TTE Training Ltd.

Phase 1
Electrical Course Notes

E-CN-007

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Test Instruments

Test Instruments

There are many instruments in the electrical workshop and each has its own correct method of operation. The most common instruments that you will be using are as follows:-

- Multimeter
- Continuity Tester.
- Insulation Resistance Tester. { Analogue
- Clip-on Ammeter. al
- Bridge Megger

When using any test instrument there are a number of guidelines that should be observed to ensure maximum personal safety. They are listed below.

Please read, remember and follow them, <u>they are there for your safety!</u>

- **Do not use the test equipment if it, or the test leads, are damaged, or if you suspect that the equipment is not functioning correctly.**
- Avoid grounding yourself when taking measurements; do not touch exposed metal objects such as pipes, outlets, fixtures, equipment chassis or cases etc., which may be at ground potential. Keep your body isolated from ground by wearing rubber-soled footwear or standing on a mat made from an approved insulating material.
- **Turn off the power to an item under test before cutting, de-soldering or breaking a circuit. Even small amounts of current can be dangerous.**
- Use caution when working on equipment that contains voltages that pose a shock hazard, i.e. above 50v. AC. or 120v. DC.
- When using probes, keep your fingers behind the guards.
- Measuring voltages which exceed the limits of the test equipment may damage the equipment and expose the operator to a shock hazard. **Never** exceed the voltage or current limits shown on the front of the equipment.
- **Ensure that the correct function and the correct terminals have been selected before using the instrument to avoid causing any damage to it.**
- **Before measuring for resistance, ensure that the circuit under test has been isolated.**
- Where possible, use fused leads to protect both the instrument and yourself from any potential shock hazard.
- All test equipment is sensitive and, in order to maintain their accuracy and reliability, they should be handled with care.
- **Do not** use test instruments that generate a test voltage, (i.e. the IR Tester), on equipment that may contain electronic components.
- **Check calibration stickers to ensure equipment has been checked for accuracy.**

Analogue Measuring Instruments

Analogue multimeters get their name from the measurement scale that is frequently used to indicate the quantity which we wish to measure. Many modern indicating devices use the movement of an indicator across a scale to represent a quantity that we require, (for example, the engine rev. counter and speedometer in a car), for a variety of reasons including:-

- They are, in general, cheaper.
- People still often prefer an analogue display rather than a digital one.
- The additional cost of digital instruments can only be justified when accuracy is essential.

The movement system of an analogue instrument is usually in the form of a permanent-magnet moving-coil. This consists of a permanent magnet, a soft-iron cylinder, an insulated copper wire coil, (mounted on spindles) connected to two spiral hairsprings (one at each spindle) and an indicating arm (connected to the spindle).

The diagram below, (Fig. 4:3), shows the front and plan elevation views of this arrangement.

