THE "MEG" TYPE of "MEGGER" INSULATION AND RESISTANCE TESTER

One of the outstanding characteristics of all types of the "Megger" instruments is *quality* of a high order. The performance and endurance records which these instruments have achieved are difficult, if not impossible, to match in any type of portable testing device. For insulation resistance, "Megger" instruments are *the recognized standard.*

The distinguishing features of the hand-operated "Meg" type instrument are: its compact case of black molded material, its hand-cranked d-c generator and its "Megger" direct-reading true ohmmeter. The instrument is used in all manner of places and on all sorts of electrical equipment. It is carried about by various means; it is sometimes handled roughly. The molded case of high-impact strength material is really tough and the hand-generator assures unfailing operation whenever and wherever the instrument is needed, and whatever the emergency.

Pointer indications of insulation resistance are given by the cross-coil true ohmmeter. There are no keys to press or any dials to adjust, and the accuracy is independent of the exact speed of the generator or strength of the permanent magnets.

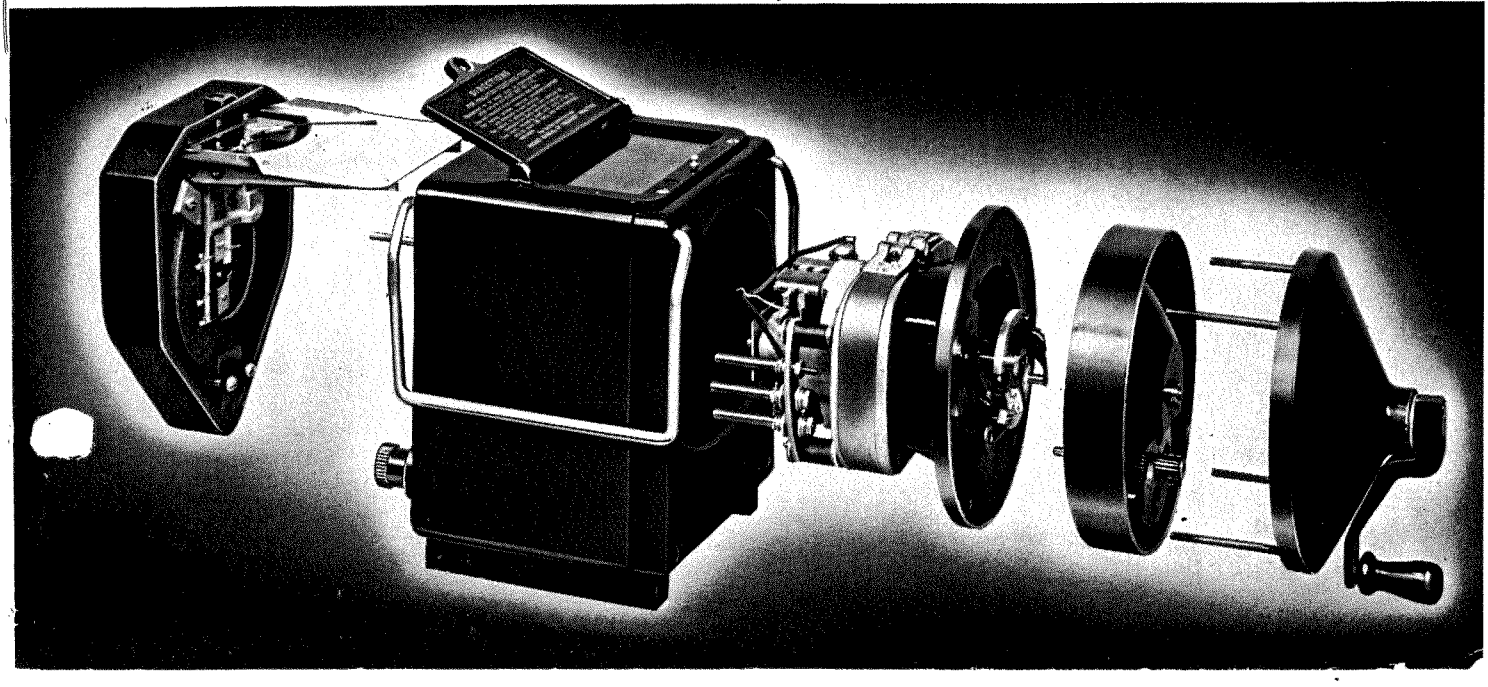
An instruction manual giving full directions for connecting and operating the instruments, includes valuable information on the protection of electrical equipment by means of insulation resistance tests.

Ratings

The "Meg" type of "Megger" instrument is available in ratings up to 2000 megohms and 1000 volts d-c. See listings on page 10.

An important accessory feature is the Ohm Scale described on page 7. Ratio and Discharge Switches also add to the usefulness of the instruments.

Figure 1. Expanded view showing general assembly.



