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Indian Standard

METHODS OF TEST FOR DETERMINATION OF INSULATION RESISTANCE OF SOLID INSULATING MATERIALS

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NEW DELHI 110002

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0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 9 February 1963, after the draft finalized by the Insulating Materials Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 With the advent of indigenous manufacture of electrical insulating materials, the need for having Indian Standard specifications covering their performance requirements and methods of testing has become more urgent particularly considering the varying atmospheric conditions met with in a tropical country like India. This is one of a series of standards on methods of testing electrical insulating materials. It lays down uniform test procedures with a view to ensuring consistency in results of tests carried out by different agencies.

0.3 The methods for determining the insulation resistance of solid insulating materials give values of resistance which include, without discrimination, both volume and surface resistance. These methods, consequently, do not give well-defined constants for the material in contrast to the methods of test for volume and surface resistivities for which a separate standard is being prepared. These methods, however, give empirical values which are appropriate for the comparison of the quality of different insulating materials.

0.4 These methods are very useful in determining the influence of humidity on hygroscopic insulating materials, in which conditioning not only appreciably modifies the insulating properties of the surface but also that of the body of the material.

0.5 This standard is based, to a large extent, on IEC Document 15 (Central Office) 25 Draft Standard Methods of Test for the Determination of the Insulation Resistance of Solid Insulating Materials.

0.6 Wherever a reference to any Indian Standard appears in these methods, it shall be taken as a reference to the latest version of the standard.

0.7 Metric system has been adopted in India and all quantities and dimensions appearing in this standard have been given in this system.

0.8 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960 Rules for Rounding Off Numerical Values (*Revised*).

1. SCOPE

1.1 This standard lays down test procedures for the determination of insulation resistance without discrimination between the volume and surface resistances involved.

1.1.1 Because of the simplicity and ease in preparing a test specimen, these methods are particularly useful for quick determination of values where great accuracy is not required.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Insulation Resistance — The insulation resistance between two electrodes which are in contact with or embedded in a specimen is the ratio of the direct voltage applied to the electrodes to the total current between them at a given time after the application of the voltage. It is dependent upon both the volume and surface resistance of the specimen.

2.2 Surface Resistance — It is the ratio of the direct voltage applied to two electrodes which are on the surface of a specimen to that portion of current between them which is in a thin layer (for instance moisture or other semi-conducting material) on the surface.

2.3 Volume Resistance — It is the ratio of the direct voltage applied to two electrodes which are in contact with or embedded in a specimen to the portion of current between them which is distributed through the volume of the specimen.

3. TEST EQUIPMENT

3.1 A suitable measuring device having the required sensitivity and accuracy may be used. Usually insulation resistance is determined either by a bridge method or by measuring the current and voltage. Brief descriptions of such measuring methods are given in Appendix A.

4. TEST VOLTAGE

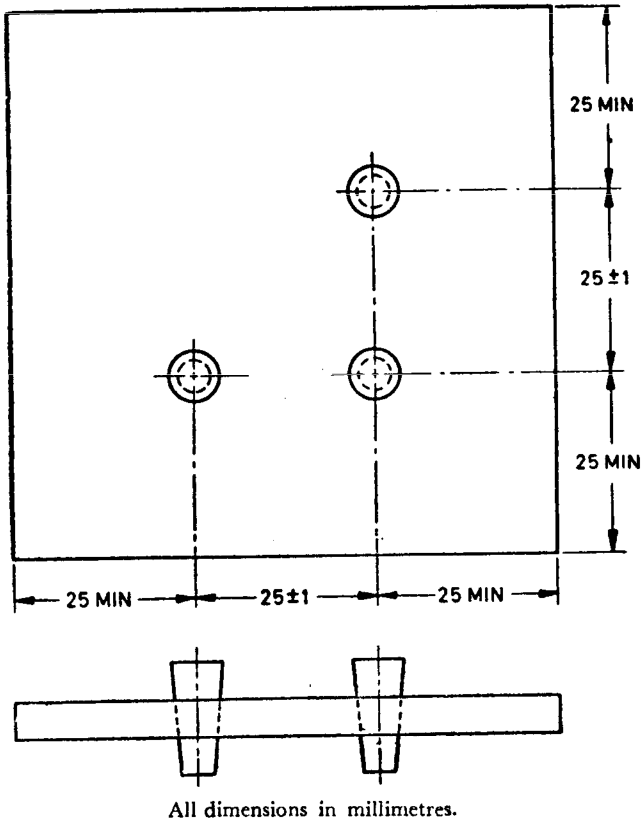
4.1 Unless otherwise specified the test voltage shall be 500 $\pm$ 10 volts dc.

