	FUSE {115v, 0.3a 230v, 0.15a	5330-0800 5330-0500
J201	BINDING POST, Insulated, GUARD	4060-0400
J202	BINDING POST, Uninsulated, Ground	4060-1800
J203	BINDING POST, Insulated, + UNKNOWN	4060-0400
J204	BINDING POST, Insulated, - UNKNOWN	4060-0400
M101	METER, 200 μ a, 600 Ω	5730-1372
P201	PILOT LIGHT, VOLTAGE ON	8390-0600
P501	PILOT LIGHT,	5600-0700
PL501	Power Cable	4200-1903
S101	SWITCH, Toggle, TEST VOLTAGE	7910-1500
S201	SWITCH, Rotary Wafer, MULTIPLIER	7890-3220
S202	SWITCH, Toggle, Function	1862-1410
S501	SWITCH, Toggle, POWER	7910-1300
T501	TRANSFORMER	0485-4014
V101	TUBE, Type 6189	8380-6189
V501	TUBE, Type 6AB4	8360-0100
V502	TUBE, Type 6AU6	8360-2100
V503	TUBE, Type 5651	8380-5651
V551	TUBE, Type OA2	8300-0100

- NOTE UNLESS SPECIFIED**
1. POSITION OF ROTARY SWITCHES SHOWN COUNTerclockwise.
 2. CONTACT NUMBERING OF SWITCHES EXPLAINED IN SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
 3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
 4. RESISTORS 1/2 WATT.
 5. RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED.
 6. CAPACITANCE VALUES ONE AND OVER IN MICROFARADS, LESS THAN ONE IN MICROFARADS.
 7. \odot KNOB CONTROL.
 8. \circ SCREWDRIVER CONTROL.
 9. AT - ANCHOR TERMINAL.
 10. TP - TEST POINT.

ANCHOR TERMINALS USED: A.T. 101-105, 107, 108, 109, 201, 202, 501-508, 551, 552



NOTE FOR 115V OPERATION
 CONNECT 1 TO 3 & 2 TO 4
 F501 F502 = 0.3 AMP
 FOR 230V OPERATION
 CONNECT 2 TO 3
 F501, F502 = 0.15 AMP

Figure 5-3. Schematic diagram of the Type 1862-C.