Fig. 4:3

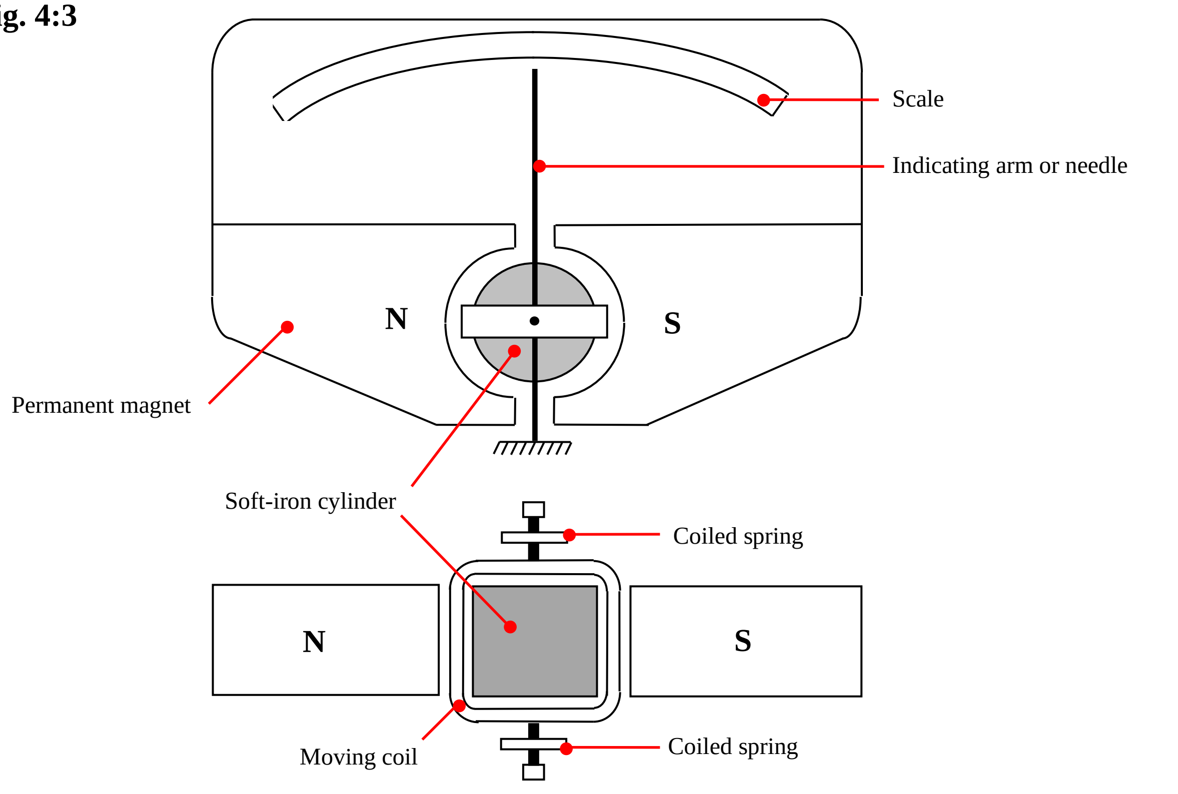
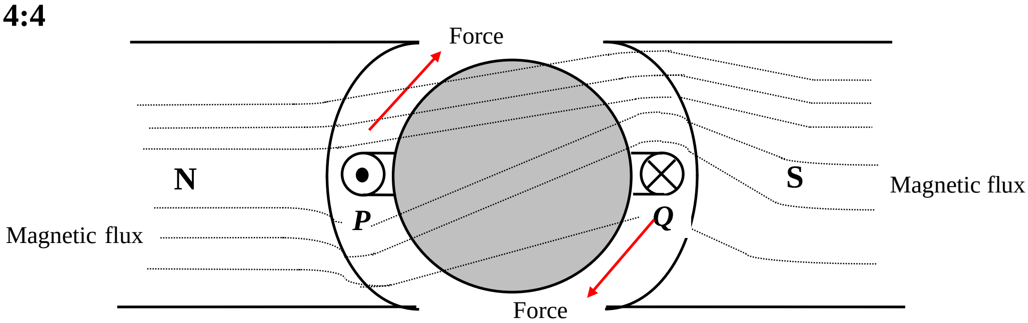


Fig. 4:4



The manner in which a force is produced when the coil is carrying a current may be understood more easily by considering a single turn *PQ*, as in the diagram above (Fig. 4:4). Suppose *P* was carrying current outwards from the paper thus *Q* is carrying the same current towards the paper.

The current in *P* tends to set up a magnetic field in an anti-clockwise direction around it and thus strengthens the magnetic field on the lower side and weakens it on the upper side. The current in *Q* strengthens the field on the upper side while weakening it on the lower side. Because the magnetic flux across the poles behaves as if it were in tension, and therefore tries to take the shortest path between poles NS, the effect of the magnetic fields around *P* and *Q* distorts the magnetic flux between the poles. This has the effect of exerting forces on the coil *PQ* causing it to deflect, or move, in a clockwise direction.

Current is led into and out of the coil by the spiral hairsprings. The coil is free to move in the air gaps between the magnet poles and the soft-iron cylinder, the function of which is to intensify the magnetic field by reducing the length of air-gap across which the magnetic flux has to pass. This also gives the magnetic flux uniform density, thereby enabling the scale to be uniformly divided.