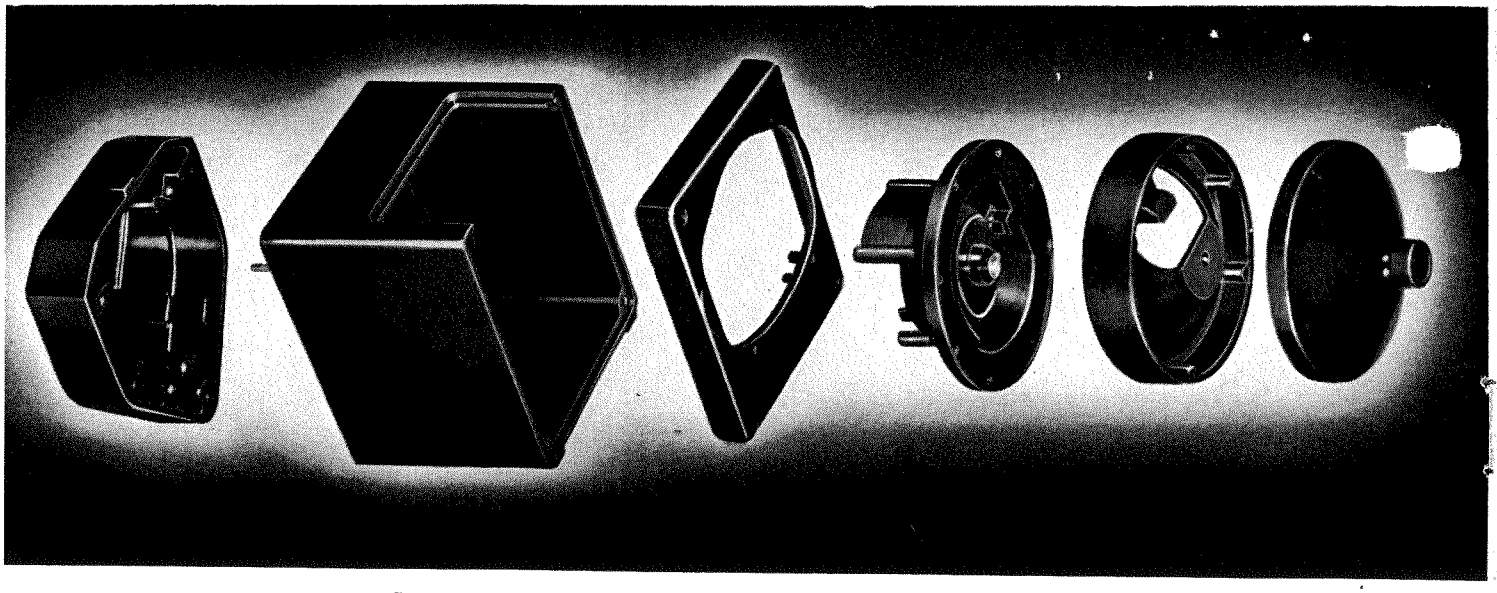


Figure 2. The specially designed individual plastic molded parts of the case. A canvas base, high impact strength material is used.

General Assembly

The principle sub-assemblies are shown in Fig. 1. The ohmmeter is mounted in a molded housing at one end of the case, and the hand generator and drive mechanism are built into separate molded units at the other end. These parts all fit together with the main case to form a strong and compact assembly.

Case

All of the various molded parts that go to make up the complete case assembly are of high impact strength, thermo-setting phenolic compound, one of the strongest and toughest molding materials that has yet been produced. It has proved eminently successful in this application.

All joints are dust-proof. The feet of the instrument are of hard fibre and are attached from the outside of the instrument for easy replacement should they become worn. Metal handles latch together over the top of the instrument for carrying. The glass over the scale is protected by a hinged metal cover.

Ohmmeter

The ohmmeter, which is shown removed from the case in Fig. 4, is of the permanent-magnet, cross-coil and pointer type. It is a *true* ohmmeter—not simply a voltmeter calibrated in ohms, therefore the accuracy is not affected by variations in the testing voltage.

Principle of Operation

Fig. 3 is a simplified diagram of the electrical circuit. The ohmmeter has two coils *A* and *B* mounted in a fixed relation to each other on the moving system, which is pivoted in spring-supported jewel bearings. The moving system carries a pointer and balancing weight (see Fig. 4) and is free to rotate through about 70 degrees in a permanent-magnet field. A C-shaped iron core (Figs. 3 and 4) is mounted in a fixed position coaxially with the moving system and forms an important part of the ohmmeter magnetic circuit. There are no control springs as in an ammeter or voltmeter. Current is led to the coils by lead-in spirals which are flexible and conducting and offer only slight restraint, so that when the generator is not being operated the pointer should float towards Infinity.

Deflecting and Control Coils

Coil *A* (Fig. 3) is connected across the current supply in series with the resistance under test and a fixed ballast resistance R', and is called the current or deflecting coil.

