BULLETIN 21-20
JUNE 1954

The Megger®

Insulation Resistance Tester

Heavy Duty Type

Hand-Cranked
Motor-Driven
High Voltage
Rectifier-Operated
Recording

FIGURE 1. Catalog 638, Triple-Voltage, 500, 1000 and 2500 volts; 50,000 megohms. Facsimile scale on page 16.

JAMES G. BIDDLE CO.
Electrical & Scientific Instruments • 1316 Arch Street • Philadelphia 7, Pennsylvania

FIGURE 2.
Catalog 637 and Catalog MD-637.
Facsimile scale on page 16.

THE Megger Tester has, over the years, become an integral part of electrical operations everywhere. Through its inherent qualities of ruggedness, accuracy, and dependability it has earned for itself the enviable distinction of being the most widely accepted device for measuring electrical resistance.

Right in stride with today's pace of production, the Megger Insulation and Resistance Tester is demonstrating, in severe industrial service, that it is the most practical and economical means for making insulation resistance tests within the ranges of the available Megger instruments.

The high ranges now available in "Megger" Insulation Testers are extremely useful in several kinds of field tests, particularly in testing circuit breaker bushings, and in making time-resistance (dielectric absorption) tests on apparatus which has relatively high 10-minute insulation resistance values.

In the case of bushings, the insulation resistance of new units should be in the order of 50,000 megohms, and any deterioration that may occur in service, which can be detected at 2500 volts d-c, will be quickly observed with a "Megger" Instrument, of that range and voltage. The high-range "Megger" Instrument in ranges up to 200,000 megohms and ratings up to 10 kv., therefore, gives the maintenance engineer a simple and relatively inexpensive tool for detecting the deterioration in bushings in its early stages.

Furthermore, certain apparatus, such as some generators, transformers and cables can have relatively high 1-minute insulation resistance values which may increase with time during a time-resistance test. In such cases—and they are frequent—the instrument range should be high enough to permit this increase of resistance with time to be readily observed.

These are only a few of the cases where the "Megger" Insulation Testers offer decided advantages. The increased usefulness of these instruments will be reflected in applications in the field of preventive maintenance and production testing.

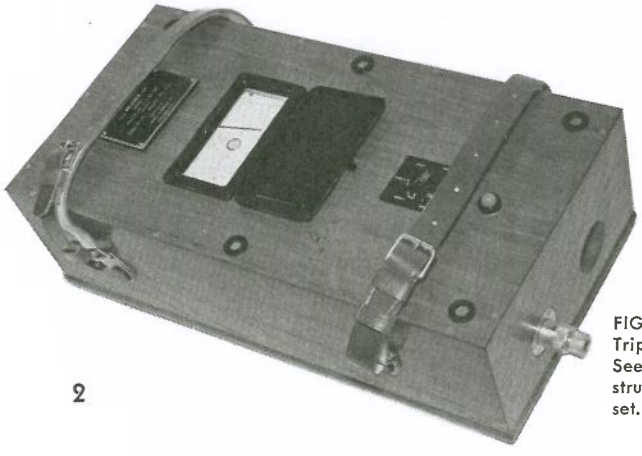


FIGURE 3. Catalog 8639, Rectifier-Operated, Triple-Voltage (5000, 2500 and 1000 volts d-c). See pages 11 and 12 for description of this instrument and also the 10,000 volt, rectifier-operated set.

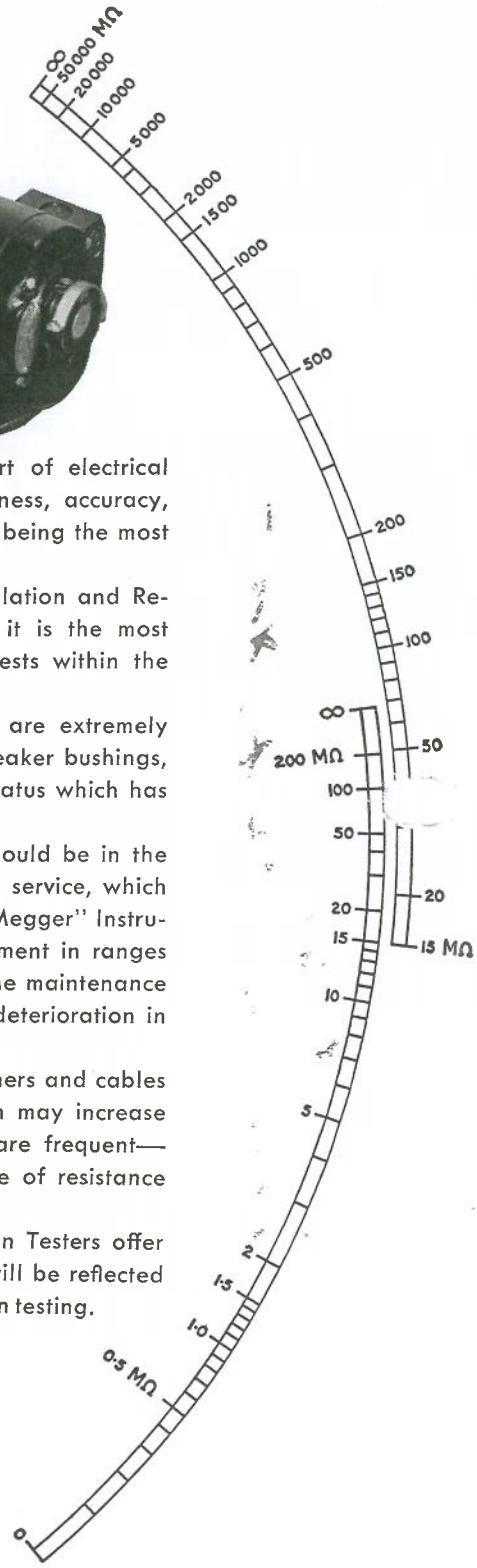


FIGURE 4. Showing the effective total scale length of a typical high range Megger i

The Heavy-Duty Hand-Crank Generator Type "Megger" Insulation and Resistance Tester

FIGURE 5. Showing a Catalog 638 instrument in use.

The "Megger" Insulation Tester is a high-range, direct-reading ohmmeter for measuring electrical insulation resistance. The heavy-duty hand-cranked type "Megger" instrument, described in this bulletin, is mounted in a substantial teakwood case, together with a direct-current generator arranged for either hand or motor operation. The instrument can be used for testing insulation resistance of practically all types and sizes of electrical equipment. Standardized ratings extend to as high as 50,000 megohms and 2500 volts d-c. The motor-driven and higher voltage rectifier-operated types are described on pages 11 and 12.

DESCRIPTION

The essential components are shown in Figs. 12 and 13. The teakwood case is in two parts—case and cover. The ohmmeter is mounted as a unit in one end of the case and the generator with driving gears as a separate unit in the opposite end. Space is provided for resistance coils, wiring, and such switching devices as may be necessary. The ohmmeter moving system is housed in a substantial molded plastic cylinder—well protected from both dirt and windage. The generator hand crank folds into a recess in the end of the case when not in use. Three binding posts are mounted on the side of the case. These are the Earth, Line, and Guard terminals. Binding post screwheads are not detachable.

The case cover contains a window protected by a hinged metal lid for viewing the scale. A leather handle is attached firmly to the case cover with a safety latch at one end for easy release. Case and cover are held together by through-bolts—one at each corner. Leveling feet are provided in order to secure maximum sensitivity, with a level mounted in the dial or scale plate.

RATINGS

The rating of a "Megger" Insulation Tester is expressed by its range *and* its operating voltage. The range is taken as the lowest figure on the scale to the highest figure in megohms before Infinity—for example, 0 to 50,000 megohms.

The operating voltage is the normal d-c voltage at which a given range of the ohmmeter is designed to operate.

See facsimile scales on page 16.

Multi-voltage and multi-range sets (see page 9) have come into increasing use because of their wide diversity of application.

Motor-driven and rectifier-operated sets are described on page 11.

USES FOR "MEGGER" INSULATION TESTERS

"Megger" Insulation Testers are used in practically all industries to test insulation resistance of all types of electrical apparatus.

The heavy-duty type of "Megger" Insulation Tester has its greatest application among power companies, railroads and large industrial plants for testing rotating equipment, transformers, cables and other apparatus. Tests are made at installation of equipment, when drying out moisture, at times of trouble and repair, and periodically thereafter in order to detect weaknesses and forestall failure.

Specific Applications

Detecting high resistance or low resistance grounds and short-circuits: in apparatus, cables and wiring—whether due to moisture, oil, dirt, corrosion, damage to insulation or to natural deterioration.

Determining the presence of moisture and other solvents or semi-conducting foreign materials: in wires, cables and other conductors, and in built-up insulation in windings; in slate, ceramic, synthetic and other solid insulating materials.

Determining dryness of insulation when drying out moisture: such as in generators, motors and transformers.

Dielectric Absorption Measurements: an effective method for detecting dirt or moisture in insulation.

Experimental Laboratory Investigations.

