Chapter I

INSULATION RESISTANCE TESTERS

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. The safety and efficiency of electrical installations and apparatus demands a high standard of insulation and electrical continuity between joints. Tests of the standard of insulation should be made at the time of installation, and thereafter at regular intervals to prevent the development of faults or to locate such faults if and when they do develop. These tests are most conveniently effected by testing the insulation resistance of the circuit or apparatus, and a variation of the tests applied may be used to locate breaks in the cable, faulty insulation, loose connectors, moisture, or similar conditions likely to cause deterioration and faults in the insulation.

2. A convenient way of making the necessary tests to the installation in situ is by the use of an ohmmeter, or an insulation tester which combines an ohmmeter and a magneto-generator assembled as a single unit; the generator, which is hand-driven, develops a testing voltage of 250, 500, or 1,000 volts (insulation resistance testers), or 30 volts (safety ohmmeters), according to the type of tester.

3. The ohmmeters and insulation resistance testers, which are described in A.P.4343S, Vol. 1, Sect. 24, are portable and self-contained. When the operator is familiar with the various possible adaptations to particular resistance-measuring requirements, accurate resistance measurements may be made over a wide range. In addition to the general uses suggested above, tests can be made of high resistance for wireless aerial and earth installations, aerial transmission and communication lines, and miscellaneous apparatus.

DESCRIPTION

Insulation resistance testers

4. The testers are supplied in leather carrying cases (*fig.* 1). The handle of the combined generator-ohmmeter has a simple freewheel device, which ensures that the

Fig. 1. Insulation resistance tester in carrying case

armature is rotated in a clockwise direction only, and prevents strain on the apparatus if the handle turning is suddenly stopped. The tester is so constructed that it will withstand a considerable amount of vibration and shock without injury; it is sealed against dust, sand, damp, and other harmful substances and conditions, and will stand up to a tropical climate.

5. There are two main groups of insulation resistance testers: those which develop a varying pressure and those with some means of voltage limitation. In the first group, among which are the 500-volt Types A and D, the generated voltage varies with the speed of handle turning, the nominal voltage being attained at a handle speed of approximately 160 r.p.m. In the second group, voltage limitation may be achieved by the incorporation of either a non-linear resistor, as in the Type C, where rotation of the handle above 160 r.p.m. does not cause a rise in voltage above 250 volts, or a slipping clutch, as in the 500-volt Type E, where the clutch slips at speeds greater than 160 r.p.m.

Note . . .

The 250-volt insulation resistance tester, Admiralty Pattern F1C/5047, has no form of voltage limitation, and the handle should not be rotated at speeds greater than 160 r.p.m.

6. A typical circuit diagram is given in fig. 2, which shows an ohmmeter of the moving coil type, having two coils mounted at a fixed angle to one another and free to rotate in the field of a permanent magnet. Both coils are in parallel across the generator, the control coil being in series with the fixed control circuit resistance, and the deflecting coil in series with another fixed resistance (to limit the current at zero) and the resistance under test.

7. A pointer mounted on the moving coil system is freely pivoted on spring-mounted jewels, and when no current is flowing will tend to rest at some point towards the infinity end of the scale. When the apparatus or circuit to be tested is connected between the terminals of the tester, and the generator handle is turned, currents pass through both the circuits, the position depending on the ratio between them, which is governed by the resistance under test. Any variations in the testing voltage will affect both control and deflecting coils equally, and as the resistance under test is connected in series with the deflecting coil only, it alone will be