Coil *B* is also connected across the current supply in series with a fixed resistance *R*, and is called the potential or control coil. Coil B' is a compensating coil in series with coil *B*.

Coils *A* and *B* are so connected that when current is supplied they develop opposing torques and tend to turn the moving system in opposite directions, and the pointer takes a position over the scale where the two torques are balanced.

When the "Megger" Tester is operated (i.e., when the crank is turned) and with either perfect insulation or nothing at all connected to the Earth and Line terminals, no current will flow in the deflecting coil *A*. The control coil *B*, however, receives current from the generator and will take a position opposite the gap in the C-shaped iron core, and where the pointer will indicate Infinity.

When a resistance is connected across the terminals, a current will flow in the deflecting coil *A*, and the corresponding torque will draw the control coil *B* away from the Infinity position into a field of gradually increasing magnetic strength until a balance is obtained between the forces acting on the two coils. Thus the control coil *B* acts like a restraining spring.

By introducing resistances of different known values across the Earth and Line terminals and marking the corresponding position of the pointer in each case, a scale calibrated in resistance is obtained. In this manner the scales of *all* "Megger" Insulation Testers are *individually* calibrated and drawn. If the Earth and Line terminals are short-

Figure 3. Basic diagram of electrical connections for the "Megger" Insulation Tester.

circuited, the pointer simply moves to Zero. The ballast resistance R' offers ample protection against excessive current in the coil A.

Variations in Generator Voltage

Scale calibration is independent of the specific value of the generator voltage. This is because the two ohmmeter coils (A and B, Fig. 3) receive current from the same source, namely the generator, and any change in the generator voltage will affect both of the coils in the same proportion. Therefore the pointer will take the same position for a given resistance under test. Consequently the scale calibration is unaffected by the exact speed at which the crank is turned, or by the exact strength of the permanent magnets, within plus or minus about 20% of normal.

Magnets

Magnets for both generator and ohmmeter are of Alnico steel, and have the advantages of permanence and stability associated with that material. They are not readily weakened by armature demagnetizing, even if the armature is short-circuited.

Accuracy

The Meg type instruments are factory-calibrated individually to within plus or minus ⅓ of 1% of *scale length.** In normal service they will maintain calibration to within plus or minus 1% of scale length.

Owing to the spring-mounted jewel construction, specially designed steel pivots and rigid inspection, mechanical injury and pivot friction are reduced to a minimum, and accuracy is usually well maintained. Even in an old or abused instrument, if the pointer is approximately correct at the Zero and Infinity readings, there is strong probability of good accuracy over the rest of the scale.

* Because of the absence of controlling springs and also the logarithmic character of the scale, the accuracy is expressed as a linear distance rather than in per cent of full scale deflection. The scale length of a Meg type insulation tester is approximately 3 inches.

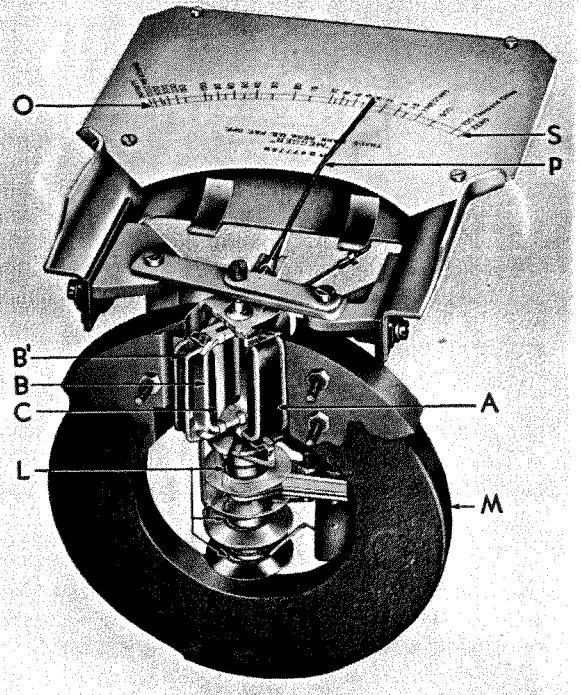


Figure 4. Ohmmeter removed from case.
O-S = Ohmmeter Scale
P = Pointer
B & B' = Potential or Control Coils
A = Current or Deflecting Coil
C = Fixed C-shaped Iron Core
L = Lead-in Spirals
M = Permanent Magnet

Guard System

The Guard system of electrical connections is a means for preventing errors in the ohmmeter readings due to possible current leakage inside or outside of the instrument between the positive and negative sides of the circuit. The principle is that of by-passing the leakage current around the ohmmeter, so that it can cause no error. For example, the Guard ring (Fig. 3) is a metallic washer supporting the Line terminal, and insulated from it. Any leakage current that may creep across the surface of the case or through the plastic material from the positive Earth terminal towards the Line terminal will be intercepted by the Guard ring. The Guard circuit offers a low resistance path for the leakage current directly to the generator, without passing through the current coil of the ohmmeter. Such a leakage condition between the testing terminals may be caused by dampness or dirt and may be unavoidable under some test conditions. In the same manner resistance coils and other live parts inside the instrument are also mounted on guarded supports.