Types of equipment on which the insulation resistance test is effective

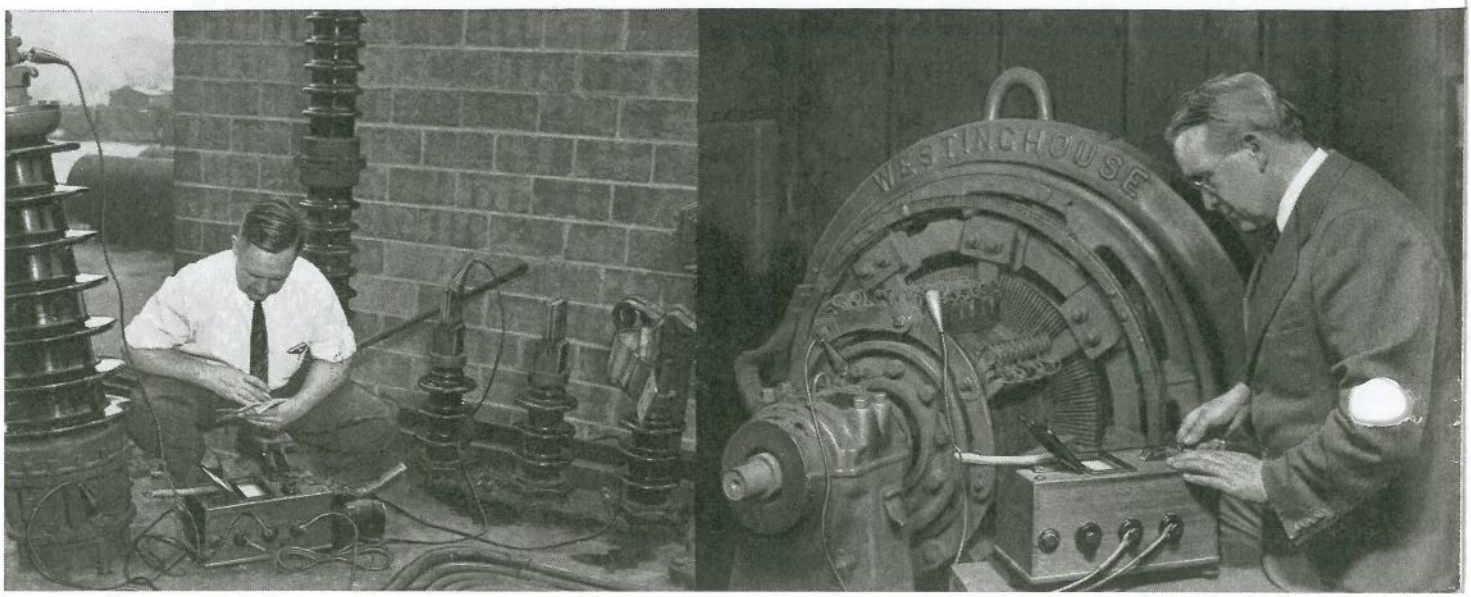
Generators
Motors
Synchronous converters
Transformers
Induction regulators
Power cables and wires
High-voltage insulators and bushings
Telephone cables and wires
Railway signal and automatic train control equipment
Wiring installations
Remote control and telemetering equipment
Series lighting circuits
Air conditioning equipment
Fabricated switchboard material
Switchboards and panelboards
Industrial control equipment
Electrical fittings
Radio and radar equipment
Electrostatic capacitors
Airplane wiring
Airport lighting equipment

Some reasons for insulation resistance measurements

In electrical utilities: In providing reliable and continuous electric service, the condition of the insulation in the electrical equipment in service is of vital importance.

FIGURE 6. On top of a large transformer, measuring nsulation resistance of bushings and winding. *Photograph Courtesy of* Philadelphia Electric Co.

FIGURE 7. Conducting a test on a synchronous converter using a hand-driven "Megger" Insulation Tester. *Photograph Courtesy of* Messinger Bearing Co.



In industrial plants: For maintenance and trouble-shooting work on important electrical equipment used in the manufacturing process.

On railroads and electric traction systems: For the maintenance of vital signal and train control equipment, the electrical apparatus in Diesel electric locomotives, and numerous other kinds of electrical circuits and devices.

In communication systems: For reliable operation of cable plant and numerous other electrical circuits and devices.

In telephone and telegraph companies: To check new cable, wiring and apparatus. To check cable splices. For general inspection and trouble-shooting.

Reasons as mentioned above, together with many others, apply to other activities such as on shipboard, in the mining industry, manufacturers of electrical equipment, to repair shops and in the aircraft industry.

Preventive Maintenance

The "Megger" Insulation Tester is an outstanding preventive maintenance tool. Rugged, dependable and indispensable, it is used by engineers, electricians and maintenance men to detect dirt, moisture and deterioration in electrical equipment—things that cannot be determined as easily in any other way.

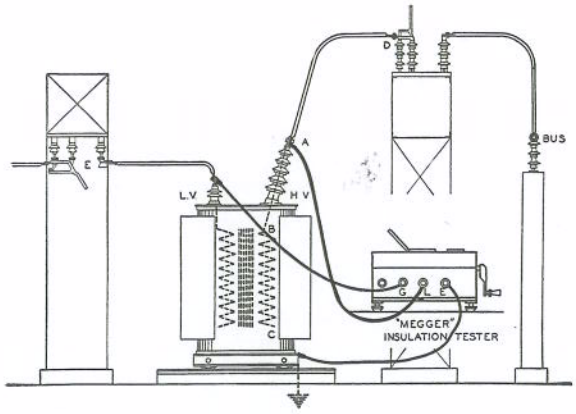


FIGURE 8. Connections for testing insulation resistance of a transformer high-voltage winding and bushings, and the high-voltage disconnect switch—in parallel, without being affected by leakage between the high and low voltage windings. Note the use of Guard connection.

To those who are unacquainted with the "Megger" instruments and the engineering "philosophy" which lies behind their use, we will gladly forward our Instruction Manual 21-J.

WHY THE "MEGGER" INSULATION TESTER CAN BE USED ON LARGE EQUIPMENT

Although "Megger" Insulation Testers have been used successfully for more than forty years on practically all types and sizes of electrical equipment, we are sometimes asked why one can test very large apparatus with a source of current of such small physical size and working through a relatively high resistance.

The answer is that the insulation resistance test is made by *direct current,* not alternating current. When apparatus is energized by alternating current, volt-ampere capacity is required for the necessary charging current. This is not the case when d-c is applied, only the capacitance charge has to be considered.

Direct current from the "Megger" Instrument very quickly builds up the necessary d-c capacitance charge, equal to the test voltage, following which the insulation resistance and the dielectric absorption effect can be observed by the pointer indications. The initial capacitance charge is completed in a matter of seconds, regardless of the size of the equipment under test, and follows well-known laws for decay of current in a capacitor.

THE "MEGGER" OHMMETER

The "Megger" ohmmeter is a permanent-magnet, moving-coil indicating instrument whose accuracy is independent of the exact voltage supplied for the test. No compensation or adjustment for voltage is necessary.

The ohmmeter consists essentially of two coils —*A* and *B* in Fig. 9, mounted in a fixed relation to each other on the same moving system with pointer attached and free to rotate in a permanent magnet field. The system is pivoted in spring-supported jewel bearings.

A C-shaped iron core 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 such as are used in ammeters and voltmeters. Current is led to the coils by lead-in spirals which are flexible and conducting and offer only slight restraint, so that when the instrument is level and no current is supplied, the pointer should float in either direction over the scale.

Deflecting and Control Coils

Coil *A* (Fig. 10) is connected across the voltage 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 voltage supply in series with a fixed resistance *R*, and is called the potential or control coil.

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. The pointer takes a position over the scale where the two torques are balanced.

With either perfect insulation or nothing at all connected to the testing terminals, no current will flow in the deflecting coil *A*. The control coil *B*, however, receives current and will take a position opposite the gap in the C-shaped iron core, Fig. 10. The corresponding position of the pointer over the scale is marked Infinity.

When a resistance is connected to the Earth and Line 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 exerted by the two coils. In this manner the control coil *B* acts like a restraining spring.

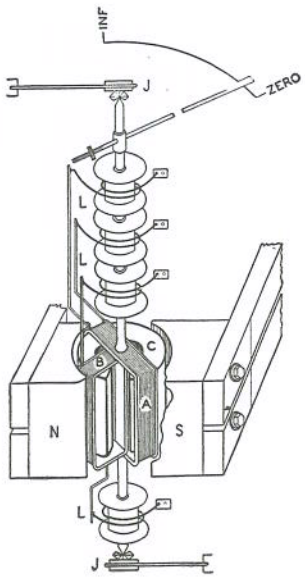


FIGURE 9. Showing in diagrammatic form the moving system and magnetic field of the "Megger" true ohmmeter.

A = deflecting coil
B = control coil
LLL = leading-in spirals hung loosely around insulating spools
JJ = spring-supported jewel bearings
NS = pole pieces of permanent magnet system
C = c-shaped iron core mounted in a fixed position coaxially with the moving system

Scales—Calibration

By connecting resistances of different known values to 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-circuited, the pointer simply moves off the lower end of the outer scale or to zero on the inner scale. The ballast resistance *R'* offers ample protection against excessive current in coil *A*. With no current supplied to the ohmmeter, the pointer will appear to relax and float as already explained.

Infinity Adjustment

The "Megger" ohmmeter has no Zero adjustment as in an ammeter or voltmeter because there is no control spring. Instead, the pointer has an Infinity position which is determined essentially by the location of the control coil *B* in the magnetic field.

As this Infinity position is apt to be critical in high-range instruments, an *Index Adjuster* (see Fig. 16) is provided, by which the pointer can be brought directly over the Infinity mark, similar to the zero setting in an ammeter or voltmeter. The adjustment is effected by a small magnetic shunt in the magnetic field of the ohmmeter.

