Transforming current (Item No.: P1376900)

Curricular Relevance

Area of Expertise:	Education Level:	Topic:	Subtopic:	Experiment:
Physik	Klasse 7-10	Elektrizitätslehre	Elektromagnetismus	Stromtransformation

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	10 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional information

When very high current strengths are required on a technical scale, e.g. for welding equipment or electric smelting furnaces, then so-called heavy current transformers are used. Their secondary coils have only a few turns of large diameter wire.
In the case of an ideal transformer under load, the primary and secondary performances are equal, so that $I_s / I_p = N_p / N_s$ is valid. The students should recognise from this experiment that the ratio I_s / I_p increases with increasing load, so that $I_s / I_p \approx N_p / N_s$ is true for the transformer under load.

Notes on setup and procedure

Should three multi-range meters be available for each working group, then I_p, I_s and U_s can be determined with the other values to save time.

Remarks

For an ideal transformer, the following relationship is valid:
$U_p / U_s = N_p / N_s$ und $U_p \cdot I_p = U_s \cdot I_s$.
From this we have:
$U_p / U_s = N_p / N_s = I_s / I_p$ or $I_s / I_p = N_p / N_s$.
It is more reasonable, that the students work with the relationship which applies in practice: $I_s / I_p \approx N_p / N_s$. They should also understand that the values of the quotients approach each other more closely, the larger the load on the transformer is. The transformer model with which the students experiment is not a heavy current transformer, as the secondary coil consists of 400 turns of thin wire. It would therefore be absurd to want to work towards the equalness of the quotients I_s / I_p and N_p / N_s . The behaviour of a transformer under heavy load can, however, be derived from the results.

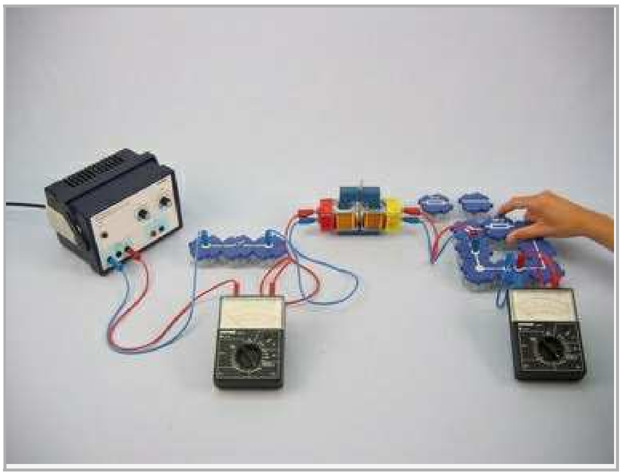
Transforming current (Item No.: P1376900)