The Guard terminal (see Fig. 7) makes it possible when desired to extend the Guard system to apparatus under test such as wires, cables and insulators. The Guard terminal is regularly supplied on all "Meg" type instruments (1) having ranges of 1000 megohms and higher, (2) having Ohm scales.

Hand Generator

The hand generator is of the two-pole, permanent-magnet type. The armature is slot-wound in two sections with ends brought out to a pair of two-part commutators. The commutator and brush rigging are covered by a tight fitting cap of plastic material, which prevents windage from affecting the moving system. In this manner the ohmmeter is as well protected as if it were in a dust-tight compartment of its own.

The generator is driven by means of a hand crank and gear train with a free-wheeling device so that the armature can spin freely when cranking is stopped, and the armature cannot be rotated backwards. Rated voltage is developed at about 160 rpm of the hand crank.

The armature runs in roller bearings. All gears and bearings are either of the oilless type or are packed with a specially adhering lubricant. Therefore no provision for oiling or other lubrication is necessary. After several years of normal use, instruments should be returned to us for general inspection and such servicing as may be necessary.

Constant-voltage Feature

In order to secure steady readings of insulation resistance where capacitance is involved, a steady or constant d-c test voltage is necessary. Hence the constant-voltage feature which also has the advantage of automatically limiting the instrument output voltage, regardless of how fast the hand crank is turned.

As explained on page 5, variations in generator voltage do not affect the accuracy of indications. A constant voltage is not necessary when testing a resistor. Insulation resistance of electrical equipment, however, is seldom if ever free from capacitance and dielectric absorption effects. The constant-voltage generator is necessary to build up and maintain a steady d-c charge on the apparatus under test.

Constant voltage is secured by means of a centrifugal governor or slip clutch which is built into the driving mechanism; see Fig. 5. By this means the armature is driven at a constant speed when the hand crank is operated at or above the slip speed, and therefore delivers a constant voltage.

Where the voltage is variable there will be surges of current into and out of the capacitance that may be associated with the insulation resistance under test. These surges will pass through the deflecting coil of the ohmmeter, see Fig. 4, without causing a proportionate change in current in the control coil, and therefore will cause the pointer to fluctuate.

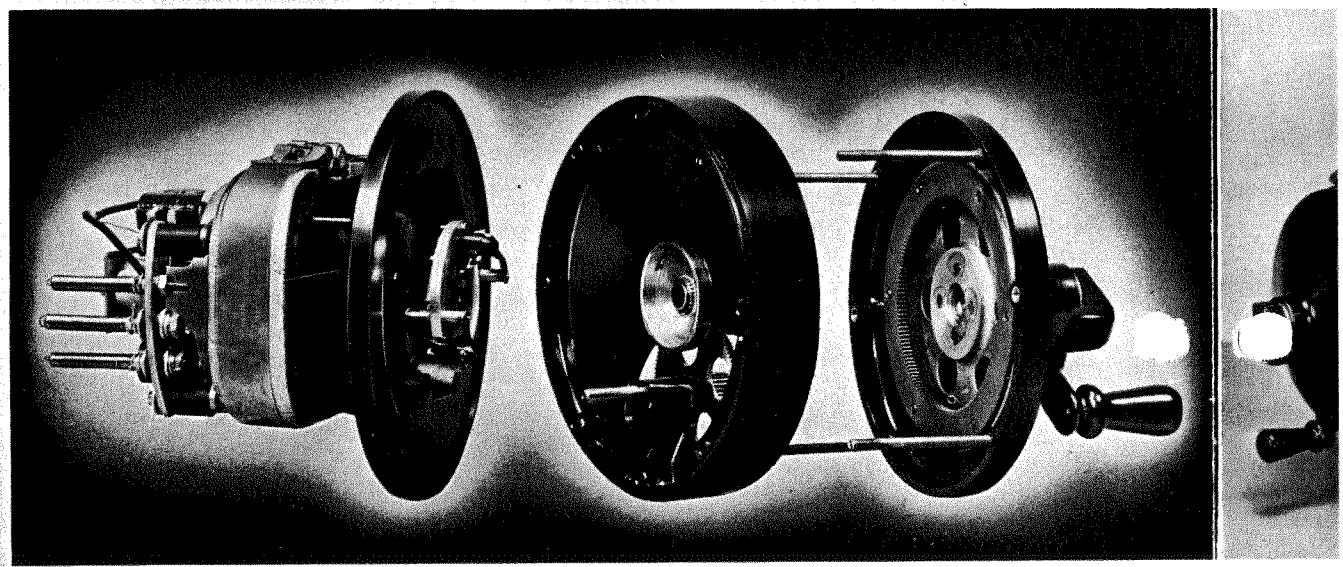


Figure 5. Direct-current magneto generator, centrifugal clutch mechanism and driving gears.