Variations in Generator Voltage

The calibration of the "Megger" Ohmmeter is not affected by the exact value of the voltage which is applied to it. This is because the two ohmmeter coils *A* and *B* (Fig. 10) receive cur-

rent from the same source. Any change in the source voltage will affect both coils *A* and *B* in the same proportion, and therefore the pointer will take the same position for a given resistance under test. Consequently the calibration is unaffected by the exact speed at which the generator is operated or by the exact strength of the permanent magnets of either the ohmmeter or the generator.

MAGNETS

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

ACCURACY

A newly designed "Megger" ohmmeter of the heavy-duty type is accurate to within one to two pointer widths at all points on the scale. In normal service the instruments maintain calibration to *within* one per cent of scale length. Owing to slight vibration when the generator is operated, pivot friction in the moving system is largely removed. This helps to maintain the original sensitivity and accuracy.

GUARD SYSTEM

The guard system of electrical connections is a means for preventing errors in the ohmmeter readings due to current leakage inside or on the outside of the instrument between the positive and negative sides of the circuit. Such leakage may be caused by dampness or dirt. The method is that of by-passing the leakage current around the ohmmeter.

For example, the guard ring (Fig. 10) 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 materials from the positive Earth terminal toward the negative Line terminal will be intercepted by the guard ring. The guard circuit offers a low resistance path for the leakage current directly to the d-c source without passing through the deflecting coil of the ohmmeter. Resistance coils and other live parts inside the instrument are also mounted on guarded supports.

Guard Terminal

The Guard terminal which is regularly supplied on high-range instruments, (see Fig. 10) makes it possible to extend the guard system to apparatus under test such as wires, cables and insulators.

High-Voltage D-C Source

When using the Earth and Guard Terminals, one has a convenient source of direct current at relatively high constant-voltage for special testing purposes. The ballast resistance (*R'* in Fig. 10) is not included, although a lower valued protective resistance is permanently connected between the Guard terminal and the generator.

This Earth-Guard connection is frequently used for breaking down high resistance faults and for operating Wheatstone Bridges at high potential when locating high resistance faults. Continuous heavy loads on the generator are naturally to be avoided.

THE "MEGGER" GENERATOR

The generator is of the two-pole permanent-magnet type, and may be hand-operated or motor-driven. The armature is slot-wound in four sections, with ends brought out to a group of four two-part commutators set at 45° to each other. This construction, together with a capacitor connected across the generator terminals, practically eliminates commutator ripple.

Hand-operated generators are driven by means of a hand crank and gear train with a free-wheeling ratchet so that the armature can spin freely when cranking is stopped, and cannot be rotated backward. Rated voltage is developed at approximately 120 rpm. of the hand crank.

Motor-driven sets are described on page 12.

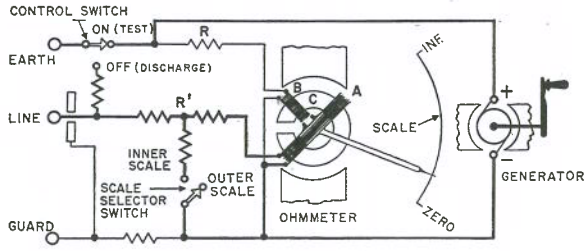


FIGURE 10. Basic diagram of electrical connections for the "Megger" Insulation Tester. The resistance under test is connected to the Earth and Line terminals.

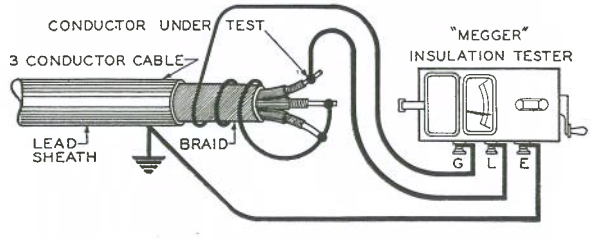


FIGURE 11. Showing use of the Guard connection to eliminate the effect of leakage to ground and also the effect of leakage to adjacent conductors. Note that the Guard wire is wrapped around the exposed insulation and also is connected to the adjacent conductors.

FIGURE 12. Showing a Catalog 638 set with the top of case removed.

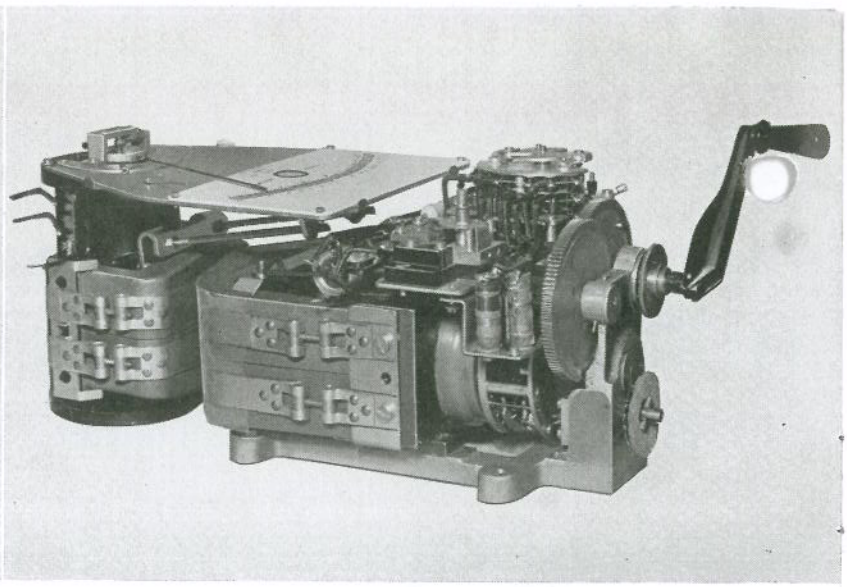


FIGURE 13. A Catalog 638 instrument with the case completely removed.

Constant-Voltage Feature

As explained on page 7, variations in generator voltage do not affect the accuracy of indications. A constant voltage is not necessary when measuring a resistor. However, insulation resistance of electrical equipment is seldom if ever free from capacitance and dielectric absorption effects. The constant-voltage generator is necessary in order 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. 13. 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. By the same means the instrument output voltage is automatically limited (to its approximate rated voltage) regardless of how rapidly the hand crank is turned.

DIELECTRIC ABSORPTION EFFECT

The dielectric absorption effect, which is a characteristic of most insulating materials, is observable by virtue of the constant-voltage feature just described. After the capacitance is charged, which actually is accomplished in a relatively short time following application of full test voltage, a continuation of the test will reveal either a constant value of insulation resistance or a rising characteristic. The latter may continue for many minutes or even hours. Since hand-cranking beyond one or two minutes becomes difficult, motor-driven sets are recommended for dielectric absorption tests.

CONTROL SWITCH

The Control Switch as shown in the lower right-hand corner on the top of the instrument in Figure 16, and in the schematic diagram in Figure 10, serves several purposes.

First, in the OFF (discharge) position, the Earth Terminal is separated from the generator, thereby permitting all terminals and connecting leads to be handled without fear of shock when the generator is in motion. This is a particular advantageous feature when the instrument is of the motor-driven type.

Also, in the OFF (discharge) position the Earth and Line Terminals are short-circuited through a resistor, thereby providing a path to drain any charge that may exist on the apparatus being tested. This feature is not only important from a safety point of view for those who may be testing apparatus involving capacitance, but it also provides a simple means, both before and between successive tests, of draining such dielectrics of any charge that may effect reading accuracy. The resistor limits the initial capacitance discharge current to a maximum of about 60 ma, and permits the voltage to reduce to about 37 per cent of the initial charge in .04 seconds per microfarad of capacitance involved.

The Control Switch has the further advantage of facilitating the accurate timing of tests, particularly when a motor-driven instrument is used for time-resistance (dielectric absorption) tests. With the motor in operation, and all connections complete to the apparatus under test, the Control Switch is very conveniently moved from the OFF (discharge) to the ON (test) position.

VOLTAGE CHARACTERISTICS

Fig. 15 shows the Earth-to-Line terminal voltage characteristic for the hand-cranked and motor-driven types. This characteristic is determined largely by the ballast resistance R' (Fig. 10), which in this instrument is 1.65 megohms.

VOLTAGE CHARACTERISTIC CURVES

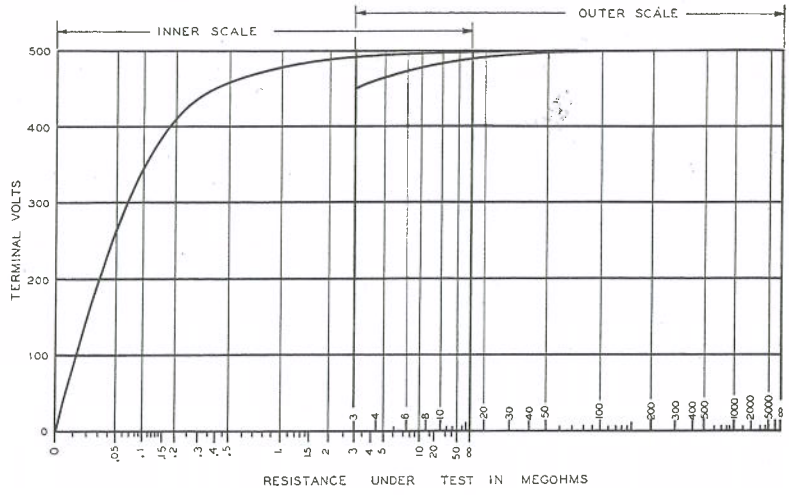


FIGURE 14. Terminal voltage characteristic of a 500 volt, 10,000-megohm MEGGER Insulation Tester, having a ballast resistance of approximately 330,000 ohms for the outer scale and 43,900 ohms for the inner scale.