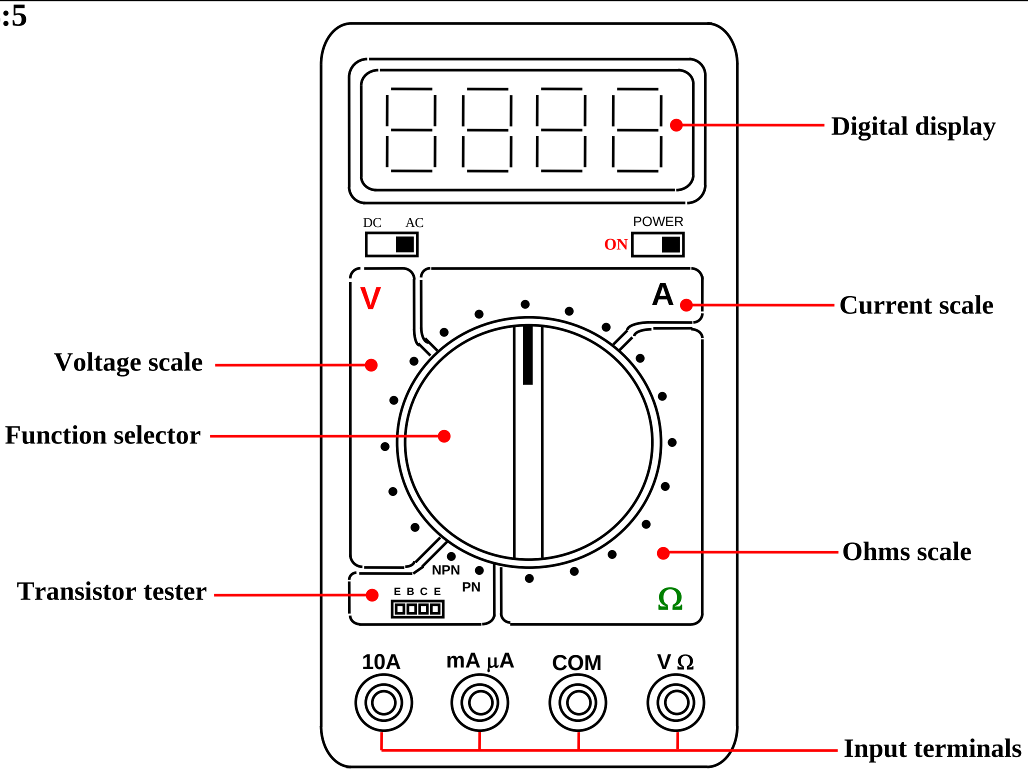
The main advantages of the moving-coil instrument are:-

- High sensitivity.
- Uniform scale.
- Well shielded from stray magnetic fields.

The Digital Multimeter

A typical digital multimeter has a four digit liquid crystal display that can measure resistance and AC and DC voltage and current, (see Fig. 4:5 below). The technological developments of the basic circuitry for these instruments, has led to them becoming much more readily available in terms of cost and efficiency. They are compact and lightweight (in comparison to the analogue meters), and their cost is small considering their capabilities.

Fig. 4:5



There are many types of digital multimeters available and it is important that, before using any instrument, you fully understand its functions and how to correctly operate it. **Failure to do so could be the major contributory factor towards an accident.**

Dead testing????????????

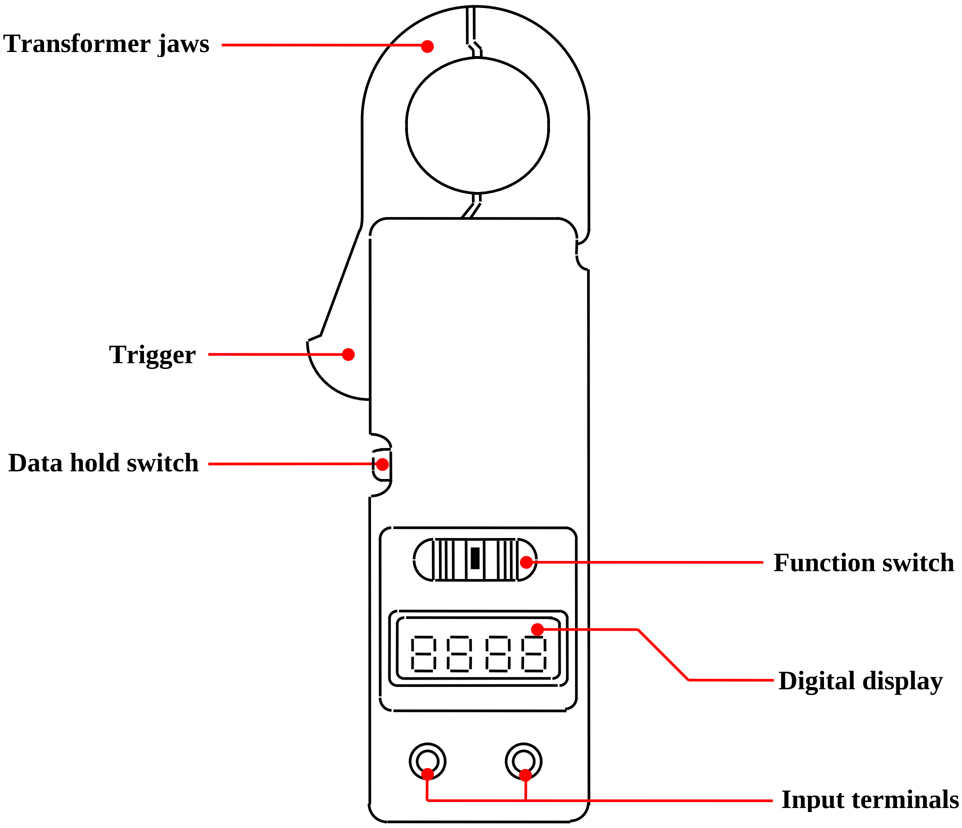
The main advantages of the digital instrument are:-