The constant-voltage feature of the hand-driven "Meg" type instrument is now considered essential by the great majority of our customers. However, *variable-voltage* "Meg" type instruments are offered for those who do not require the constant-voltage feature.

Note—The constant-voltage "Meg" type instruments have heretofore been designated as "Super-Meg" type, to distinguish them from the variable-voltage "Meg" type.

Voltage Characteristics

An important factor in the use of insulation testing instruments is the proportion of the rated voltage that is actually applied to the resistance under test. This depends upon the voltage regulation of the current source and the resistance in series with the ohmmeter or other indicator.

In "Megger" instruments the voltage regulation of the current source is practically 100%.

Fig. 6 shows the Earth-to-Line terminal voltage characteristic for a 500-volt, 200-megohm "Meg" type instrument, due to the ballast resistance (R′, Fig. 3) which in this instrument is approximately 100,000 ohms. If the resistance under test happens to be 100,000 ohms, the rated instrument potential of 500 volts will obviously be divided equally between these two resistances and the voltage at the Earth and Line terminals will be 250. When testing an external resistance of 1 megohm, the terminal voltage will be in the ratio of 1,000,000 to 1,100,000, i.e., 10/11 of the total, or approximately 455 volts.

This example shows: (a) that over the upper two-thirds of the linear scale (the principal working range of the instrument) 90% or more of the rated voltage is applied to the equipment under test, and (b) that low insulation resistance is automatically protected from what otherwise might be too high a voltage.

This is a favorable voltage characteristic because the voltage applied is relatively high and uniform when the resistance under test is high; and the applied voltage is automatically limited to lower values when the resistance under test is low.

Voltage characteristic data for other ratings of the "Megger" instruments are available upon request.

SELECTOR SWITCH FEATURES

By means of a selector switch mounted in the side of the instrument as shown in the cover illustration, three important accessory features, and combinations of them, can be included in various ratings of the "Meg" type instruments. These are:

1—Ratio Switch designated by the suffix A.

2—Ohm Scale designated by the suffix R.

3—Discharge Switch designated by the suffix K.

Figs. 8 to 13 show the six types of these selector switches that are available. Specifications are given on page 10.

Ratio Switch

The Ratio Switch (Fig. 8) divides by 10 the regular megohm scale. Thus an instrument having a normal range of 0 to 200 megohms has also a range of 0 to 20 megohms, permitting insulation resistance measurements to as low as 1000 ohms.

The selector switch has two positions: ÷ 1 and ÷ 10.

The Earth and Line terminals are used for both ranges.

Ohm Scale

The Ohm scale, Figs. 15, 17, 19, and 21, has a range from 0 to 10,000 ohms. It permits one to make quick tests of conductor resistance without resorting to other test equipment — often of great advantage when trouble-shooting. The Ohm scale is used in addition to and independently of the Megohm

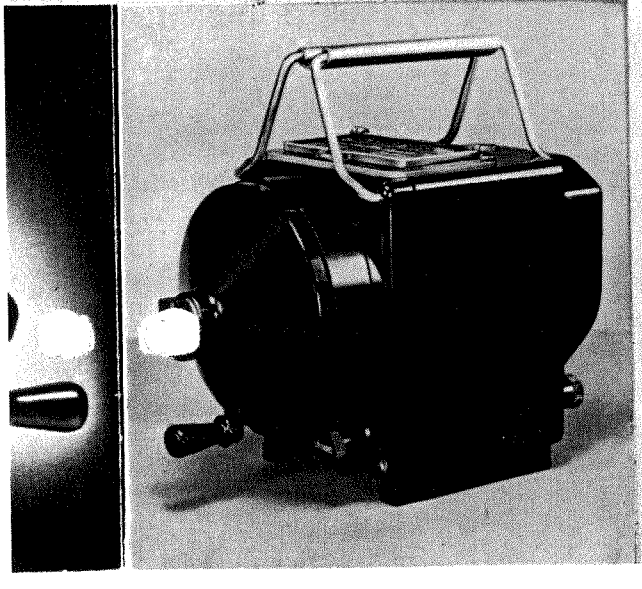


Figure 6. Earth-to-line terminal voltage characteristic of a 500-volt "Meg" type instrument having a ballast resistance of 100,000 ohms.

←Figure 7. The "Meg" type instrument showing the Guard terminal.

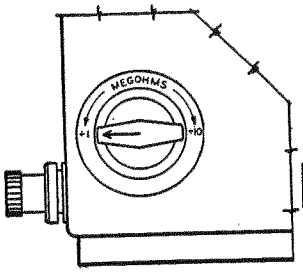


Figure 8. Megohm Scale with Divide-by-10 (The A Switch).