Task and equipment

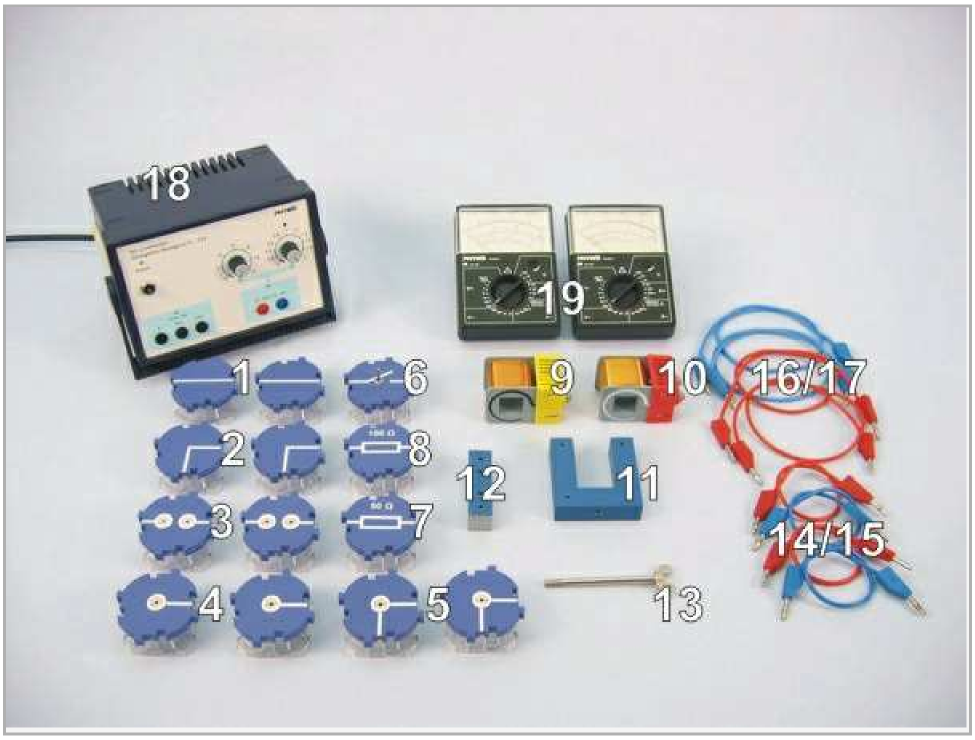
Task

How does a transformer perform under load?

Set up a model of a transformer and use it to examine which conformity to law is given when the transformer is under load.



Equipment



Position No.	Material	Order No.	Quantity
1	Straight connector module, SB	05601-01	2
2	Angled connector module, SB	05601-02	2
3	Interrupted connector module, SB	05601-04	2
4	Junction module, SB	05601-10	2
5	Angled connector module with socket, SB	05601-12	2
6	On-off switch module, SB	05602-01	1
7	Resistor module 50 Ohm, SB	05612-50	1
8	Resistor module 100 Ohm, SB	05613-10	1
9	Coil, 400 turns	07829-01	1
10	Coil, 1600 turns	07830-01	1
11	U-core	07832-00	1
12	Yoke	07833-00	1
13	Tightening screw	07834-00	1
14	Connecting cord, 32 A, 250 mm, red	07360-01	2
15	Connecting cord, 32 A, 250 mm, blue	07360-04	2
16	Connecting cord, 32 A, 500 mm, red	07361-01	2
17	Connecting cord, 32 A, 500 mm, blue	07361-04	2
18	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
19	Multi-range meter, analogue	07028-01	2

Set-up and procedure

Set-up

Set up the circuit as shown in Fig. 1 and Fig. 2; first without the voltmeter; the switch is open, the yoke is placed bare side down on the U-core and firmly connected with the tightening screw; the 1600 turns coil is the primary coil of the model.