- Easy to read display
- Compact size
- More functions than its analogue counterpart.

The Clip-on Ammeter

There are both analogue and digital versions of this instrument available. Both operate on the same principle; that is one of current induced in the transformer coil, or clamp, by the magnetic flux that surrounds the current-carrying conductor under test. In reality, the clip-on ammeter is actually a multimeter however test leads are required if it is to be used for measuring voltage or resistance.

Fig. 4:6



The advantage that this type of meter has over a standard multimeter is that, in order to measure current, the conductors of the circuit under test, do not need to be isolated or disconnected.

In order to measure current the transformer jaws are opened via the trigger, placed around the phase conductor of the circuit under test, and then closed by releasing the trigger. The magnetic field surrounding the current carrying conductor induces a current into the transformer jaws which is then shown on the display via the calibrated circuitry inside the instrument.

The Continuity & IR Tester

We use this instrument for checking **continuity** and **insulation** resistance values in electrical circuits. The older models consist of a manual generator which generates approximately 500V. a.c. and a bridge rectifier to convert the test voltage to d.c. The more modern push-button type relies on a 9V battery to supply the initial voltage which, when the instrument is used for insulation testing, is boosted via the internal circuitry to 500V d.c.

I.E.T. Regulations state that the test voltage for installations must be selected in accordance with the Circuit nominal voltage of the installation. In the case of domestic installations this would be 500v.d.c.

The modern push-button megger is available as an analogue or digital instrument however the principle of operation for testing is the same for both types.

Continuity Test

The I.E.T. Regulations state that the protective (earth) conductor shall be continuous and that its resistance shall not exceed a set figure. To ensure that this conductor has adequate section and is not broken, the test is usually made by measuring the voltage dropped along its length when a large current flows through it.

Insulation Test

This test is used to measure the **value of insulation resistance** between the individual conductors and between the conductors and earth.

General Measurement (Volts Amps Watts)

The measurement of any of the values given for voltage, current, and power can be done using simple meters connected into the circuit. In figure 4.7a it can be seen that to measure the voltage across a load or supply to the dc motor, the voltmeter must be connected in parallel. To measure current through the motor an ammeter is connected in series, and a wattmeter is a combination of both and must be connected in series and parallel.