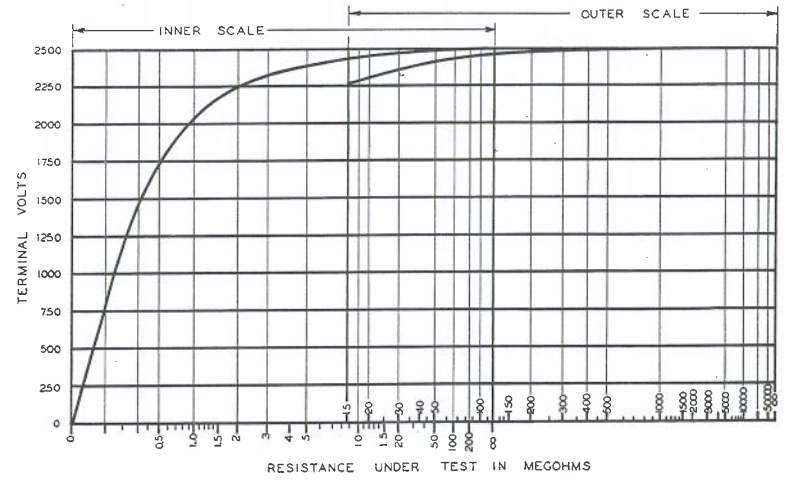


FIGURE 15. Terminal voltage characteristic of a 2500-volt, 50,000-megohm MEGGER Insulation Tester, having a ballast resistance of 1.65 megohms for the outer scale and 220,000 ohms for the inner scale.

TESTS USING MULTI-VOLTAGE MEGGER INSULATION TESTER

Recent maintenance practice trends indicate the value of testing insulation with d-c voltages at levels somewhat higher than the peak value of the rated a-c voltage of the equipment being tested. Such d-c tests have in some cases been shown to reveal nondestructively incipient weaknesses in insulation which could not otherwise be found except possibly by corona detection at nondestructive a-c test voltage levels.

The technique involves the application of two or more d-c voltages, and critically observing any reduction of insulation resistance at the higher voltage. Any marked or unusual reduction in insulation resistance for a prescribed increase in applied voltage is an indication of an incipient weakness.

It is important to mention that the merits of this technique arise from more recent investigations which indicate that rather high d-c voltage can be used to detect weaknesses without damaging the insulation. The maximum value of voltage which should be used will depend largely on the cleanliness and dryness of the insulation to be tested. This will be considered in more detail further along in this discussion.

To meet this trend of testing at two or more

d-c voltages we offer two types of 3 voltage Megger instruments as shown in the table on page 17. It will be noted that the hand cranked and motor driven types are available with three output voltages in one instrument—500, 1000 and 2500 volts. The rectifier operated type is available with output voltages of 1000, 2500 and 5000 volts. The low and intermediate voltage ratings of both types can be changed to meet customer specifications on special order.

In making tests on insulation at several d-c voltages the ohmmeter method of measurement has at least two advantages over the voltmeter-ammeter method. First, prescribed fixed voltages are switched into use, and one instrument measurement made with the direct reading ohmmeter. The voltmeter-ammeter method requires an adjustment of voltage as observed by the voltmeter followed by an ammeter reading. One of the greatest advantages of the ohmmeter can best be explained by referring to Figure 17.

In Figure 17(a) the change which may occur in leakage current after the absorption current has disappeared is shown plotted against three different voltages. The change in current between 500 and 1000 volts is shown to be linear, indicating no change in the insulation as a result of applying these two voltages. This is an assumption, but is a condition which is not uncommon in practice. If the insulation continued to be stable at 2500 volts the linearity of the voltage-current relationship would continue as shown by the dotted extension of the curve. If, on the other hand, the next voltage step to 2500 volts causes a change of conductance of the insulation it will be revealed by a nonlinear relationship between voltage and current. It is this change in linearity that must be revealed in the voltmeter-ammeter method.

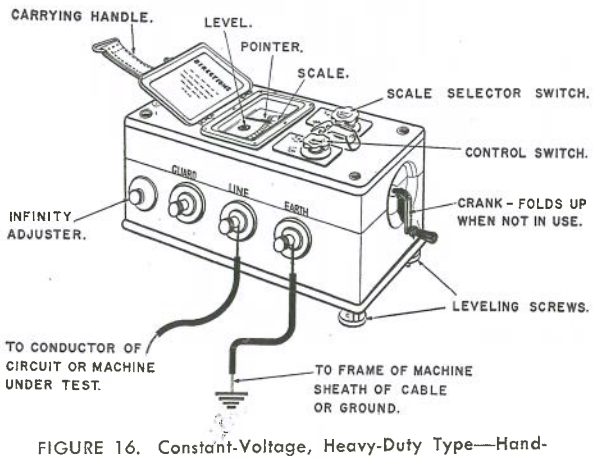


FIGURE 16. Constant-Voltage, Heavy-Duty Type—Hand-Driven "Megger" Insulation Tester.

Figure 17(b) shows the same situation in terms of voltage and resistance. As long as the voltage-current relationship is linear the resistance will remain constant and be shown as a horizontal line. When nonlinear conditions appear at a higher voltage the voltage-resistance curve reveals this condition very clearly by a drop in the horizontal line.

Therefore, in the case of the voltmeter-ammeter method the ammeter must be read at increasing values for each voltage step and any change in the rate of rise detected. It is obvious then that it is much easier to detect changes in condition of the insulation at increasing voltages by using the "Megger" instrument.

We wish to emphasize that the curves in Figure 17 indicate leakage current only, and not the absorption current which may appear for a period of time with each change in voltage. In both the voltage-current and voltage-resistance methods it may be necessary to wait an appreciable time after each voltage change for the absorption current to disappear before taking a reading.

To better understand the technique of making insulation resistance tests at two or more voltages the following steps are suggested, using an industrial or traction motor classed in the 300 to 1000 volt range as an example:

1. Make a one minute Megger instrument test at 500 volts to serve as a basis of comparison for subsequent steps.
2. After a careful cleaning operation make a second 500 volt Megger instrument test to determine the effectiveness of this cleaning.
3. If the one minute insulation resistance value is subnormal, or if the 60 second/30 second insulation resistance ratio is no greater than one at this point then a drying operation may be desirable before using a higher test voltage. However, making another test at 1000 volts and comparing these readings with those from the 500 volt test will help in determining the need for drying. If the 1000 volt test value is appreciably less than that at 500 volts then a drying operation should be performed. On the other hand, if the

1000 volt and 500 volt test values are approximately the same it is reasonable to assume that the decision to perform a drying operation can be deferred until after the next step.

4. Make a Megger instrument test at 2500 volts. If there is no appreciable difference in the 500 and 2500 volt test values good evidence has been obtained that the motor in question is in reliable condition as far as its insulation is concerned. If there is an appreciable difference in the two, there is, on the other hand, good evidence that more thorough reconditioning is called for. If the insulation fails under the 2500 volt test, after following steps 1, 2 and 3, we believe there is a likelihood that the motor in question, which in this example is a unit considered to be classed in the 300 to 1000 volt range, would fail in service even though an attempt were made to recondition it on the basis of low voltage tests only.

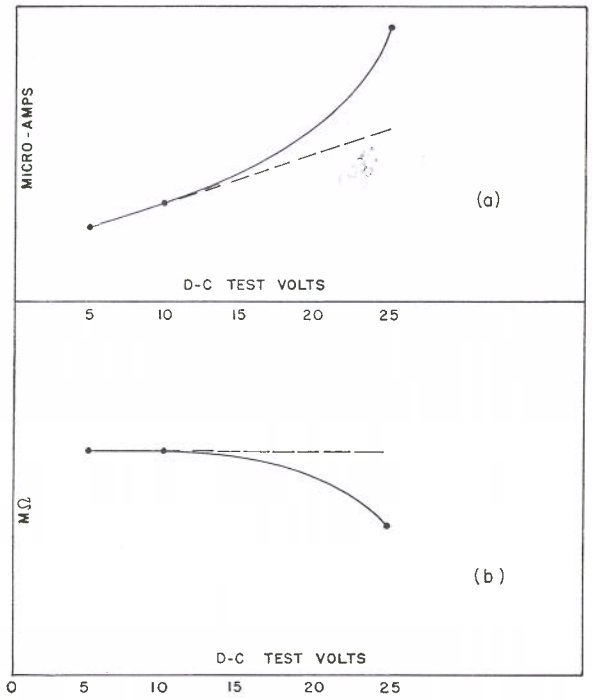


FIGURE 17.

We wish to stress that this discussion of the possible merits of testing low voltage equipment at two or more d-c voltages is to date based on limited knowledge and experience. Any acceptance of this method by users of Megger Insulation Testers should be on the basis of investigating its possibilities, and not on an assumption that it is a proven method recommended by the James G. Biddle Co.