4.2 The test voltage shall be steady enough to keep charging current minimum as compared to the current flowing through the specimen. A steady voltage may be obtained either by batteries or by a stabilized power pack.

5. ELECTRODES

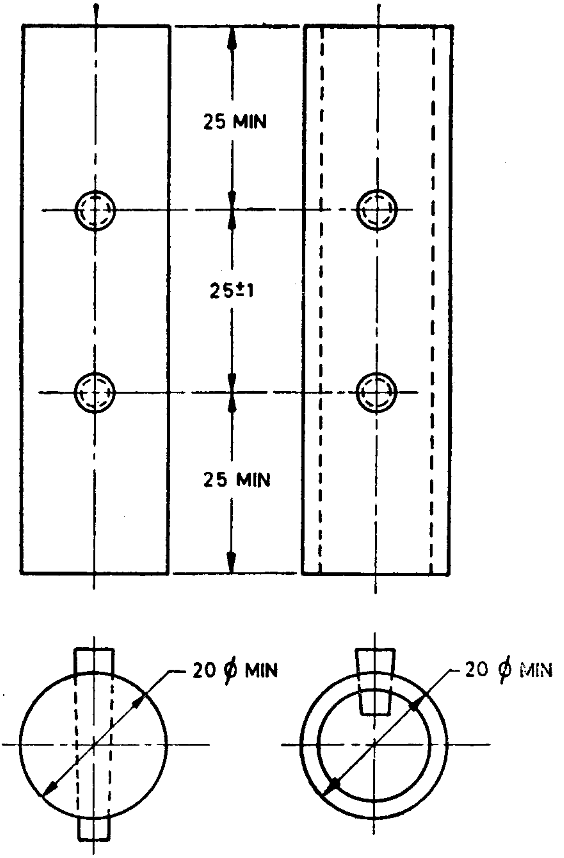
5.0 The electrodes shall be made of such a material that they do not corrode under the conditions of test or react with the material being tested.

5.1 Taper Pin Electrodes — Clean brass or stainless steel pins of approximately 5 mm diameter and having a taper of approximately 2 percent and of sufficient length to comply with **6.1.1**, shall be used. The electrodes may be used with flat specimens, tubes and rods (*see* Fig. 1 and 2). Three-pin electrode system may be used for plate specimens



All dimensions in millimetres.

Fig. 1 Plate Specimen for Taper Pin Electrodes as shown in Fig. 1 and the insulation resistance values shall be specified for both perpendicular directions. This shall be the preferred method for plate specimens.



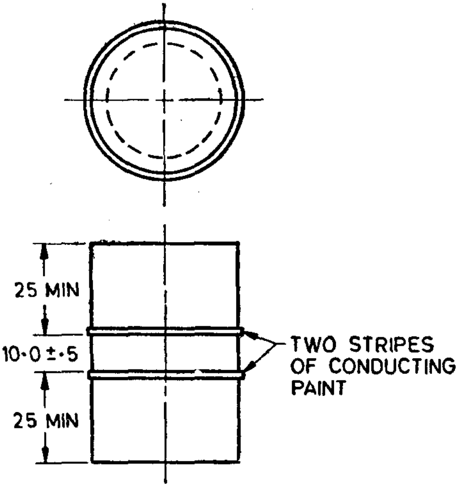
All dimensions in millimetres.

FIG. 2 ROD OR TUBE SPECIMENS FOR TAPER PIN ELECTRODES

5.2 Conducting Paint Electrodes — Conducting paint may be used as an electrode material. Two stripes of conducting paint one millimetre wide are applied around tubes and rods so that nearest edges are 10·0 ± 0·5 mm apart (*see* Fig. 3). The vehicle of conducting paint should be of such a nature that it will not have any effect on the insulation resistance to be measured. (This may easily be done by mounting the tube or rod in a lathe and rotating it against a small brush or drawing pen containing the paint.)

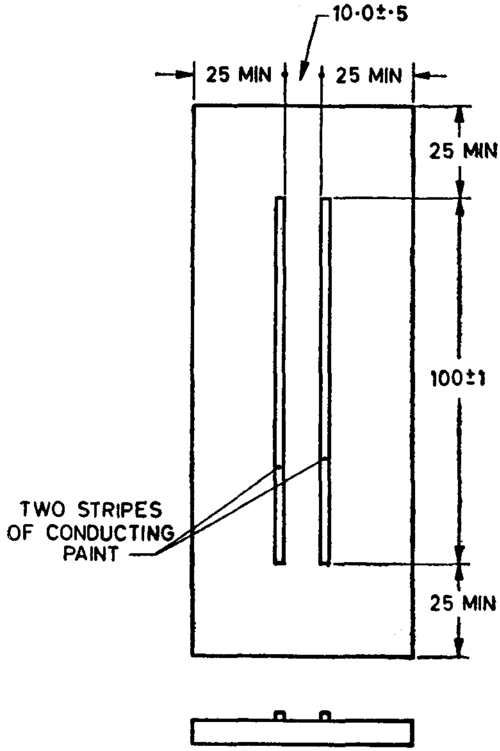
This type of electrode may also be used on plate specimens. In this case the electrodes shall be two parallel stripes of conducting paint one millimetre wide. The total length of each electrode shall be 100 ± 1 mm, their nearest edges being spaced 10·0 ± 0·5 mm apart (*see* Fig. 4).