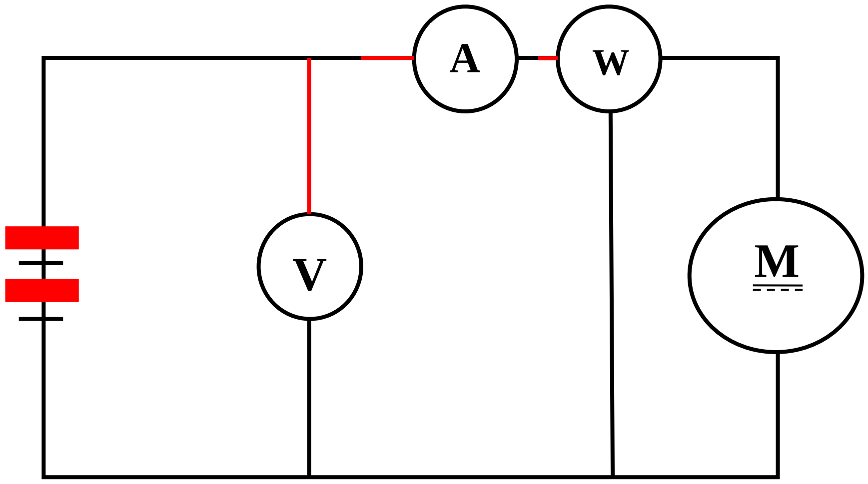
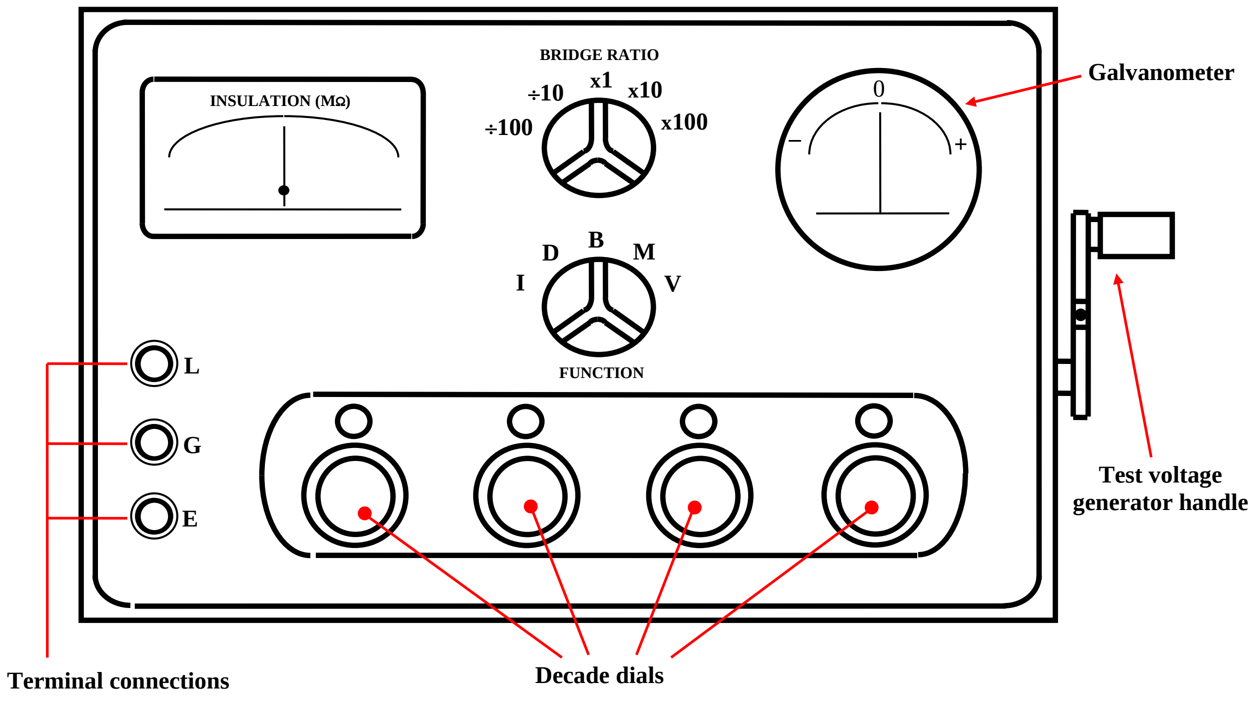


FIGURE 4.7a

The Bridge Megger

This instrument is used for a number of electrical procedures, namely Insulation, Bridge, Murray and Varley tests. Each has its own purpose and is briefly described below. The test voltage generated by this instrument is approximately 1,000V.

Fig. 4:8



Insulation Test

This test is used to accurately measure the **value of insulation resistance** of the cables under test. The function switch is turned to select "Insulation", (I), and the test leads from the terminals L and E are connected to the conductors and / or earth. The handle is then rotated at a steady speed and the value of insulation resistance, (in Meg-ohms), is indicated on the scale. When the test is complete the function switch should be turned to "Discharge", (D), in order to remove any stored charge in the cables under test.

Bridge Test.

This test is used to accurately measure the **value of an unknown resistance** (e.g. a motor winding). The function switch is turned to select "Bridge", (B), and the test leads from terminals L and G are connected to each end of the resistance under test. Select the (x1) scale on the Bridge Ratio switch and set the decade dials to zero and rotate the handle at a steady speed. The decade dials should then be adjusted until the galvanometer indicates minimum deflection (remains centre scale).

If a reading is unobtainable the Bridge Ratio switch should be altered to the "x10" or, if required, the "x100" scale. If the resistance under test is of a low value then a more accurate reading can be obtained by selecting "÷10" or, if required, "÷100" on the Bridge Ratio switch. This will give accuracy to one or two decimal places respectively.

Balance Test.

This test is used to measure resistance values of motor windings to determine whether the windings are “balanced” (measure the same resistance).

Should the value of the resistance readings for any test require more accuracy, or if a greater test voltage was required, then we would use the **Bridge Megger.**