GENERAL RADIO COMPANY

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REDESIGNED MEGOHMMETER SIMPLIFIES INSULATION RESISTANCE MEASUREMENT

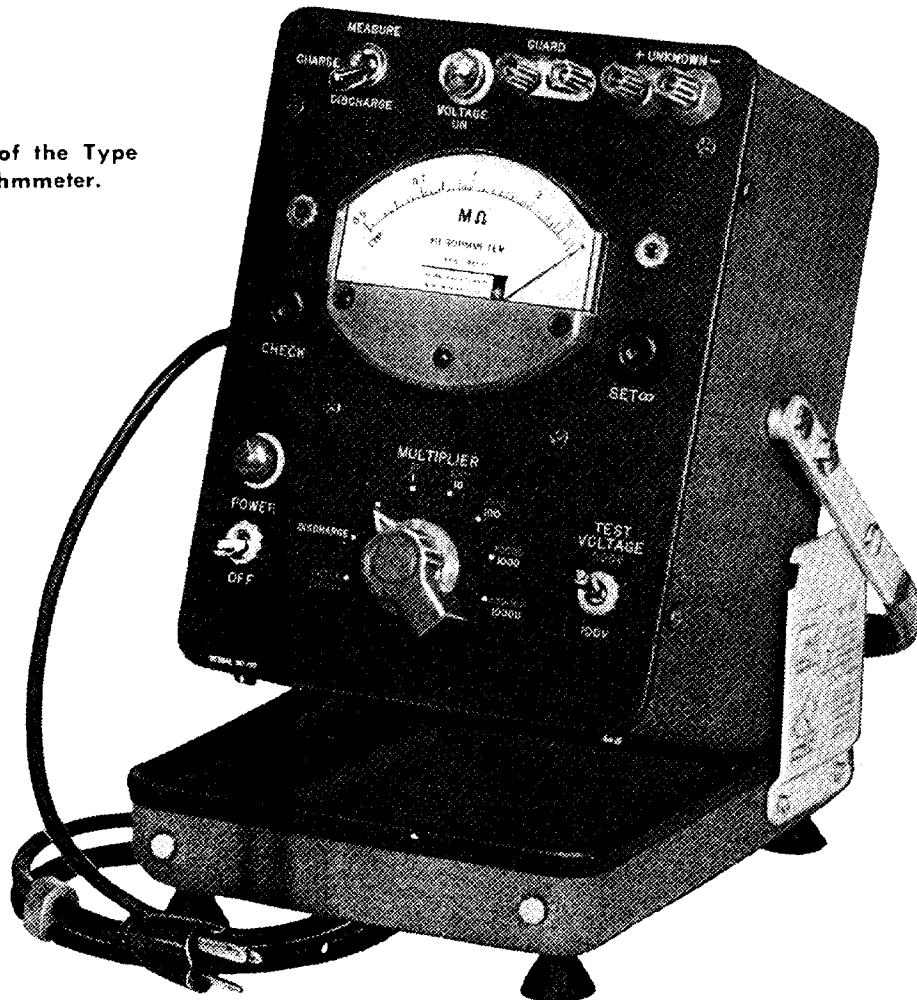
Users of the TYPE 1862-B Megohmmeter¹ who were kind enough to return questionnaires describing their use of the instrument and their suggestions as to how it could be improved will be pleased to know that they have had a hand in redesigning this popular instrument to make what should be an even more satisfactory unit. The new TYPE 1862-C, shown in Figure 1, has incorporated

¹A. G. Bousquet, "New Model of Megohmmeter Has Two Test Voltages," *General Radio Experimenter*, 29, 9, December, 1954

most of the ideas suggested and a couple we thought up ourselves. However, we could not add everything asked for, because we felt (and users agreed) that the small size and modest cost of the instrument were among its important features.

The most noticeable change is in the packaging. The new model is housed in the Flip-Tilt case, which has won wide approval, particularly for its ability to support the instrument with its panel at

Figure 1. View of the Type 1862-C Megohmmeter.



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almost any angle. Correct viewing angle is important for any instrument whose output is a meter reading. The Flip-Tilt case is especially versatile in this respect* and offers as well the added features of easy portability and protection for both transit and storage. Prominent also in the appearance is the large panel meter, the new GR design with its maximum-length, open scale. Further, for easy reading and interpolation, the movement is reversed, so that resistance values increase from left to right.

A new feature is the separate, 3-position DISCHARGE-CHARGE-MEASURE toggle switch. This is important for those who use the instrument to make repetitive measurements on a given range. With the older instrument, the MULTIPLIER switch had to be used for discharging, and, if the measurements were made on a high resistance range, this resulted in a lot of switch rotating for each measurement. The DISCHARGE position on the MULTIPLIER switch is still provided.

The voltage is removed from the unknown terminals if either switch is set to DISCHARGE. An indicator lamp, located near the measurement terminals, is lit when the test voltage is applied. The lamp, which is especially bright

* For details, see page 7.

when 500 volts are applied, provides a warning to the operator, for, although the instrument current itself is not dangerous, a charged capacitor on the terminals is dangerous and could be lethal.

One change repeatedly asked for was the new, 100-volt test voltage, which is a standard for many measurements. This replaces the 50 volts provided on the older instrument. The accuracy is the same for both 100 and 500 volts, in contrast to the poorer accuracy on the 50-volt range of the older model. Internal changes include the use of semiconductor rectifiers and a "premium" tube in the meter circuit, whose low grid current improves the stability of measurements of very high resistances.