5.3 Bar Electrodes — The electrodes are metal bar clamps about 10 × 10 × 50 mm which are spaced 25·0 ± 0·5 mm apart between their nearest edges (*see* Fig. 5). The electrodes are used for thin sheet material (usually one millimetre or less in thickness) and for flexible tapes. The assembly should be mounted on a support whose resistance is at least one hundred times greater than that of the materials to be measured. Alternatively, the test specimen may be supported in air by the leads attached to the electrodes. For rigid materials the bars have tin foil wrapped around them and after the bars have been clamped onto the test specimen, the tin foil shall be pressed down with a thin tool along the edge of the electrodes to assure intimate contact with the test piece.



All dimensions in millimetres.

FIG. 3 ROD OR TUBE SPECIMEN FOR CONDUCTING STRIPE ELECTRODE



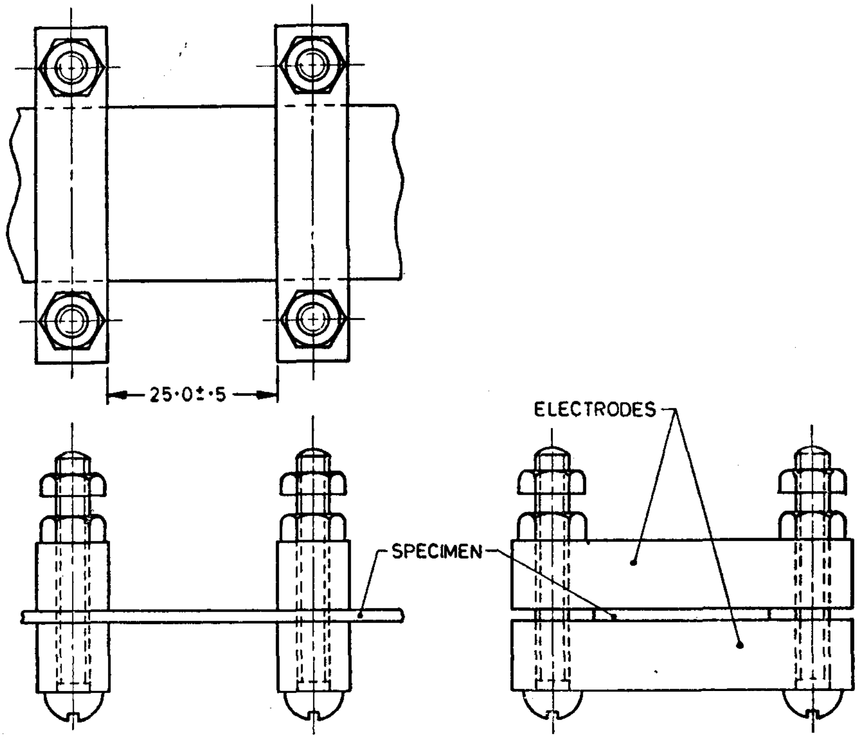
All dimensions in millimetres.

FIG. 4 PLATE SPECIMEN FOR CONDUCTING STRIPE ELECTRODE

6. SHAPE AND SIZE OF TEST SPECIMENS

6.1 For measurements with taper pin electrodes, the test specimens shall be plates having a size at least 75 × 75 mm (*see* Fig. 1), or tubes or rods at least 20 mm in diameter and 75 mm long (*see* Fig. 2).

6.1.1 To introduce the electrodes, the plates shall be drilled with three holes, and tubes or rods shall be drilled with two holes along parallel diameters whose centres are 25 ± 1 mm apart. After reaming with a reamer the diameter of each hole at the larger end shall be not less than 4·5 mm and not greater than 5·5 mm. The holes shall be drilled completely through



All dimensions in millimetres.

FIG. 5 BAR ELECTRODES FOR TAPS OR THIN SHEET MATERIAL

the specimen — in the case of tubes through one wall only — and shall be reamed throughout the full length. While drilling and reaming this specimen, care shall be taken to see that the material adjacent to the hole is not damaged (for example, split, broken or charred) in any way. The holes shall be at least 25 mm from the outer edges of the test specimen.

