High current transformer (Demo) (Item No.: P1434405)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 16-19
Topic: Electricity
Subtopic: Electromagnetism
Experiment: High current transformer (Demo)

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	20 Minutes	1 Student

Additional Requirements:

- Power Supply

Experiment Variations:

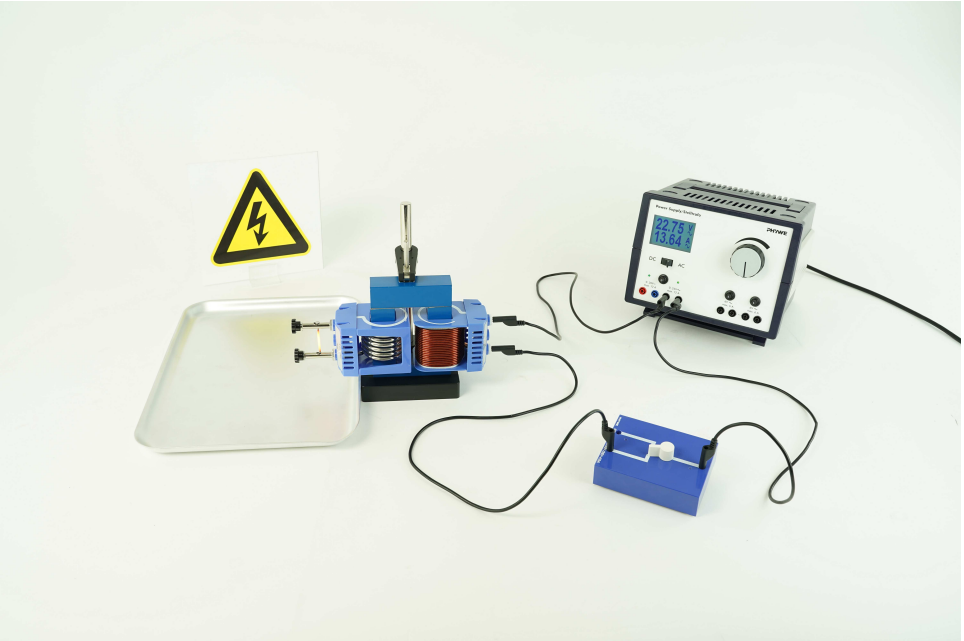
Keywords:

Transformer, Coil, Number of turns, current ration, Melting temperatur

Informations for teachers

Introduction

With a transformer with a certain ratio of the number of turns, high currents can be generated. With a high-current transformer of suitable numbers of turns, current strengths can be generated which cause metal pieces of larger diameter to glow or melt.



Equipment

Position No.	Material	Order No.	Quantity
1	PHYWE variable transformer with digital display DC: 0...20 V, 12 A / AC: 0...25 V, 12 A	13542-93	1
2	Clamping device for iron cores	06506-00	1
3	Iron core, I-shaped, laminated	06500-00	1
4	Iron core, U-shaped, laminated	06501-00	1
5	Coil, 6 turns	06510-00	1
6	Coil, 75 turns	06511-01	1
7	Two-way switch, single pole	06030-00	1
8	Iron nails, d 2,2mm,l 50mm,20 pcs	06534-00	1
9	Connecting cord, 32 A, 750 mm, black	07362-05	3
10	Caution Label - high voltage	06543-01	1
11	Protective desk plate 40 x 40 cm	39180-10	1
12	Holder for caution plate	06549-01	1

Safety information

In this Experiment high currents are genererated.

The experiment is only to be operated by a specialist supervisor; never let students perform the experiment.

This experimental setup delivers high electric currents that are dangerous to touch. The setup does not ensure a sufficient isolation against these electrical hazards. Therefore, the following advice is **strictly** to be followed!

- Put up a warning sign “electrical hazards” (e.g. 06543-01) before starting the experiment.
- The experiment is to be set up only when there is absolutely no voltage applied (disconnect power plug completely!); check every part once again before connecting the power supply to the mains.
- Changes in the experimental set-up are only to be made after disconnecting the power plug.
- **Important**: In order to prevent the danger of an electric shock, only perform the experiment with one hand (and the other hand in the trouser pocket).
- The nail is heated and remains hot for some time even when the circuit is switched off. Caution: Risk of burns!