MOTOR-DRIVEN AND RECTIFIER-OPERATED SETS

Motor-driven and rectifier-operated "Megger" Insulation Testers are used:

1. Where a number of tests are made at one location, as in testing separate conductors in telephone cable.
2. For dielectric absorption measurements on the insulation of generators, transformers and cables.
3. Where high resistance values are indicated continuously, such as moisture content of paper in production.
4. As a convenient source of direct current at relatively high voltage.
5. And, in the case of the rectifier-operated types, where higher ranges and higher output voltages than those available in the hand cranked and motor driven types are required.

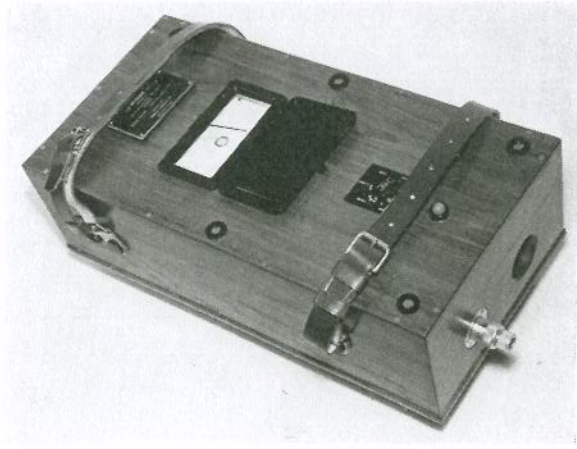


FIGURE 18. Catalog 8639, Rectifier-Operated, Triple-Voltage (5000, 2500 and 1000 volts d-c).

Motor-driven and rectifier-operated "Megger" Sets are simple to operate, direct-reading by pointed deflection, rugged and portable; and they are of sufficient range and accuracy for most *practical* purposes. Various ratings are listed on page 17.

Description of Motor-Driven Testers

The motor-driven "Megger" Insulation Tester is similar to the hand-operated sets already described, except that the d-c generator is driven by a motor which can be connected to a convenient outlet.

The generators in motor-driven sets have bearings and other features properly designed for motor operation. They are for continuous, or 24-hour duty. The driving motors which are rubber-mounted to reduce vibration are usually rated 1/20 hp, 115 volts, 60 cps. Other voltage and frequency ratings can be supplied.

The motor and its supporting bracket can be removed quite easily and the set made available for hand operation where an external source of current may not be available. This change can be made in the field.

Motor-driven "Megger" Sets are supplied complete with motor, starting switch, and six feet of rubber-insulated extension cord with plug, ready for connecting and operating.

For Accessory Equipment, see pages 14, 15, 17 and 18.

For Specifications, see page 16.

It must not be implied that a hand-operated "Megger" instrument can be motor-driven simply by attaching a motor. Hand-driven sets can be modified and rebuilt as may be necessary for motor drive, but they must be sent to us for that purpose.

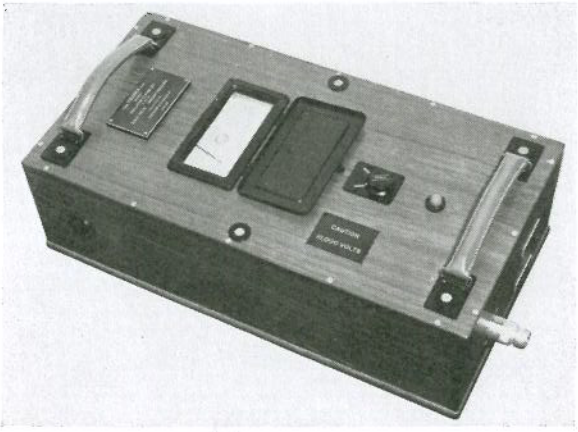


FIGURE 19. Catalog 8640, Rectifier-Operated, Single-Voltage (10,000 volts d-c).

Description of Rectifier-Operated Testers

Rectifier-operated Megger insulation testers are identical in principle, quality and operation to the other types, except that the hand cranked generator is replaced with a built-in power supply to be plugged into any 115 volt, 60 cycle lighting circuit.

There are two models: one having a range up to 100,000 megohms at 5000 volts with 1000 volt and 2500 volt intermediate ranges, and one having a range up to 200,000 megohms at 10,000 volts with no intermediate voltage ranges.

The d-c power supplies for both of these types include conservatively rated selenium rectifiers and constant voltage transformers. The constant voltage transformer feature is an especially important one in that it materially reduces pointer excursions caused by supply voltage variations when testing equipment having appreciable capacitance.

The moving systems of these two models are equipped with vibrators to reduce pivot to jewel friction so that high sensitivity can be achieved. This feature makes possible the high ranges available in these instruments by providing the same mild vibration which is used from the gear trains to reduce friction in the hand cranked and motor driven models.

Both of the rectifier-operated models are equipped with automatic discharge switches so arranged that when the a-c input switch is either switched off or the supply plug is withdrawn from the receptacle, the Line and Earth output terminals are automatically short circuited through a current limiting resistance. This safety feature provides a positive means of draining the geometric capacitance charge from the specimen at the completion of a test.

Photographs of these rectifier-operated models are shown in Figures 18 and 19. Scale facsimiles are shown on page 16, and regulation curves in figures 20 and 21. For complete specifications see page 17, and for accessory equipment see pages 14 to 18.

VOLTAGE CHARACTERISTIC CURVES

FIGURE 20. Terminal voltage characteristic of a 5000 volt, 100,000 megohm Megger Insulation Tester.

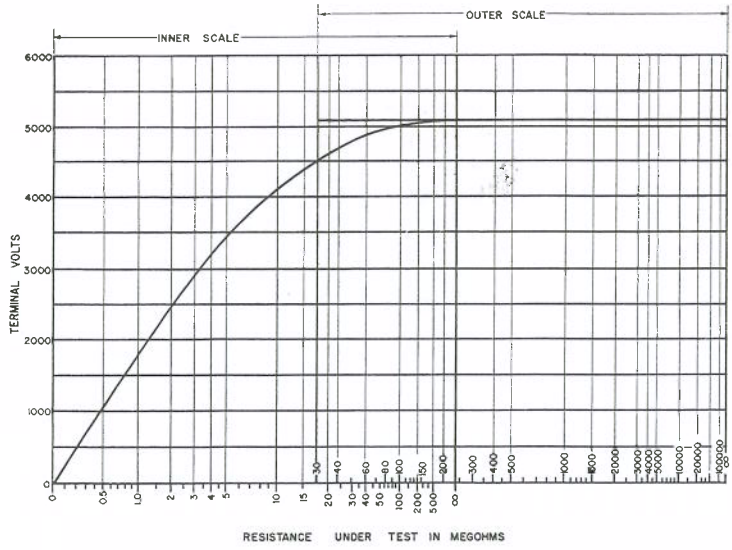
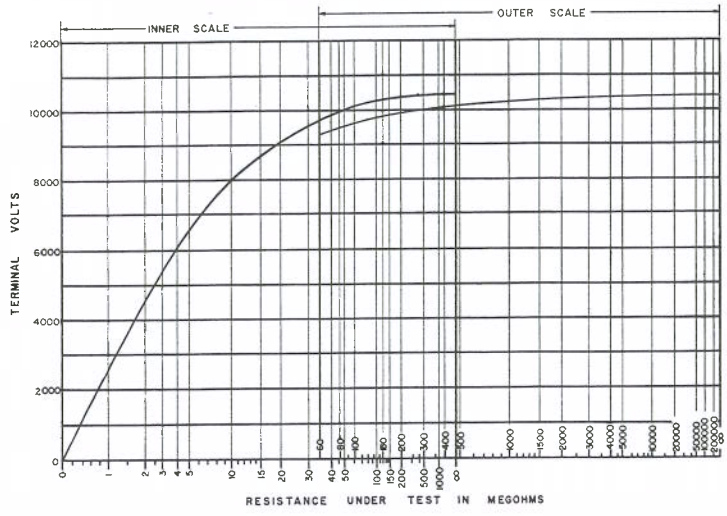


FIGURE 21. Terminal voltage characteristic of 10,000 volt, 200,000 megohm Megger Insulation Tester.



OPERATING AND SERVICING "MEGGER" INSULATION TESTERS

Instruction Manual

An Instruction Manual is included with each instrument. It contains full directions for connecting and operating, and also includes valuable information on making insulation resistance tests on various types of electrical equipment.

Lubrication — Servicing

All bearings in both hand and motor-operated types are packed with lubricant when assembled, and do not need further attention for a long time. Consequently, no provision is made for oiling.

Instruments that are in daily use should be returned *at least* every *five* years for such lubrication and servicing as may be necessary.

Repairs — Modifications

We repair, rebuild, and modify specially all types of "Megger" Insulation Testing Instruments and strongly advise that they be sent to us for that purpose.

Do not attempt to repair a "Megger" instrument yourself. Return it to us with the seals unbroken. Disregard of this advice, however well intended, may cause delay and a repair bill larger than necessary.

NOTE: When writing in regard to instruments for servicing or repair, please give serial number.

ACCESSORIES

Carrying Cases

The experience of many years is incorporated in the design and construction of suitable carrying cases for giving adequate protection to "Megger" instruments. The leather carrying case, Fig. 24, is of best quality sole leather, plush-lined inside, and ribbed for strength and for protecting the instrument terminals. Corners are heavily re-enforced; carrying strap and other fittings are as illustrated.

