Experiments with high currents

Objects of the experiment

- Applications of the transformer to obtain high temperatures using extremely strong currents at low voltage.

Principles

In the experiment P3.4.5.5, a transformer is assembled in which the primary side with 500 turns is connected directly to the mains voltage. In a melting ring with one turn or a welding coil with five turns on the secondary side, extremely high currents of up to 100 A can flow, sufficient to melt metals or spot-weld wires.

Equipment list

1	U-core with yoke	562 11
1	Clamping device	562 12
1	Mains coil with 500 turns	562 21
1	Ring-shaped melting ladle	562 20
1	Melting ring	562 32
1	Coil with 5 turns	562 19
1	Sheet-metal strips, set of 5	562 31

Carrying out the experiment

Warning

In these experiments you are dealing with high temperatures and molten metals.

Take great care and use only the wooden handles.

Touch the metal parts only after sufficient cooling, even a non-glowing part might be quite hot.

Perform the experiments only on a heat resistant surface without inflammable material nearby.

People standing close to the experiment should wear protective clothing (not inflammable!) and protective glasses, as there could be drops of liquid metal spilled around.

a) Model of an induction oven

The 500 turn coil 562 21 is used as the primary coil, and the melting ladle as the secondary coil, as a coil with only one short-circuited turn (Fig. 1). As for all transformer experiments connected to the mains, the yoke 562 11 must be tightly clamped using the clamping device. Suitably bend the tin strip 562 32, place it in the ladle 562 20 and switch on the current on the primary side. The tin will melt after a short time and collect in the ladle. Switch off the current, remove the yoke and wait for the tin to solidify. When the ladle is tipped up, you can make the tin fall out and show it around. It is also possible to melt it again and

Fig. 1: Melting tin in an induction oven.

Fig. 2: Burning through a thick wire.

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to pour it in the angle between two small boards, where it will quickly solidify to form a rod with three edges.

b) Melting a thick wire

- The secondary coil is now formed by the welding tongs as a coil with 5 turns 562 19 (Fig. 2). Stretch a 10 cm long piece of iron wire or a long nail with a diameter of approximately 3 mm between the attached terminals. Before screwing tightly, press the handles of the coil together a little so that the wire is under slight tension. When you switch on, the wire becomes red-hot within a short time and breaks when it is white-hot. It is possible to “repair” it by bringing the ends of the broken wire together with the primary current switched on. This is done by pressing together the tongs using the handles. If necessary, rub the contact points a little against each other. You will soon notice that the contact point becomes red-hot. This red-hot condition continues the extend around the point of breakage and as soon as this has become white-hot and there are sparks, switch off the current and allow the wire to cool down.
- It is instructive to carry out measurements during these experiments, by connecting an ammeter for alternating current with a measurement range of approx. 10 A on the primary (not secondary!) side. When the current is switched on, the instrument initially indicates approx. 8 A, and then the deflection returns to 5 A and less when the wire is heated up. The transformation ratio of the transformer in this experiment is 1:100 for the current, and for this reason a current of the order of magnitude of 800 A flows through the cold wire, and still between 400 and 500 A in the red-hot wire. The term “high-current experiment” is therefore justified, and there is no other simple way of producing such large currents. – The experiment also demonstrates the increase in resistance of iron with temperature.

c) Spot welding

- The same set-up as for the previous experiment is used to demonstrate spot welding. This experiment demonstrates how sheet metal strips are welded together point by point if the appropriate place is brought between the contacts of the tongs, heated there until it is white-hot and then pressed together gently. The simple process is widely used in practice.
- It is best to let a helper hold both sheets in the correct position together under the tong contacts. Press the sheets together when you see that current is passing through, release the pressure a little and then press more firmly when white-heat is reached. The current should then either be switched off or you should go immediately to the next point which must be spot welded. The transformer can be used to weld together sheets up to 0.75 mm thickness. If necessary, the points to be connected must be cleaned a little before welding. – Technically correct welding requires a lot of practice.
- It is also possible to carry out soldering, above all hard soldering, by heating the parts to be connected above the melting temperature of the solder (silver or brass) by the current. In practice, steel belt saws in industry are frequently repaired using the above method.

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