6.1.1.1 The taper pins used as electrodes shall be pressed (not hammered) into the holes so that they fit tightly and extend on each side of the material by not less than 2 mm (*see* Fig. 1 and 2).

6.2 For measurements with conducting paint electrodes, the test specimens shall be rectangular plates of at least 60 × 150 mm in size (*see* Fig. 3), or rods or tubes at least 60 mm long (*see* Fig. 4).

6.3 For measurements with the bar electrodes, the test specimens in the form of tapes or thin bars shall be 25 mm or less in width and at least 50 mm long.

7. PROCEDURE

7.1 The number of test specimens to be used for each test shall be specified in the material specification. They shall be properly selected, cleaned, mounted and conditioned before resistance measurements are made.

7.1.1 *Selection of Test Specimen* — As the measured value of the insulation resistance depends to a great extent on the condition of the surface of the test specimen, care should be taken to select test specimens having undamaged surfaces.

7.1.2 *Cleaning of Test Specimen* — In many cases it may be desirable to test the material in the condition in which it is to be used after handling and processing. In this event, the test specimens should not be cleaned. If cleaning is desired, the surfaces of the test specimens should be cleaned before conditioning with an alcohol and ether mixture, or other suitable solvent that has no effect on the material of the specimen and shall not be handled with bare fingers afterwards (acetate rayon gloves are recommended).

7.1.3 *Mounting of Test Specimens* — In mounting the test specimens for measurement, there shall be no conducting path between the electrodes other than those associated with the test specimen, for example, specimens shown in Fig. 1 to 5 shall be held by the edges or supported from the electrodes so that none of the electrodes touches anything but its lead and specimen. In case the above method is not possible the specimen may be rested on an insulating material whose insulation resistance is about 100 times that of the specimen under test.

7.1.4 *Conditioning of Test Specimens* — The test specimens shall be conditioned and preconditioned as specified in the material specifications (*see also* IS : 2260-1963 Recommendations for the Conditioning and Testing of Electrical Insulating Materials).

7.2 The resistance shall be measured while the specimen is still in the conditioning atmosphere but under certain circumstances it may be measured after removal from the conditioning atmosphere. In the latter case, the test shall be carried out as quickly as possible after removal from the conditioning atmosphere and the period elapsing before testing and the conditions during measurements shall be quoted in the test report.

7.3 Unless otherwise specified the time of electrification at the test voltage shall be one minute (*see* Appendix A).

8. EXPRESSION OF RESULTS

8.1 Each test specimen shall be measured individually.

8.2 In case of conducting paint stripes around tubes and rods the resistance shall be expressed corresponding to a 100 mm length of electrode using the relation :

$$R_{100} = \frac{l}{100} R_x$$

where

R_{100} = resistance corresponding to length of electrode of 100 mm,

l = length of electrode in millimetre, and

R_x = resistance corresponding to length of electrode of d mm.

8.3 When measuring with the bar electrodes test specimens less than 25 mm in width, the resistance R_x shall be referred to a resistance R_{25} corresponding to a width of 25 mm using the relation :

$$R_{25} = \frac{\text{Width}}{25} \times R_x$$

9. TEST REPORT

9.1 The test report shall contain following information :

a) Designation of insulating material;

b) Dimensions of test specimens;

c) Method of test and type of electrodes, including nature of conducting paint when used;

d) Whether the electrodes have been applied before or after conditioning;

e) Cleaning procedure used;

f) Conditioning and preconditioning;

g) Time elapsed and conditions during measurement if not in the conditining choamber;

h) Test voltage;

j) Time of electrification; and

k) Individual values of insulation resistance obtained.

NOTE — There is no advantage in showing the overall results in the form of an arithmetical mean of the individual values, because high values influence the results too strongly, and the low values have too great an influence when the result is given in the resistance calculated taking the mean of the conductivities of the several test specimens. It is consequently preferable to use the arithmetical mean of the logarithm of the individual results, which will provide the geometrical mean and so avoid this undue influence of individual results.

APPENDIX A

(*Clauses* 3.1 *and* 7.3)

GENERAL PRINCIPLES REGARDING METHODS OF RESISTANCE MEASUREMENT

A-1. MEASUREMENT

A-1.0 The determination of the resistance of an insulator is not fundamentally different from that of a conductor. In both cases, the resistance is measured by the ratio of a voltage to a current. The methods available can be separated into two groups, as follows.

A-1.1 Voltmeter-Ammeter Method — In this method the current is measured by a microammeter or galvanometer (*see* Fig. 6) or by a dc amplifier which indicates current by measuring the voltage drop across a known resistor (*see* Fig. 7) and the voltage is measured by an indicating voltmeter. In some cases the ratio of voltage to current is measured in a single instrument to indicate resistance directly.