The wood traveling cases, Figs. 25 and 26, are specially designed for express or other shipment. It is built of heavy hardwood with a hinged cover, and is fitted inside with rubber half-balls for cushioning and protecting the instrument.

Cases of these types are available for hand, motor, and rectifier-operated "Megger" sets.

Test Leads

Durable, properly designed, insulated test leads are available from us for all types of Megger Insulation Testers. They are rubber insulated, and have smooth, oil resistant jackets so that they can be easily kept clean. Lugs which properly fit the terminals of Megger instruments are supplied on one end, and stout spring clips with rubber boots on the other end. Conductor sizes and strands are chosen for flexibility and mechanical strength.

Unshielded test leads are available for the lower range instruments, and for the Earth and Guard terminals of all types except the 10 kv rectifier operated instrument.

Shielded test leads are available and can be used for the Line terminals of all types, but are specially intended and recommended for use with instruments having ranges of 20,000 megohms and above.

With the introduction of instruments having ranges up to 200,000 megohms, the insulation resistance of the Line test lead must always be maintained at a high value so that its leakage will not enter into the measurement. The shielded test lead, with the shield connected to Guard, accomplishes this by preventing any leakages over its terminations or through the lead insulating material from being measured.

The trend toward more general use of the instrument Guard terminal in making insulation resistance measurements has also made shielded cable desirable. It permits Guard connections to the equipment under test without the bother of providing a third test lead.

The 10 kv, Catalog No. 8640 Tester is provided with special terminals, and special shielded leads are supplied as a standard part of this instrument. All other types are listed without output test leads, which are supplied only when specified. See page 17.

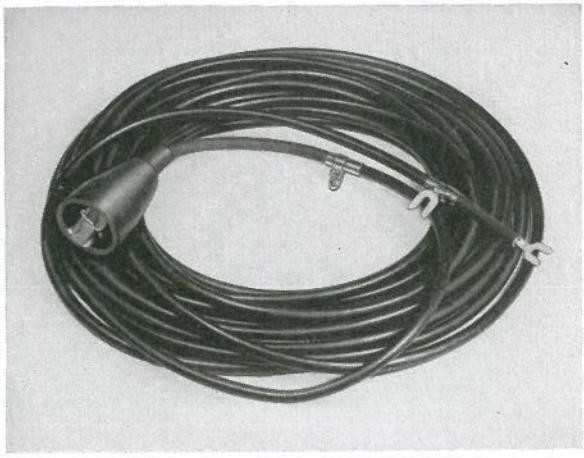


FIGURE 22. Shielded Test Lead.

Dielectric Absorption Test Sheets

Almost as important as the tests themselves are the records from those tests. To facilitate the orderly recording of all pertinent information we have available convenient printed forms for recording tests made on Rotating Equipment, Power Transformers, and Power Cables. These forms have been carefully designed, based on the experience and suggestions of numerous users of "Megger" Insulation Testers. See Fig. 31.

Insulation Resistance Record Cards

These cards are for keeping in convenient and graphic form, records of insulation resistance tests on electrical equipment. By observing the trend of the curve such records are of great value in anticipating trouble due to weakened or defective insulation. Readings can be taken and recorded at intervals such as once a month for three years, or once every two months for six years. See Fig. 30.

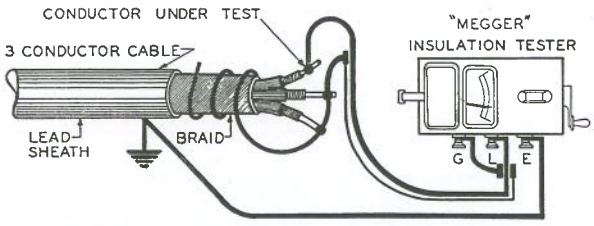


FIGURE 23. Showing an application of the shielded test lead in a case where the GUARD connection is being used to eliminate the effect of leakage to ground and also the effect of leakage to adjacent conductors. Note how, with ordinary leads, a third lead would be necessary from GUARD to the exposed insulation.

FIGURE 24. Catalog 660 leather carrying case for "Megger" Insulation Testing Sets.

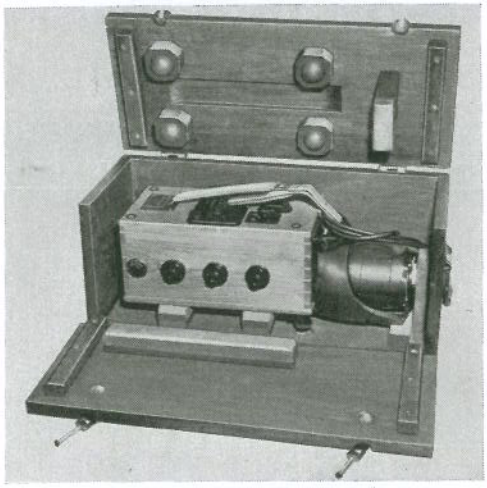


FIGURE 25. Interior of a Catalog 667 wood traveling case with a Catalog MD 638 instrument.

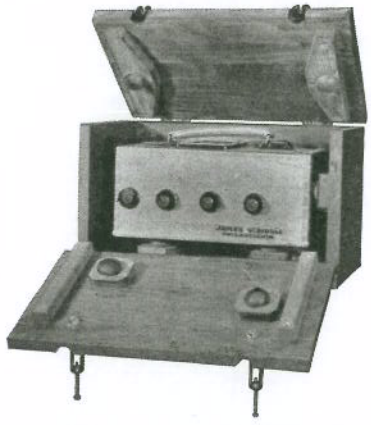


FIGURE 26. Interior of Catalog 663 wood traveling case showing rubber half-balls used for cushioning.

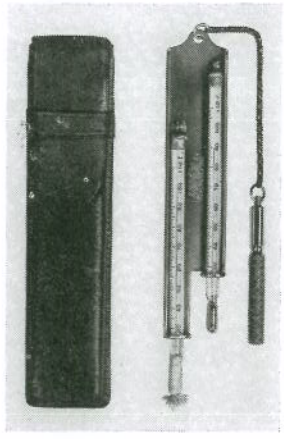


FIGURE 27.
Pocket Sling Psychrometer.

FIGURE 28.
Bushing
Guard
Spring.

FIGURE 29. Thermometers.

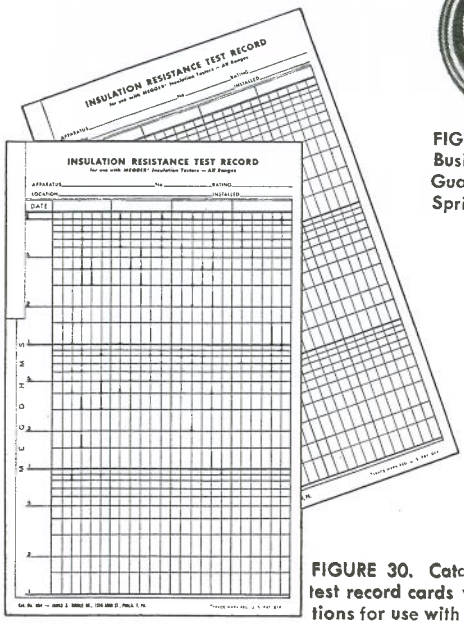


FIGURE 30. Catalog 954 improved insulation resistance test record cards with three cycles of logarithmic graduations for use with any range of MEGGER Insulation Tester.

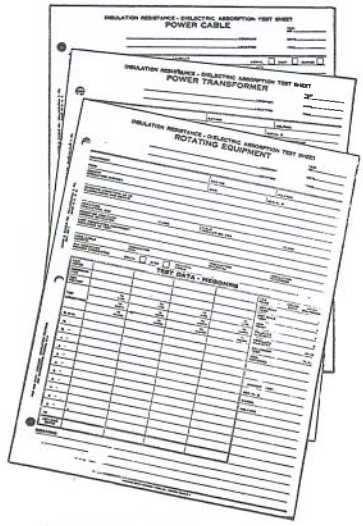


FIGURE 31. Dielectric Absorption Test Data Report Sheets.

FACSIMILE SCALES *(All approx. 5 1/8")*

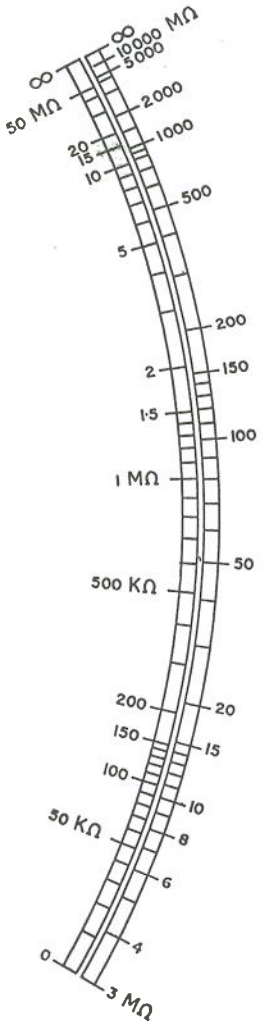


FIGURE 32. Catalog 635, 10,000 megohms, 500 volts d-c.