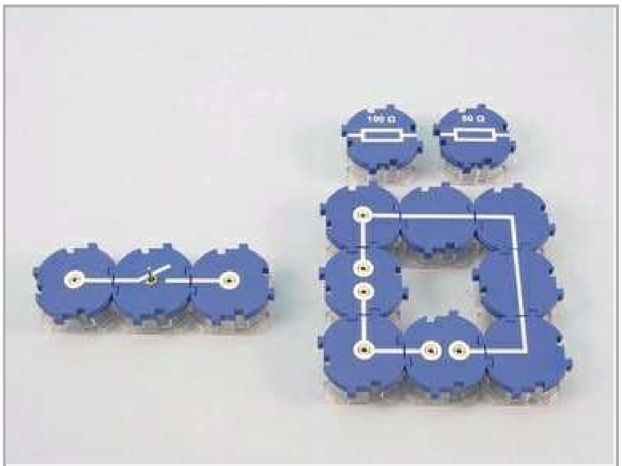


Fig. 1

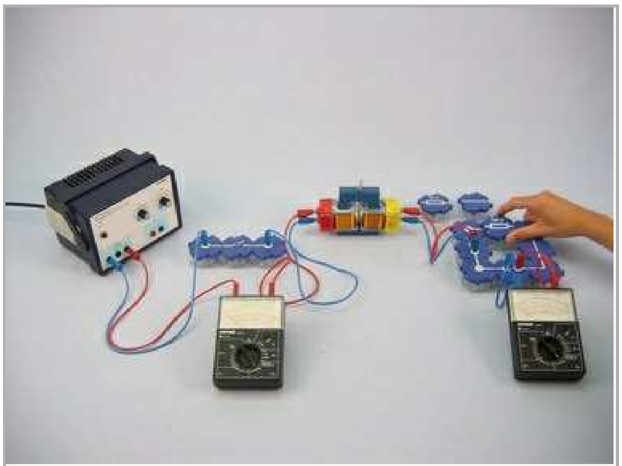


Fig. 2

Procedure

- Select the 30 mA~ measurement range, set the power supply to 12 V~ and switch it on.
- Insert the 100 Ω resistor in the secondary circuit, close the switch and measure the currents I_p (in the primary circuit) and I_S (in the secondary circuit). Note the measured values in Table 1.
- Carry out the same procedure with the 50 Ω resistor, again measuring I_p and I_S and noting the values.
- Set the 300 mA~ measurement range and short circuit the secondary coil by replacing the resistor by a connector building block (see Fig. 3); again measure I_p and I_S and note the measured values.
- Open the switch and reconnect the measuring instrument for the primary current as voltmeter parallel to the secondary coil (shown in Fig. 4); select the 10 V~ measurement range.
- Close the switch, measure the short-circuited U_S and note the value in Table 1.
- Replace the connector building block by the resistor; successively insert the components in the secondary circuit as above, and in each case measure U_S and note the value.
- Switch off the power supply.

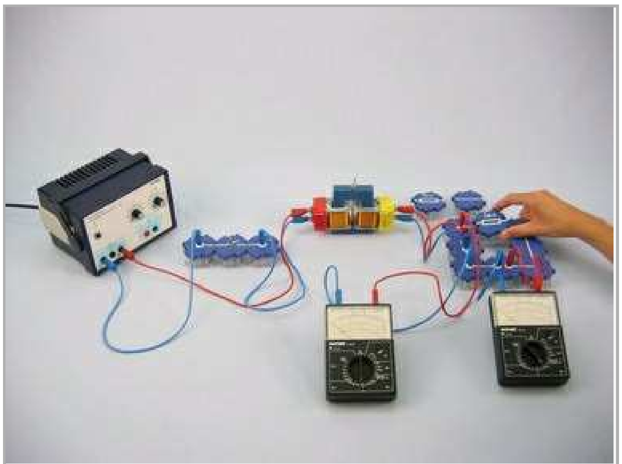


Fig. 3

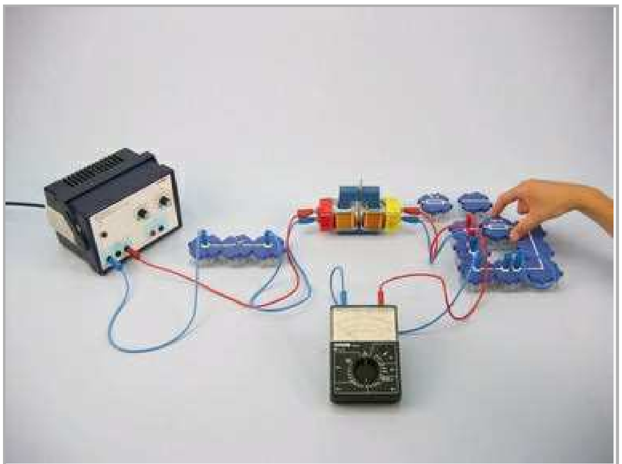


Fig. 4

Report: Transforming current

Result - Table 1

Record your measured values (N_p = 1600; N_s = 400; U_p = 12 V~)

Component in the secondary circuit	I_p in mA	I_s in mA	U_s in V	I_s / I_p
100 Ω resistor	1	1	1	1
50 Ω resistor	1	1	1	1
short circuit	1	1	1	1

Evaluation - Question 1

How does the secondary voltage U_s react when the strength of the secondary current I_s, the load on the transformer, increases?

....

....

....

....

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

Evaluation - Question 2

For a transformer without load we found: U_p / U_s ≈ N_p / N_s, i.e. that the voltages behave roughly the same way as the numbers of turns.

a) How large is the ratio N_p / N_s for the transformer you have experimented with?

b) Calculate the quotients I_s / I_p and enter their values in the Table.

c) Which value do the quotients I_s / I_p appear to approach?

d) Which law must accordingly be valid for a transformer under heavy load? (Express the relationship between the strengths of the currents and the numbers of turns mathematically and in words.)

....

....

....

....