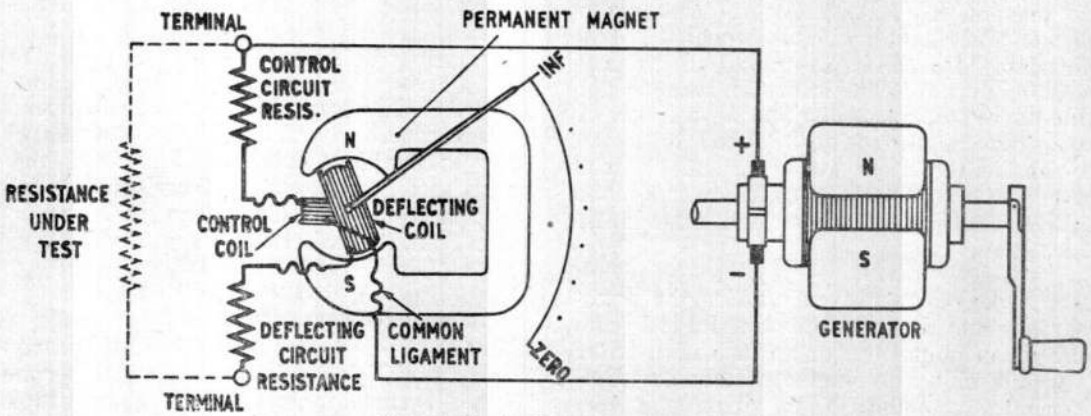

Fig. 2. Typical circuit diagram

responsible for the position of the pointer on the scale.

8. The instrument should be held with the dial horizontal when in use. The leather carrying case in which it is supplied can be adjusted with a strap to hold the instrument in the flat position while slung over the operator's shoulder, leaving both his hands free. The case has a window over the scale, holes cut to allow cable connection with the terminals, and allows for the handle of the generator to be turned with the instrument still strapped inside the case.

Megger-bridges

9. This type of instrument combines the functions of an insulation resistance tester with those of a Wheatstone bridge, i.e., it may be used for measuring either insulation or conductor resistance. It consists of a hand-driven generator and a direct-reading ohmmeter, both similar to those incorporated in insulation resistance testers, combined with a variable decade resistance and ratio arms, either in one case or in two readily-connected parts.

Safety ohmmeters

10. Safety ohmmeters are normally used for determining the continuity and insulation resistance of such circuits as those incorporating a detonator fuse, and are so constructed that the generator cannot give a current exceeding 10 mA or 12 mA, depending on type, even if the brushes are short-circuited or the handle turned at a speed greater than 160 r.p.m. A freewheel device allows the armature to come to rest slowly when the handle turning is stopped abruptly, thus relieving the transmission from strain and ensuring that the armature is turned in the right direction. The generator and ohmmeter are again similar to those in insulation resistance testers.

OPERATION

11. All tests should be made in a "dead" circuit. Generally speaking, the testing pressure used should not exceed twice the normal pressure for which the apparatus is designed, but it is laid down that aircraft equipment should be tested at 250 volts, the only exception being detonator circuits, wireless circuits or other special equipment.

12. In all types of testers it is desirable that the instrument be kept away from magnetic surfaces, cable runs, electrical instruments or live circuits while the test is being made, and whenever possible tests should be made under cover and in dry atmospheric conditions. Further, it is essential that the tester should be kept steady and so placed that the handle can be turned easily and smoothly without rocking or sliding the tester. Never rest the tester on the pole-piece or bed-plate of a dynamo or electrical machine of any nature.

13. The speed at which the handle should be turned is printed on the scale. It should be remembered when using the variable pressure types to test a circuit having much electro-static capacity that a steady rate of handle speed as near as possible to the given rate must be maintained to obtain a steady reading on the scale. Excessive speed may produce a pressure high enough to break down the insulation in the circuit or instrument under test. In the limited voltage types a speed slightly above the given rate will ensure that the pressure is kept steady.

14. Careful observation of the results obtained, and comparison with previous figures for the same test, will often give the operator a clue as to the condition of the circuit or apparatus under test. For instance, if the insulation is damp, the scale reading will fall as the voltage rises; it may then rise as the insulation dries out, or a complete breakdown may occur. Sudden variations in the readings recorded are often due to intermittent sparking between conducting particles on the surface or sometimes on the body of the insulation of the circuit or apparatus tested.