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Introduction

Application and task

Transformers are needed to transform an input current larger, smaller or equal. Current transformers are usually installed in the power supply in many electrical devices.
In this experiment, currents are transformed so highly that a nail can be heated and starts to glow.

Theory

In technology, transformers are used, among other things, to convert a certain alternating current I_1 (primary current) into an alternating current I_2 (secondary current) of a different strength. The number of turns N_1 and N_2 of the primary and secondary coils are in a certain ratio, which in case of a loaded transformer corresponds to the reverse ratio of the currents:

$\frac{I_1}{I_2} = \frac{N_2}{N_1}$

The current strength I_2 depends on the primary current I_1 and the ratio of the number of turns:

$I_2 = I_1 \cdot \frac{N_1}{N_2}$.

In a high-current transformer with a sufficiently high transmission ratio, it can be considerably greater than the current I_1 and can be used to generate thermal effects.

$n = \frac{N_1}{N_2}$

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Setup and procedure

Setup

Set up the experiment according to Fig 1.

The I-shaped iron core is placed ontop of the U-core with the coil with 75 turns (primary coil) and the coil with 6 turns (secondary coil). The clamping device ensures that the connection between the iron cores is mainly free of air gaps. In order to prevent glowing material from falling onto the table, the safety base plate is placed under the secondary side of the transformer.

The primary coil (75 turns) is connected to the AC connection power source via the open switch. A nail is pushed into the holes on the connections of the secondary coil (6 turns) and tightened with the two knurled screws.

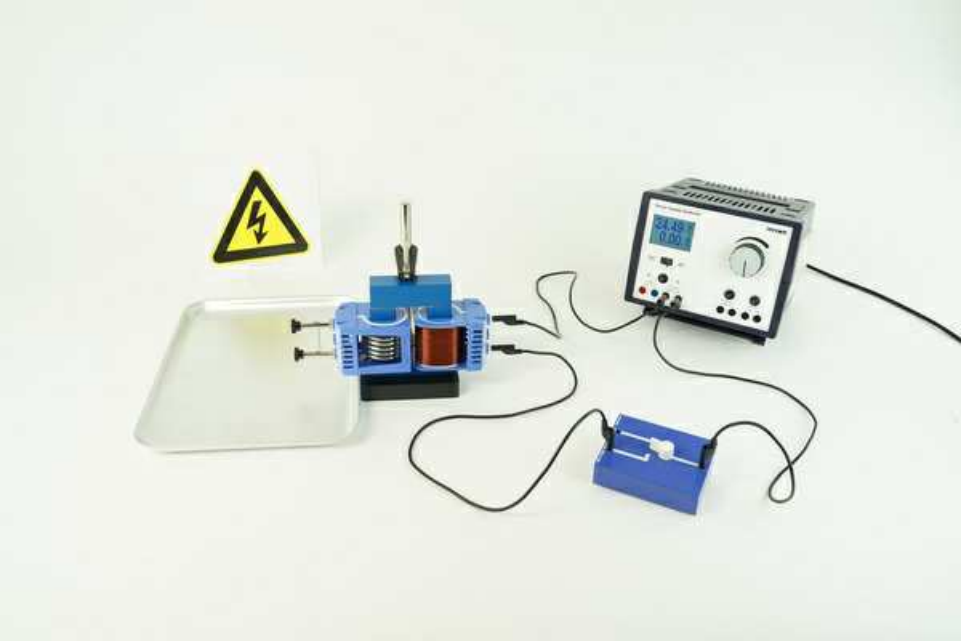

Fig. 1

Procedure

Set the power supply to 25 V AC.
Close the primary circuit with the switch and watch the nail.

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Evaluation

Observation

After closing the switch, the nail begins to glow. Its temperature rises until it melts and the secondary circuit is interrupted.

Result

The ratio $n = N_1 : N_2 = 75 : 6 = 12.5$ thus results in a high current I_2 in the secondary circuit, which causes the nail to glow and finally to melt.

Anmerkung:

- The secondary currents do not exactly match the value that results from the relationship

  $I_2 = \frac{N_1}{N_2} \cdot I_1$

  The current is a little bit smaller. The deviation can be attributed to the ohmic resistance of the nail.
- The melting temperature for iron is $T = 1808\,K$.

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