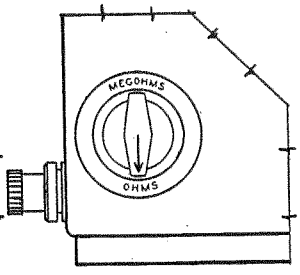


Figure 9. Megohm and Ohm Scales (The R Switch).

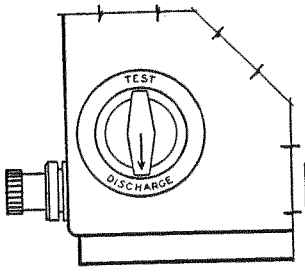


Figure 10. Megohm Scale and Capacitance Discharge Switch (The K Switch).

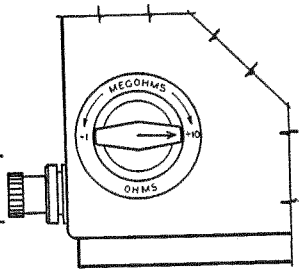


Figure 11. Megohm Scale with Divide-by-10 and Ohm Scale (The AR Switch).

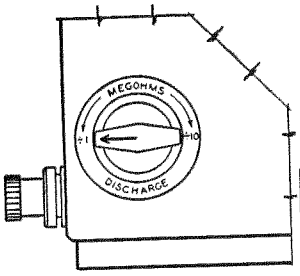


Figure 12. Megohm Scale with Divide-by-10 and Discharge Switch (The AK Switch).

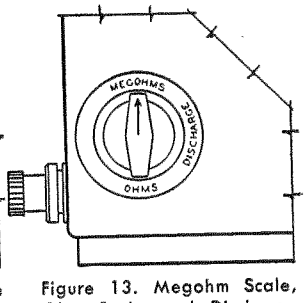


Figure 13. Megohm Scale, Ohm Scale and Discharge Switch (The RK Switch).

scale. The selector switch, Fig. 9, has two positions marked MEGOHMS and OHMS.

The Earth and Line terminals are used for the Megohm scale. The Guard and Ohms terminals are used for the Ohm scale.

Discharge Switch

The Discharge Switch (Fig. 10) is a convenient means by which the capacitance charge in apparatus under test can be discharged. This charge is built up during the test because the test voltage is d-c.

Discharging capacitance removes a hazard to persons and equipment that might come in contact with charged apparatus after the test is completed. The discharge switch opens the circuit between the measuring portion of the instrument and the testing terminals, and short-circuits the latter through a current-limiting resistor.

Thus the charge is dissipated in a manner that does no harm to the apparatus or to the "Megger" instrument. Obviously the testing leads remain connected during the discharging time.

The discharge switch has two positions marked TEST and DISCHARGE.

Combinations

The Ratio Switch and Ohm Scale can be supplied in the same instrument.

The Discharge Switch and *either* the Ratio Switch *or* the Ohm Scale can be supplied in the same instrument.

Special problems can be considered.

Insulated Testing Leads

Insulated leads should be durable and of the best quality insulating material. Rubber-insulated, single-

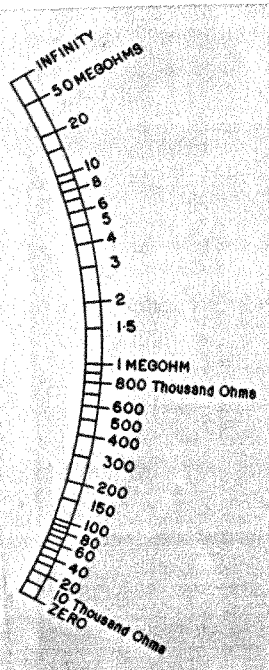


Figure 14. Cat. Nos. 7673 and 7674, 250 volts.

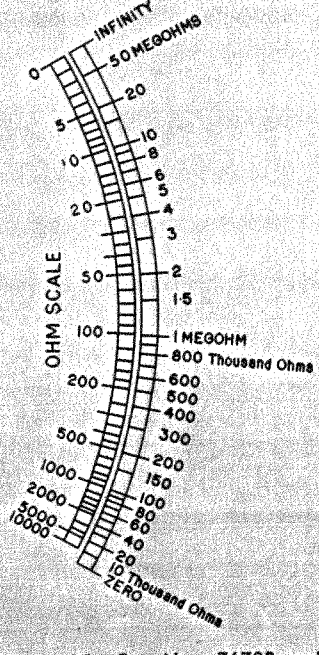


Figure 15. Cat. Nos. 7673R and 7674R, 250 volts.

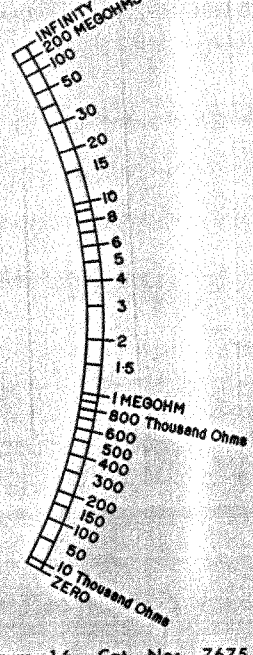


Figure 16. Cat. Nos. 7675 and 7676, 500 volts.