Insulation resistance testers

15. Place the tester with the scale uppermost, in such a position that the handle may conveniently be turned without displacing the instrument. Before making any connections, test the instrument by turning the handle, when the pointer should promptly move over the scale towards the infinity mark.

16. Connect suitable leads to the instrument terminals. Taking care that the leads are not in contact with anything, turn the handle again, when the pointer should once more move to the infinity mark. Join the leads together and turn the handle slowly, and the pointer should move across the scale to zero; if these two tests are satisfactory, it may be safely assumed that the instrument will read correctly on all points of the

scale. If the test is not satisfactory, there is most probably a leak in the leads themselves, and fresh leads must be substituted.

17. When the insulation of the leads themselves is assured, connect the loose ends to the circuit to be tested. Turn the handle at the speed indicated on the dial, and at the same time observe the position of the pointer on the scale. The reading shows the value of the insulation resistance under test.

18. If several successive readings show infinity resistance, touch the further ends of the test leads together while turning the handle slowly to make sure that the leads are not disconnected or broken.

19. It will be appreciated that comparison of one reading with another will be of greater value in insulation testing than the absolute value obtained in any one test. Thus, if a record of daily, weekly or monthly readings shows insulation resistance of some item to be between 4 and 5 megohms, a sudden reading of only 1 megohm will suggest the development of trouble at some point which can then be traced and corrected before an actual breakdown occurs.

20. When a testing voltage is applied to any system of appreciable electrostatic capacity, a current will flow into the system until it is fully charged, even though the insulation is perfect. In this instance the pointer will fall at first, then, when the system is fully charged, will rise to the correct insulation reading.

21. If the handle of the tester is not turned at a constant rate, or, with the limited voltage types, the speed is allowed to drop below 160 r.p.m., a variable current will result, so that the part under test will alternately be charging and discharging, and the pointer reading will be unsteady.

Megger-bridges

22. The procedure for insulation testing is in general the same as described in para. 15 to 21; particular instructions, and information on other tests that can be made, will be given in the chapters in A.P.4343S, Vol. 1, on the individual testers.

Safety ohmmeters

23. These instruments are extremely simple to use. Connect the two terminals to the resistance to be measured; turn the handle at above 160 r.p.m., and the value of the resistance will be indicated on the scale.

SERVICING

24. Insulation resistance testers are issued sealed, and beyond keeping them clean and dry and handling them with reasonable care on all occasions, nothing can be done to them in the way of repair or adjustment beyond the small points described in the following paragraphs. They are extremely reliable, and what may appear to be faulty functioning is more likely to be faulty operation.

25. The instrument should always be kept in the carrying case provided, as it is unnecessary to remove it from the case when making a test. When it is carried slung from the shoulder, great care should be taken not to knock or jar the tester, which, though robustly constructed, is a delicate mechanism and will be damaged by rough handling.

26. The leads, where provided, are of standard length and resistance and should be kept dry, free from acute bends, and the insulation kept intact. Any suspicion of break or partial break, any faulty insulation or doubtful fixing to connectors should be given careful attention. Leads cannot be repaired in service, and if a fault or any damage should occur, the leads must be returned to Stores and a new pair requisitioned.

27. The generators have well-cut gears which run easily in roller bearings. They are protected against the ingress of fine sand or dust, and require attention only at long intervals. This attention cannot be given in service, and if it is suspected that the bearings are not in good order, the instrument must be returned to Stores for attention.

28. Before the resistance box of the megger-bridge is used, the switches should be rotated a few times to ensure the removal of any film of resistance material which may have been deposited by atmospheric conditions.

29. It is advisable to check the accuracy of the testers from time to time by connecting resistances of known ohmic value between the terminals and making the test in the normal way. The readings recorded on the scale of the tester should be correct to within 10 per cent.

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