A-1.1.1 *Voltmeter-Ammeter Method Using a Galvanometer*

A-1.1.1.1 The voltmeter and galvanometer are connected to the voltage source and to the test specimen as shown in Fig. 6. The applied voltage is measured by a dc voltmeter, preferably having such range and accuracy as to give minimum error in voltage indication. In no case shall the voltmeter have an error greater than ± 2 percent of full scale; nor a range such that the deflection is less than one-third of full scale. The current is measured by a galvanometer having a high current sensitivity. The galvanometer is provided with a precision Ayrton universal shunt for so adjusting

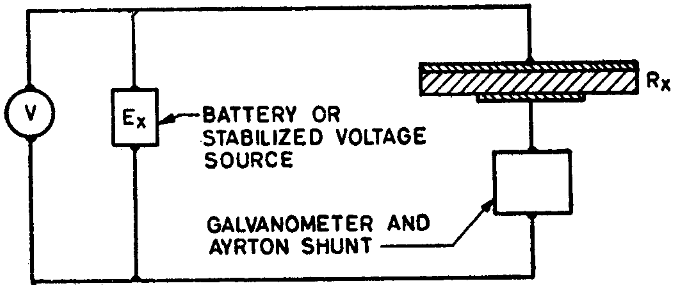
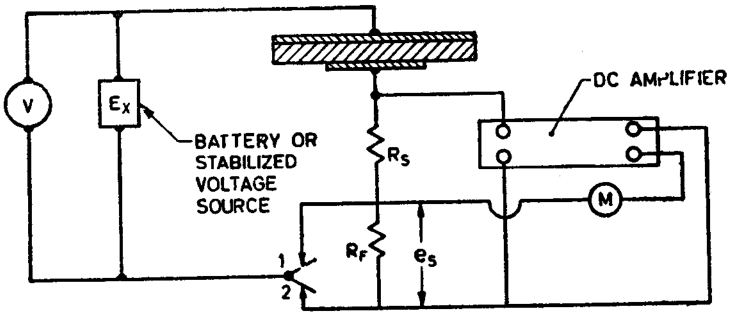
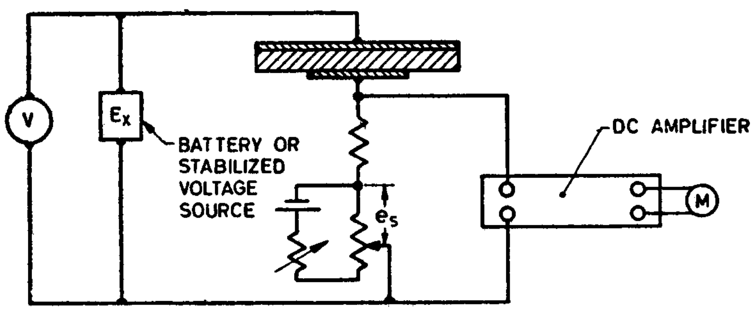


FIG. 6 VOLTMETER-AMMETER USING A GALVANOMETER



7A Normal Use of Amplifier and Indicating Meter



7B Amplifier and Indicating Meter as Null Detector

FIG. 7 VOLTMETER-AMMETER METHOD USING DC AMPLIFICATION its deflection that the readability error does not in general exceed ± 2 percent of the observed value. The galvanometer is calibrated to within ± 2 percent. The galvanometer can also be made direct-reading in current by providing a suitable additional fixed shunt.

A-1.1.1.2 The unknown resistance R_x shall be calculated as follows:

$$R_x = \frac{E_x}{I_x} = \frac{E_x}{K\,dF}$$

where

E_x = applied voltage;

I_x = total current;

K = galvanometer sensitivity in amperes per scale division;

d = deflection in scale divisions; and

F = ratio of the total current I_x to the galvanometer current.

A-1.1.1.3 With a galvanometer having a sensitivity of 500×10^{-12}A per millimetre scale division, and with 500 V applied, a resistance of 10^{12} ohms can be detected by a 1-mm deflection. Since the Ayrton shunt errors are negligible, the maximum percentage error in the computed resistance is the sum of the percentage errors in galvanometer sensitivity, galvanometer deflection and indicated voltage. If the galvanometer deflection is at least 25 mm, read to the nearest 0·5 mm; the resultant galvanometer error will not exceed 4 percent. Hence 4×10^{10} ohms at 500 V can be measured with a maximum error of $\pm$ 6 percent when the voltmeter reads full scale, and ± 10 percent when it reads one-third full scale. The desirability of a good voltmeter is readily seen.