Our survey indicated that over 80% of the instruments were used for insulation resistance measurements, and the rest were used to measure volume and surface resistivity or high-valued resistors. The insulation resistance measurements were on cables, capacitors (leakage), transformers, connectors, relays, printed circuits, motors, and switches. With the new model these measurements can be made with even more ease than in the past.

— H. P. HALL

SPECIFICATIONS

Range: 0.5 to 2,000,000 megohms at 500 volts and to 200,000 megohms at 100 volts. There are six decade steps selected by a multiplier switch.

Scale: Each resistance scale up to 500,000 megohms utilizes 90% of the meter scale. Center-scale values are 1, 10, 100, 1000, 10,000, and 100,000 megohms for 500-volt operation.

Accuracy: From $\pm 3\%$ at the low-resistance end of each decade to $\pm 12\%$ (accuracy to which the scale can be read) at the high-resistance end up to 50,000 megohms. There can be an additional $\pm 2\%$ error at the top decade.

Voltage on Unknown: 100 or 500 volts, as selected by switch on front panel. Indicator lamp is

lighted when voltage is applied. Current available limited to safe value. Voltage across unknown is 500 volts ± 10 volts, or it is 100 volts ± 4 volts. This voltage source is regulated for operation from 105- to 125- (or 210- to 250-) volt lines.

Terminals: Unknown, ground, and guard terminals. All but the ground terminals are insulated. The voltage is removed from the terminals in the DISCHARGE position of either switch.

Calibration: Switch position is provided for standardizing the calibration at 500 volts.

Power Requirements: 105 to 125 (or 210 to 250) volts, 40 to 60 cps, 25 watts. Instrument will operate satisfactorily on power-supply frequencies up to 400 cps.

SPECIFICATIONS (Cont.)

Accessories Supplied: Spare fuses, two color-coded test leads.

Cabinet: Flip-Tilt; relay-rack model also is available.

Dimensions: Portable model, case closed — width 11½, height 8¼, depth 7½ inches (295

by 210 by 190 mm), over-all; rack model — panel 19 by 5¼ inches (485 by 135 mm); depth behind panel 5 inches (130 mm).

Net Weight: Portable model, 9 pounds (4.1 kg); rack model, 10 pounds (4.6 kg).

Shipping Weight: Portable model, 16 pounds (7.5 kg); rack model, 23 pounds (10.5 kg).

Type		Code Number	Price
1862-C	Megohmmeter, Portable Model	1862-9703	\$310.00
1862-9844	Megohmmeter, Rack Model	1862-9844	310.00

WESCON-1963 — August 20-23

Cow Palace, San Francisco

We look forward with pleasure to welcoming *Experimenter* readers to the General Radio exhibit at Wescon. Many new instruments will be on display.

Several of these have been described in recent issues of the *Experimenter*. Others are shown for the first time and will be described in forthcoming issues.

Type 1900-A Wave Analyzer — A new narrow-band analyzer, 20 to 50,000 cps, with 3 bandwidths — 3, 10, and 50 cps.

Type 1564-A Sound and Vibration Analyzer — 2.5 to 25,000 cps, 1/3- and 1/10-octave bands, all-solid-state circuitry, line or battery power.

Type 1308-A Audio Oscillator and Power Amplifier — 20 to 20,000 cps, 200-watt output up to 1 kc, low distortion, good regulation, metered output, solid-state circuitry.

Counters — Type 1130-A with Type 1133-A Range-Extension Unit (*Experimenter*, February-March, 1963); Type 1150-A (*Experimenter*, April

1962); Type 1151-A (*Experimenter*, April-May, 1963); Type 1137-A Data Printer (*Experimenter*, April-May, 1963); Type 1136-A Digital-to-Analog Converter; Type 1521-A Graphic Level Recorder.

Type 1025-A Standard Sweep-Frequency Generator (*Experimenter*, January, 1963).

Type 1806-A Electronic Voltmeter (this issue).

Type 900 Precision Coaxial Connectors (*Experimenter*, February-March, 1963).

Type 1531-P2, -P3 Stroboscope Accessories.

Booth 2215-2218

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