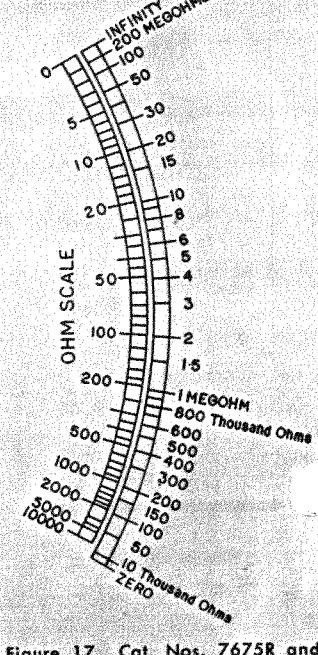


Figure 17. Cat. Nos. 7675R and 7676R, 500 volts.

Figure volts, c volts.

conductor No. 14 stranded wire with oil-resistant jacket is recommended. The outer jacket should be smooth, with no outer braid. Lugs should be fitted for attaching to the instrument terminals, and stout spring clips are recommended for connecting to the apparatus or circuit under test. Any convenient length of lead may be used. Joints are to be avoided.

We offer heavy-duty leads of various lengths made to these specifications. See page 11.

Carrying Cases

Two types of carrying cases are available, one of fabrikoid-covered wood, and another of best quality leather. Each has a hinged lid with snap fastener and includes a leather strap which may be used as a shoulder strap or for carrying by hand.

These cases are each made in two sizes, one for the instrument only (any rating) and the other with a separate compartment of a size suitable for one pair of 6-foot heavy-duty insulated testing leads. See Fig. 23 for sizes.

Cases are listed on page 11.

Insulation Resistance Record Cards

These are for keeping records of insulation resistance tests in convenient written and graphic form. One side is ruled for recording test results, including temperature and humidity conditions. On the other side a graph may be drawn, showing at a glance the trend of the insulation resistance for a given piece of equipment.

Two sizes of these cards are available as listed on page 11.

Selection of Rating

The main consideration is the type or types of equipment that are to be tested. The range, voltage and accessory features can then be decided upon.

For testing high-voltage apparatus—use Cat. No. 7680, rated 2000 megohms and 1000 volts.

For the general run of industrial equipment rated up to 440 volts, a 500-volt, 200 megohm instrument, Cat. No. 7676 is suitable. This is the most popular rating, especially with the Ohm Scale—Cat. No. 7676-R.

For low-voltage apparatus, including low-voltage control wiring, a 100- or 250-volt instrument may be used. However, most electrical equipment should withstand 500 volts d-c.

An all-round rating, and one that is becoming increasingly popular, because it is suitable for all types, sizes and voltage ratings of electrical equipment, is Cat. No. 7679-R, 1000 megohms, 500 volts, and with Ohm Scale reading from 0 to 10,000 ohms.

As mentioned on page 7, variable-voltage instruments, Cat. Nos. 7671, 7673 and 7675, are available for testing equipment having a negligible amount of electrostatic capacitance. They are slightly lower in cost than the constant-voltage models.

ILE SCALES (All Approximately 3")

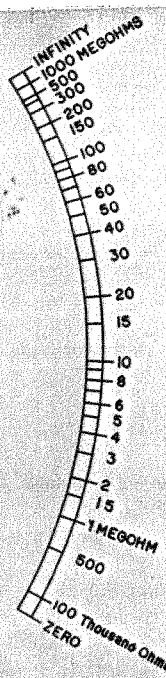


Figure 18. Cat. Nos. 7679, 500 volts, and 7679-S and 7679.4, 400 volts.

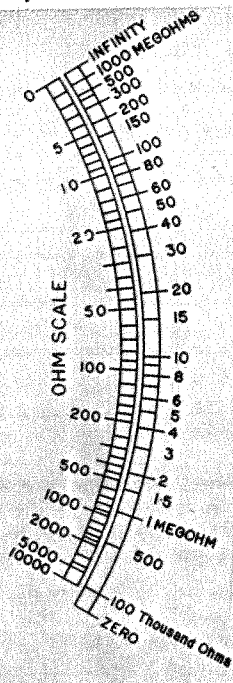


Figure 19. Cat. Nos. 7679R and 7679.4-R, 500 volts.

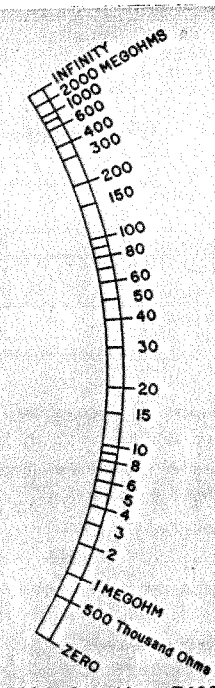


Figure 20. Cat. Nos. 7680 and 7680-A, 1000 volts.