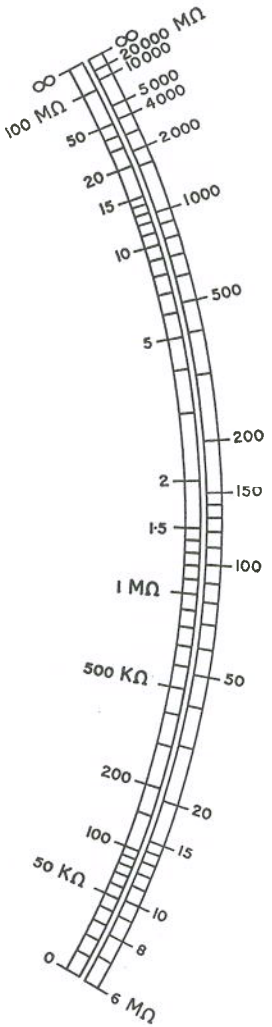


FIGURE 33. Catalog 636, 20,000 megohms, 1000 volts d-c.

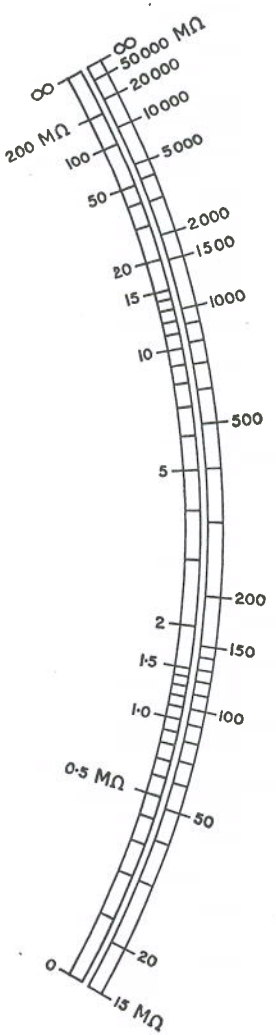


FIGURE 34. Catalog 637, 50,000 megohms, 2500 volts d-c.

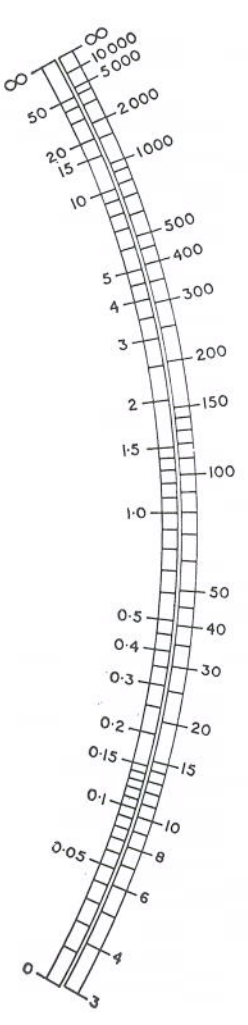


FIGURE 35. Catalog 638, 50,000 megohms, 2500 volts d-c. (x1, x2, x5.)

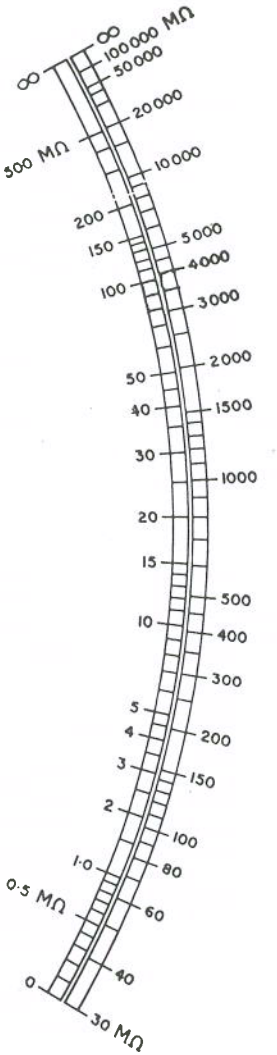


FIGURE 36. Catalog 8639, 100,000 megohms, 5000 volts d-c.

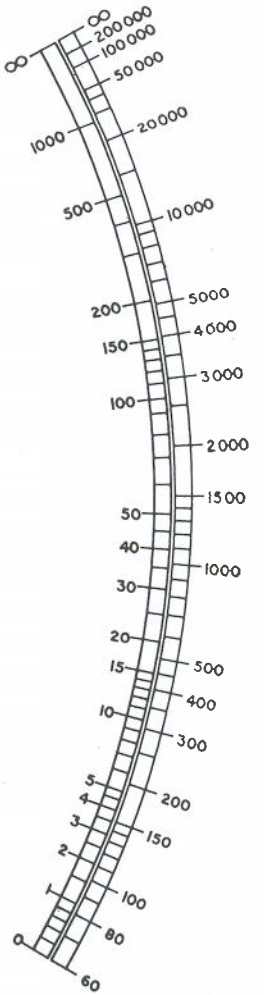


FIGURE 37. Catalog 8640, 200,000 megohms, 10,000 volts d-c.

ACCESSORIES *(cont'd)*

Bushing Guard Spring

This simple device is for making the Guard connection to the outer surfaces of porcelain bushings in circuit breakers and transformers and to cable pot heads. A coiled strip of spring steel is extended and allowed to wrap itself around the insulator. The Guard lead is then attached to the spring.

The size listed on page 18 has a length of about 60″ which is sufficient for most insulators. The spring steel is ⅜″ wide and relaxes, for carrying into a compact coil of some 9 turns, about 2½″ in diameter, as shown in Fig. 28.

Special requirements can be met.

Thermometers

Insulation resistance varies widely with temperature. Also, if the temperature of the apparatus under test is lower than that of the surrounding air, there may be surface leakage due to deposition of moisture. For these reasons temperature measurements at time of test are important. For users of "Megger" Insulation Testers, we offer three types of thermometers as listed. Other types may be used if desired.

Sling Psychrometer

This instrument is used for humidity and dew-point determinations—which are especially desirable when testing insulation resistance of important equipment. A convenient type is listed. Other types may be used.

SPECIFICATIONS

Facsimile Scale	Rating: Inner Scale Megohms	Rating: Outer Scale Megohms	Rating: Volts D-C	With Hand-Operated Generator: Cat. No.	Price	Weight (app.)	Dimensions (approx.)	With Motor-Driven Generator: Cat. No.	Price	Weight (app.)	Dimens. (app.)
SINGLE-VOLTAGE SETS (Hand or Motor-Operated)											
Fig. 32	0-50	3-10,000	500	635		30 lbs.	14x8x8″	MD-635		40 lbs.	22x8x8″
Fig. 33	0-100	6-20,000	1,000	636	*	30 lbs.	14x8x8″	MD-636	*	40 lbs.	22x8x8″
Fig. 34	0-200	15-50,000	2,500	637		30 lbs.	14x8x8″	MD-637		40 lbs.	22x8x8″
TRIPLE-VOLTAGE SET (Hand or Motor-Operated)											
	0-250	15-50,000	2,500								
Fig. 35	0-100	6-20,000	1,000	638	*	32 lbs.	14x8x8″	MD-638	*	42 lbs.	22x8x8″
	0-50	3-10,000	500								
HIGH VOLTAGE, RECTIFIER-OPERATED SETS**											
SINGLE-VOLTAGE SET											
Fig. 37	0-1000	60-200,000	10,000	8640	*	54 lbs.	23x12x 10½″			SEE NOTE	
TRIPLE-VOLTAGE SET											
	0-500	30-100,000	5,000								
Fig. 36	0-250	15-50,000	2,500	8639	*	50 lbs.	23x12x 10½″				
	0-100	6-20,000	1,000								

*See Price List.

**All motor driven and rectifier operated Testers are supplied with input cords. Except in the case of the 10 kv Tester, output leads are supplied only when ordered as accessories. See page 14.

Note: This Tester is supplied complete with 3 output leads; 1 for Line, 1 for Guard and 1 for Earth, all rated 10 kv.

ACCESSORIES

for Heavy-Duty Type "Megger" Insulation Testers

Catalog No. | (For Description see pages 14, 15 and 17.) | Price

CARRYING CASES

660 Leather carrying case for any specified rating of hand-operated instrument .....
666 Leather carrying case for any specified rating of motor-driven instrument .....
8751 Wood case for Catalog 8640 (10,000 v. instrument) .....
663 Wood traveling case, cushioned with rubber half-balls, for any specified rating of hand-operated instrument..
667 Wood traveling case, cushioned with rubber half-balls, for any specified rating of motor-driven instrument..
8750 Wood case for Catalog 8639 (5000 v. instrument) .....

NOTE: When ordering carrying cases for new instruments, give catalog number of the instrument.
When ordering carrying cases for old instruments, give serial number of the instrument.

TESTING LEADS—*For use with hand-crank and motor-drive instruments*

963 Leads, 12′ long, per pair .....
963-T Leads, 12′ long, per set of three .....
964 Leads, 25′ long, per pair .....
964-T Leads, 25′ long, per set of three .....
965 Leads, 50′ long, per pair .....
965-T Leads, 50′ long, per set of three .....
966 Leads, 100′ long, per pair .....
966-T Leads, 100′ long, per set of three .....

SHIELDED TEST LEADS—*For use with hand-crank and motor-drive instruments*

699-1 Single shielded cable, 25′ length.....
699-2 Single shielded cable, 50′ length.....
699-3 Single shielded cable, 100′ length.....

according to THR 6/25/57
new tab: 5000 V d-c
3500 V a-c

For use with 5,000 v. Rectifier-Operated Instrument

699-4 Single shielded cable, 25′ length.....
699-5 Single shielded cable, 50′ length.....
699-6 Single shielded cable, 100′ length.....
Also available in additional lengths.