A-1.1.2 *Voltmeter-Ammeter Method Using dc Amplification*

A-1.1.2.1 The voltmeter-ammeter method can be extended to measure higher resistances by using dc amplification to increase the sensitivity of the current-measuring device. Generally, but not necessarily, this is achieved only with some sacrifice in precision, depending on the apparatus used. Measure the applied voltage by a dc voltmeter as prescribed in **A-1.1.1**, It is subject to the same error considerations indicated therein. Measure the current in terms of the voltage drop across a standard resistance, as illustrated in Fig. 7A and 7B.

In the circuit shown in Fig. 7A the specimen current I_x produces across the standard resistance R_s a voltage drop which is amplified by the dc amplifier and read on an indicating meter or galvanometer. The net gain of the amplifier usually is stabilized by means of a feedback resistance R_f from the output of the amplifier. The indicating meter can be calibrated to read directly in terms of specimen current I_x or in terms of the feedback voltage e_s which is determined from the known value of the resistance of R_f and the feedback current passing through it. When the amplifier has sufficient intrinsic gain, the feedback voltage e_s differs from the voltage $I_x R_s$ by a negligible amount. As shown in Fig. 7A the returned lead from the voltage source E_x can be connected to either end of the feedback resistor R_x. With the connection made to the junction of R_s and R_f (switch in position 1), the entire resistance of R_s is placed in the measuring circuit and any alternating voltage appearing across the specimen resistance is amplified only as much as the direct voltage $I_x R_s$ across R_s. With the connection made to the other end of R_f (switch in position 2), the apparent resistance placed in the measuring circuit is R_s times the ratio of the degenerated gain to the intrinsic gain of the amplifier; any alternating voltage appearing across the specimen resistance is then amplified by the intrinsic amplifier gain.

In the circuit shown in Fig. 7B, the specimen current I_x produces across the standard resistance R_s a voltage drop which is balanced out by adjustment of an opposing voltage e_s from a calibrated potentiometer, the dc amplifier and the indicating meter serving only as a very sensitive, high-resistance, null detector. The return lead from the voltage source E_x is usually connected as shown, to include the potentiometer in the measuring circuit. When connections are made in this manner, no resistance is placed in the measuring circuit at balance; a steeply increasing fraction of R_s is included in the measuring circuit, however, as the potentiometer tap is moved off the balance. Any alternating voltage appearing across the specimen resistance is amplified by the net amplifier gain. The dc amplifier may be either conductively coupled or provided with input and output converters. Induced alternating voltages across the specimen usually are sufficiently troublesome as to require a resistance capacitance filter preceding the amplifier. The input resistance of this filter should be at least 100 times greater than the effective resistance that is placed in the measuring circuit by resistance R_s.

A-1.1.2.2 Calculate the resistance R_x as follows:

$$R_x = \frac{E_x}{I_x} = \frac{E_x}{e_s} . R_s$$

where

E_x = applied voltage;

I_x = specimen current;

R_s = standard resistance; and

e_s = voltage drop across R_s, indicated by either the amplifier output meter or the calibrated potentiometer.

A-1.1.2.3 The maximum percentage error in the computed resistance is the sum of the percentage errors in the voltages E_x and e_s and the resistance R_s. The applied voltage E_x is subject to the same errors noted in **A-1.1.1.** The errors in e_s and R_s are generally dependent more on the characteristics of the apparatus used than on the particular method. The most significant factors that determine the errors in e_s are indicator error, amplifier zero drift and amplifier gain stability. With modern well-designed amplifiers, gain stability is usually not a matter of concern. With existing techniques, the zero drift of conductively coupled dc amplifiers cannot be eliminated, but it can be made slow enough to be relatively insignificant for these measurement; with careful design of converter-type amplifiers, zero drift is virtually non-existent. Consequently, the null method shown in Fig. 7B is theoretically less subject to error than those methods employing an indicating instrument, provided, however, that the potentiometer voltage is accurately known. The error in R_s is to some extent dependent on the amplifier sensitivity. For measurements of a given current, the higher the amplifier sensitivity the greater the possibility that lower-valued highly precise wire-wound standard resistors can be used. Such amplifiers can be obtained. Standard resistances of 10^9 ohms, known to ± 2 percent, are a distinct possibility, however, and with a typical amplifier sensitivity of 1 mV per scale division, a current of 10^{-12}A could be detected. At 500V applied, this would correspond to the detection of a specimen resistance of 500×10^{12} ohms. If 100 mV input to the amplifier gave full-scale deflection on an indicating meter having an error not greater than 2 percent of full scale, a resistance of 5×10^{12} ohms could be measured with a maximum error of ± 6 percent when the voltmeter read full scale, and ± 10 percent when it read one-third full scale.