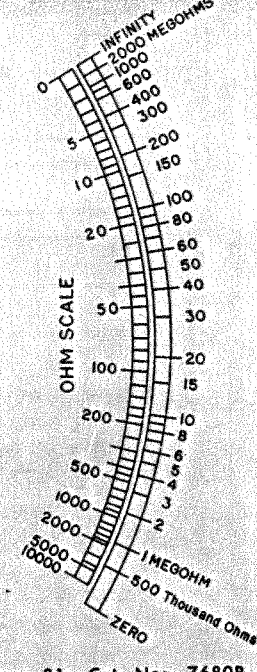


Figure 21. Cat. Nos. 7680R and 7680-AR, 1000 volts.

"MEGGER" INSULATION TESTERS—"MEG" TYPE

WITH CONSTANT-VOLTAGE D-C HAND-GENERATOR

Cat. No.	Range	Facsimile Scale In—	D-C Hand Generator	Price* with Test Leads and Cat. 7699 Fabrikoid Case	Price** for Instrument Only in Cat. 7697 Fabrikoid Case
7674	0 to 50 Megohms	Fig. 14	250 Volts		
7674-R	0 to 50 Megohms 0 to 10,000 Ohms	Fig. 15	250 Volts		
7676	0 to 200 Megohms	Fig. 16	500 Volts		
7676-R	0 to 200 Megohms 0 to 10,000 Ohms	Fig. 17	500 Volts		
7676-K	0 to 200 Megohms with Discharge Switch	Fig. 16	500 Volts		
7679	0 to 1000 Megohms	Fig. 18	500 Volts		
7679-A†	0 to 1000 and 0 to 100 Megohms	Fig. 18	500 Volts		
7679-R†	0 to 1000 Megohms 0 to 10,000 Ohms	Fig. 19	500 Volts		
7679-K†	0 to 1000 Megohms with Discharge Switch	Fig. 18	500 Volts		
7679-AR†	0 to 1000 and 0 to 100 Megohms 0 to 10,000 Ohms	Fig. 19	500 Volts		See Attached Price Schedule
7679-AK†	0 to 1000 and 0 to 100 Megohms with Discharge Switch	Fig. 18	500 Volts		
7679-RK†	0 to 1000 Megohms 0 to 10,000 Ohms with Discharge Switch	Fig. 19	500 Volts		
7679.4	0 to 1000 Megohms	Fig. 18	400 Volts		
7679.4-R	0 to 1000 Megohms 0 to 10,000 Ohms	Fig. 19	400 Volts		
7679.4-K	0 to 1000 Megohms with Discharge Switch	Fig. 18	400 Volts		
7679-S‡	0 to 1000 Megohms with Discharge Switch	Fig. 18	400 Volts		
7680	0 to 2000 Megohms	Fig. 20	1000 Volts		
7680-A†	0 to 2000 and 0 to 200 Megohms	Fig. 20	1000 Volts		
7680-R	0 to 2000 Megohms 0 to 10,000 Ohms	Fig. 21	1000 Volts		
7680-K	0 to 2000 Megohms with Discharge Switch	Fig. 20	1000 Volts		
7680-AR†	0 to 2000 and 0 to 200 Megohms 0 to 10,000 Ohms	Fig. 21	1000 Volts		

With Variable-Voltage d-c Hand-Generator

7673	0 to 50 Megohms	Fig. 14	250 Volts	Variable-Voltage	See Attached Price Schedule
7673-R	0 to 50 Megohms 0 to 10,000 Ohms	Fig. 15	250 Volts		
7675	0 to 200 Megohms	Fig. 16	500 Volts		
7675-A	0 to 200 and 0 to 20 Megohms	Fig. 16	500 Volts		
7675-R	0 to 200 Megohms 0 to 10,000 Ohms	Fig. 17	500 Volts		

*These prices include the instrument as specified, one pair Cat. 963 heavy-duty insulated test leads 12 ft. long, 100 4" x 6" record cards and one instruction manual, all in Cat. 7699 fabrikoid-covered carrying case.

For Cat. 7694 leather case instead of Cat. 7699 fabrikoid case .....**add** .....

**These prices include the instrument as specified, 100 4" x 6" record cards and one instruction manual, all in Cat. 7697 fabrikoid-covered carrying case.

For Cat. 7692 leather case instead of Cat. 7697 fabrikoid case .....**add** .....

†**Selector Switch Features,** designated by the suffix letters —A, —R, and —K, are described on page 7. With certain exceptions, they can be supplied on any rating of the constant-voltage "Meg" type instruments.

‡For use only by Western Electric and Associated Bell Telephone Co.'s Cat. 7679.4-K is the equivalent instrument for use elsewhere.