INSULATION RESISTANCE RECORD CARDS—for use with all types, except Recording

954 For any range, 3-cycle log 5″ x 8″ per 100.....
per 1000.....
948 Range 0 to 10,000 megohms, size 4″ x 6″ per 100.....
per 1000.....
958 Range 0 to 10,000 megohms, size 5″ x 8″ per 100.....
per 1000.....

DIELECTRIC ABSORPTION TEST DATA REPORT SHEETS

951-1 Report sheet for recording test data on Rotating Equipment .....
951-2 Report sheet for recording test data on Power Transformers .....
951-3 Report sheet for recording test data on Power Cables .....
Each pad consists of 50 triplicate sets of data sheets.
In quantities of 1 to 4 pads, each.....
In quantities of 5 to 9 pads, each.....
In quantities of 10 or more, each.....

BUSHING GUARD SPRING

7976 Bushing guard spring, ⅜″ x 60″ approx. (Other sizes can be supplied).....

THERMOMETERS

Prince Glass Pocket Test Thermometer with metal pocket case, 6½″ long, range 10° to 110° C. *Precision Thermometer and Instrument Co. Catalog No. 186-C*

Taylor Maximum Registering Glass Thermometer, 5½″ long, with metal pocket case, range—15° to 105°C. *Taylor Instrument Company, Catalog 21480*

Weston Model 226-L Testing Thermometer, dial type, indicating, with 8″ stem and 1¾″ head, range 0° to 100°C. *Weston Electrical Instrument Co., Model No. 226L007*

SLING PSYCHROMETER

Sling Psychrometer consisting of one dry and one wet-bulb thermometer graduated 30° to 110°F., with swivel handle and chain connection, and leather case. *Precision Thermometer and Instrument Co. Catalog No. 430.*

Prices will be quoted on request.

"MEGGER" INSULATION TESTERS

Heavy-Duty Recording Type

This instrument was developed primarily for making records of insulation resistance over a necessary period of time when drying out moisture in armatures, field coils, transformers and other electrical equipment.

It can be used also for field measurements of dielectric absorption in large generators and other equipment, and for miscellaneous insulation resistance measurements where a graphic (paper chart) record is needed.

The recording "Megger" set consists of a "Megger" true ohmmeter, essentially as described on page 6, arranged so that the position of the pointer is marked at appropriate intervals on a moving paper chart.

Instead of using a built-in generator, an external source of direct current of approximately the rated voltage is required. (Rectifier-operated Power-Supplies are available.) The exact value of this voltage is not critical, but care must be taken that the voltage is steady when testing equipment having an appreciable amount of capacitance.

The paper chart, which is 3½ inches wide, has a length of 65 feet and therefore can be operated continuously for 32 days at a speed of 1 inch per hour. Chart feed is by means of an eight-day spring clock. A thirty-day spring clock as well as other chart speeds, such as ½ inch, 3 inches and 6 inches per hour are available on special order.

A special tapping system of recording the ohmmeter reading is used so as to avoid undue load on the instrument moving system. In every detail of design and construction the instrument is of the highest quality—comparable to other types of "Megger" instruments. The recording mechanism will be found to compare favorably in design, performance and ease of adjustment to the best makes of recorders now used for other types of electrical measurement.

SPECIFICATIONS

Catalog No.	Range in Megohms	Voltage	External D-C Supply Milliamps. Max.
1084	0 — 100	500	Not more than 12 milliamperes for the lowest reading on the scale.
1085	0 — 500	500	
1086	0 — 200	1000	
1087	0 — 1000	1000	
~~1088~~	~~10 — 5000~~	~~1000~~	NO

The above are equipped with an eight-day spring clock, and for chart speed of 1 inch per hour.

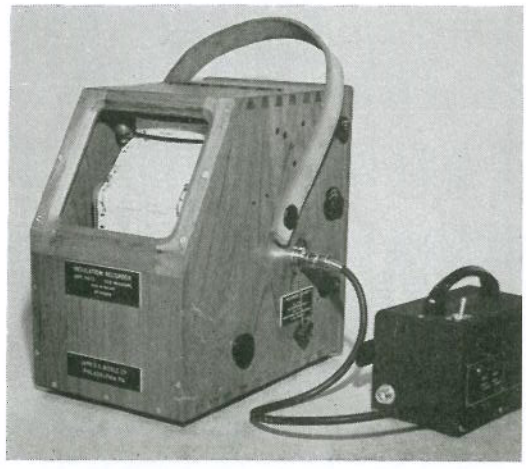


FIGURE 38. Heavy-duty Recording Type of "Megger" Insulation Tester.

ACCESSORIES

Prices will be quoted on request.

Catalog No.	
1091	Rolls of chart, 65 feet in length, ruled 1 inch per hour.....
1092	Typewriter Ribbon .....
1094	Additional pair of gear wheels, for chart speed of ½ inch per hour .....
1096	Additional pair of gear wheels, for chart speed of 3 inches per hour .....
1097	Additional pair of gear wheels, for chart speed of 6 inches per hour .....
1745	Power Supply for Cat. 1084 and 1085 instruments, 115v, 60 cycle input, 500v d-c output.....
1748	Power Supply for Cat. 1086, 1087 and 1088 instruments, 115v, 60 cycle input, 1000v d-c output.....

FIGURE 39. Facsimile scale of Catalog 1087.

"MEGGER" INSULATION AND RESISTANCE TESTER

Heavy-Duty "BRIDGE-MEGGER" Type

These instruments combine the functions of a high-range "Megger" Insulation Tester and a precision portable Wheatstone bridge. They cover a wide range of resistance measurements—from as low as .01 ohm to as high as 2000 megohms.

As shown in Fig. 40, the "Bridge-Megger" set consists of a "Megger" Insulation Tester of the heavy-duty type with hand-operated generator, and a separate, calibrated, four-dial resistance box. The two units are connected together when making Wheatstone bridge measurements.

For insulation resistance tests, the set is operated in the usual manner, by means of the d-c hand-generator and the "Megger" direct-reading ohmmeter. For Wheatstone bridge measurements a change-over switch is set to BRIDGE and the resistance box and unknown are connected. Using the hand-generator as a source of current, the dial resistance box and a ratio dial are manipulated until the ohmmeter pointer (which serves as a galvanometer) stands over the Infinity mark on the scale. The unknown is then read from the ratio and resistance dial settings. Directions are included for various kinds of resistance measurements, and for locating faults on wires by the Varley loop method.

Motor-driven "Bridge-Megger" sets are also available.

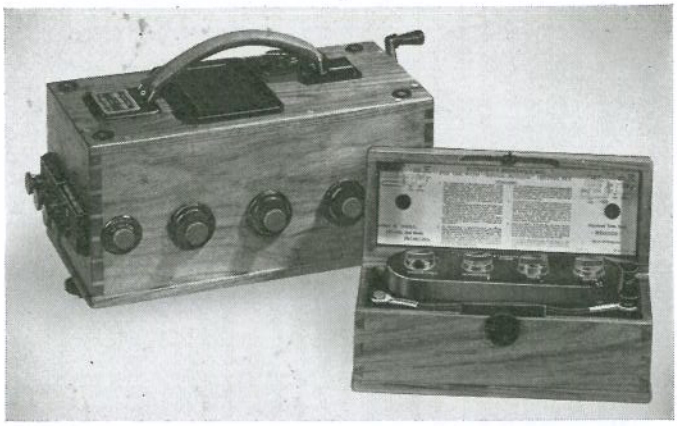


FIGURE 40. "Bridge-Megger" Insulation Tester with resistance box.

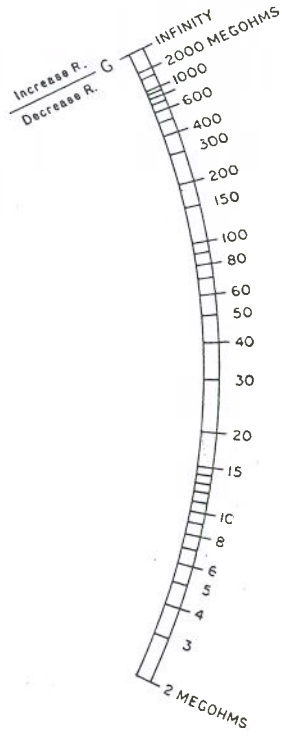


FIGURE 41. Facsimile scale of Catalog 652-B, 1000 volts.

SPECIFICATIONS

Facsimile Scale	Rating		Hand-Operated		Motor-Driven	
	Range	Volts D-C	Cat. No.	Price	Cat. No.	Price
Fig. 34	1 to 1000 megohms	500	651	On request	MD-651	On request
	.01 to 999,900 ohms	250				
	1 to 1000 megohms	500	651-B		MD-651-B	
	.1 to 100 megohms					
	.01 to 10 megohms					
	.01 to 999,900 ohms	250				
	2 to 2000 megohms	1000	652		MD-652	
	.01 to 999,900 ohms	500				
	2 to 2000 megohms	1000	652-B		MD-652-B	
	.2 to 200 megohms					
	.02 to 20 megohms					
	.01 to 999,900 ohms	500				

Each of the above includes the separate four-dial Resistance Box, with short leads for connecting it to the main unit of the set. Carrying cases are available.