A-1.2 Comparison Method — In this method the unknown resistance is compared with a known resistance. This comparison is effected by determining the ratio of the currents when the same voltage is applied successively to the two resistances (*see* Fig. 8) or by balancing the two resistances in a Wheatstone bridge (*see* Fig. 9). For all of the methods the unknown resistance must be large compared to any standard resistances placed in series with it so that it will have essentially full voltage placed across it.

A-1.2.1 *Comparison Method Using a Galvanometer*

A-1.2.1.1 A standard resistance R_s and galvanometer are connected to the voltage source and to the test specimen as shown in Fig. 9. The galvanometer and its associated Ayrton shunt shall be as described

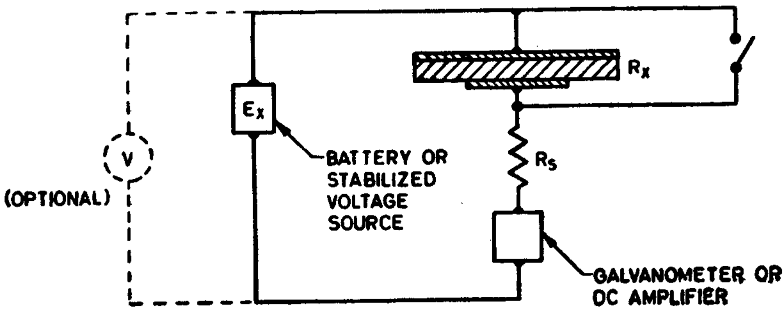


FIG. 8 COMPARISON METHOD USING A GALVANOMETER

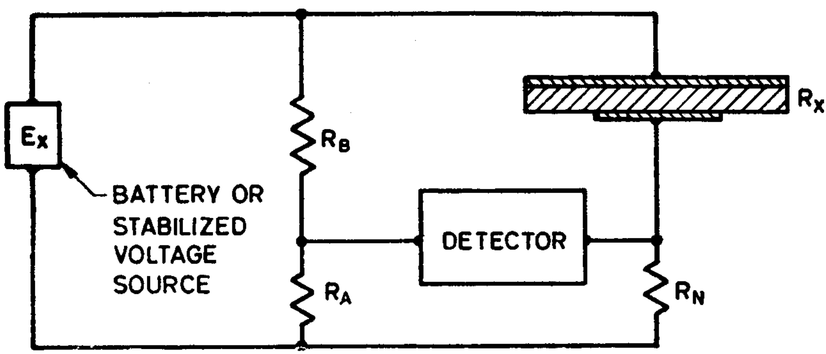


FIG. 9 COMPARISON METHOD USING A WHEATSTONE BRIDGE

in **A-1.1.1.1.** It is convenient, but not necessary, to connect a voltmeter across the source for a nominal check of its voltage. The switch is provided for short-circuiting the unknown resistance in the process of measurement. Sometimes provision is made to short-circuit either the unknown or standard resistance, but not both at the same time.

A-1.2.1.2 In general, it is preferable to leave the standard resistance in circuit at all times to prevent damage to the galvanometer and shunt in case of specimen failure. With the same voltage applied, determine the ratio of the unknown resistance to the standard resistance from the ratio of the current with the unknown resistance short-circuited to that with the unknown resistance in circuit, and then short-circuit it, the corresponding galvanometer deflections d_x and d_s being made as large and as nearly equal as possible by suitable adjustment of the Ayrton shunt.

A-1.2.1.3 The unknown resistance R_x is calculated as follows:

$$R_x = R_s\left(\frac{K_s\, d_s\, F_s}{K_x\, d_x\, F_x} - 1\right) = R_s\left(\frac{d_s\, F_s}{d_x\, F_x} - 1\right)$$

where

F_x and F_s = ratios of the total current to galvanometer current with R_x in circuit and short-circuited, respectively; and

K_x and K_s = corresponding galvanometer current sensitivities, which are assumed to be equal for nearly equal deflections d_x and d_s.

In case R_s is short-circuited when R_x is in circuit, R_x shall be computed as follows:

$$R_x = R_s \frac{d_s\, F_s}{d_x\, F_x}$$

A-1.2.1.4 The maximum percentage error in the computed resistance is given by the sum of the percentage errors in R_s, the galvanometer deflections and the assumption that $K_x = K_s$. The latter assumption is correct to well within ± 2 percent over the useful range (250 mm or more) of a good, modern galvanometer. The error in R_s depends on the type of resistor used, but resistances of 100000 ohms, with a limit of error of $\pm 0{\cdot}1$ percent, are available. With a galvanometer such as that described in **A-1.1.1.3**, and with 500 V applied, a resistance of 10^{12} ohms could be detected. At this voltage, with the above-noted standard resistor and with $F_s = 10^5$, d_s would be 100 mm, with a readability error of not more than $\pm 0{\cdot}5$ percent. If d_x were approximately 15 mm, the readability error would not exceed $\pm 3{\cdot}5$ percent, and a resistance of the order of 7×10^{10} ohms would be measured with a maximum error of ± 6 percent.

A-1.2.2 *Comparison Method Using a Wheatstone Bridge*

A-1.2.2.1 The test specimen is connected into one arm of a Wheatstone bridge as shown in Fig. 9. The three known arms shall be of as high a resistance as practicable, limited by the errors inherent in such resistors. Usually, the lowest resistance R_A is used for convenient balance adjustment with either R_B or R_N being changed in decade steps. The detector shall be a dc amplifier, with an input resistance high compared to any of these arms.

A-1.2.2.2 The unknown resistance R_x is calculated as follows:

$$R_x = \frac{R_B\, R_N}{R_A}$$

where

R_A, R_B and R_N are as shown in Fig. 9. When arm A is a rheostat, its dial can be calibrated to read directly in megohms after multiplying by the factor R_B R_N which, for convenience, can be varied in decade steps.

A-1.2.2.3 When the detector has adequate sensitivity, the maximum percentage error in the computed resistance is the sum of the percentage errors in the arms A, B and N. With a detector sensitivity of 1 mV per scale division, 500 V applied to the bridge, and $R_N = 10^9$ ohms, a resistance of 500×10^{12} ohms could be detected, assuming that the bridge were balanced to one scale division. Assuming negligible errors in R_A and R_B with $R_N = 10^9$ ohms known to within ± 2 percent, and with the bridge balanced to one detector scale division a resistance of 20×10^{12} ohms could be measured with a maximum error of ± 6 percent.

A-2. REPRODUCIBILITY

A-2.1 Because of the variability of the resistance of given specimen with test conditions, and because of non-uniformity of the same material from specimen to specimen, determinations are usually not reproducible to closer than 10 percent, and are often even more widely divergent (a range values of 10 to 1 may be obtained under apparently identical conditions).

This condition is in contrast to the determination of the resistance of metallic conductors, which is one of the most precise of electrical measurements.

A-3. INSULATION RESISTANCE OF MEASURING CIRCUIT

A-3.1 The insulation of the measuring circuit is composed of materials which at best, have properties comparable with those of the material under test. Errors in the measurement of the specimen may arise from :

a) Shunting of the specimen resistance, reference resistors, or the current measuring device by insulations resistance of unknown, and possibly variable, magnitude.

b) Stray currents from spurious external voltages which are usually unknown in magnitude and often sporadic in character.

A-3.2 An approximate correction of these difficulties may be obtained by making the insulation resistance of all parts of the circuit as high as possible under the conditions of use.

A-3.3 To ensure satisfactory operation of the equipment a measurement should be made with the high potential lead to the specimen disconnected.

Under this condition the equipment should indicate infinite resistance within its sensitivity. If suitable standard resistances of known values are available they may be used to test the operation of the equipment.

A-4. FLUCTUATION OF VOLTAGE

A-4.1 Any fluctuations in applied voltage may result in charging and discharging currents being superimposed on the current which it is desired to measure. Therefore the voltage should be steady.

A-5. TIME OF ELECTRIFICATION

A-5.1 When a potential is applied to a specimen the current through it decreases asymptotically (except in rare cases) towards a limiting value which is the conduction current and which may be as little as 0·01 of the current observed when the voltage has been applied for one minute. This decrease of current with time is due to dielectric absorption (interfacial polarization, volume charge, etc) and the sweep of mobile ions to the electrodes.

A-5.2 Depending upon the characteristics of the specimen material, the time required for the current to decrease to within one percent of its final value may be from a few seconds to many hours. Thus in order to assure that measurements on a given material are comparable, it is necessary to specify the time of electrification.

A-5.3 The conventional arbitrary time of electrification has been one minute. For some materials, misleading conclusions may be drawn from the test results obtained at this arbitrary time. A resistance-time curve should be obtained under the conditions of test for a given material as a basis for selection of suitable time of electrification which must be specified in the test method for a particular material for each condition of test (temperature, humidity, etc).

A-5.4 Occasionally a material may be found for which the current increases with time. In this case special study should be made and arbitrary decisions as to time of electrification should be made.

A-5.5 A specimen which has a volume charge, looses it gradually when its electrodes are connected together. The loss of this volume charge can be observed by measuring the current which flows when the specimen is connected directly across the current-measuring device. It should be established that the test specimen is completely discharged before attempting the first measurement, a repeat measurement or a measurement with reversed voltage.