Task

To assemble a simple model of an alternating current generator and use it to obtain a clear understanding of how alternating current is generated technically.

Equipment

Bar magnet, l = 72 mm	07823.00	1
Rotating stem	07836.00	1
Coil, 400 turns	07829.01	2
Coil, 1600 turns	07830.01	1
U-core	07832.00	1
Yoke	07833.00	1
Lamp holder E10	17049.00	1
Filament lamp, 4V/0.04 A, E10, 1 pc.	06154.03	(1)
Connecting cable, 25 cm, red	07313.01	2
Connecting cable, 25 cm, blue	07313.04	2
Connecting cable, 50 cm, red	07314.01	1
Connecting cable, 50 cm, blue	07314.04	1
Multi-range meter	07028.01	1

Set-Up and Procedure

— Set up the experiment as shown in Fig. 1, first without the I-core (yoke).
— Turn the adjusting screw at the back of the instrument to move the pointer of the measuring instrument away from the zero point, as far as possible to the right; select the 100 mV/50 μA measurement range.
— Screw the magnet tightly to the rotating stem.
— Position the magnet between the two coils so that the poles are each about 1 cm distant from the coils.
— Rotate the magnet at different speeds and observe the measuring instrument; note what you observe under (1).
— Insert the I-core in one of the coils and again rotate the magnet; observe the measuring instrument; note what you observe under (2).
— Turn the magnet slowly and thereby observe how often the pointer of the measuring instrument is deflected to the left and to the right during one complete revolution; note what you observe under (3).
— Rotate the magnet as quickly as possible and thereby observe the pointer of the measuring instrument, compare this with the previous deflections and note your result under (4).
— Replace the two coils with 400 turns with the single coil with 1600 turns and connect it to the measuring instrument; slide the yoke in the coil and rotate the magnet alongside it, compare the pointer deflection with that found in (2), note the result under (5).
— Fit the coil with 1600 turns on the U-core; connect the lamp holder with 4 V/0.04 A filament lamp directly to the coil; insert the the thin end of the rotating stem with magnet in the U-core (Fig. 2), selecting a distance of about 5 mm between the magnet and the U-core; rotate the magnet very quickly, observe the lamp and note your observation under (6).

Observations

(1)

Fig. 1

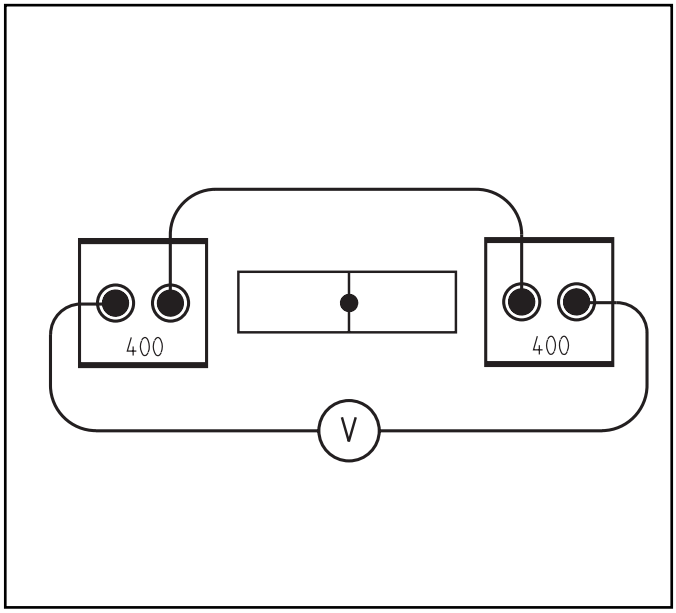
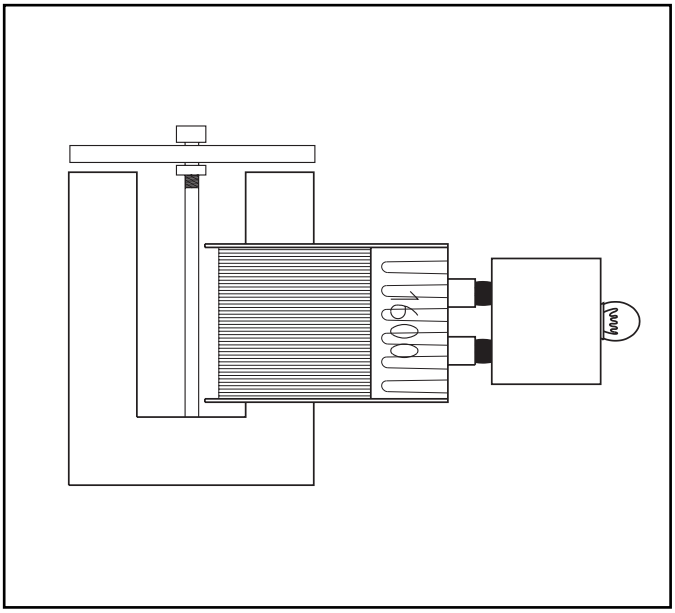


Fig. 2



(2)

(3)

(4)

(5)

(6)

Evaluation

1. What can be concluded from the observation, that the pointer of the measuring instrument swings to and fro past the zero point during the rotation of the magnet?

2. Explain the observation noted under (2).

3. Explain the observation noted under (4) and then state the reason why an instrument designed to measure direct current (or direct voltage) cannot be used for measurements in an alternating current circuit.

4. Explain the observation noted under (5).

(How can alternating current be generated?)

The students are already well acquainted with a simple alternating current generator, the dynamo on their bicycle, whose working principle is to be worked on in this experiment.
Technically, inner pole machines are used to generate high alternating voltages. These are generators with stationary induction coils and rotating (electro)magnets.
The very simple model which the students are to construct and experiment on is an inner pole machine.

Notes on Set-Up and Procedure
It must be ensured, that the coils are so connected that the alternating voltages generated do not cancel each other out.
The model of the galvanometer is not suitable for the detection or recognition of alternating voltage, as the natural vibration of the pointer of this instrument is too weakly damped.
When time must be saved, then the displacement of the pointer of the measuring instrument from the zero point should be performed earlier, in the preparation for the experiment.

Observations
(1) When the magnet is rotated, the pointer of the measuring instrument swings back and forth past its position of rest in rhythm with the rotations.
(2) The pointer deflections are greater than previously.
(3) The pointer swings once left and once right during one complete revolution of the magnet.
(4) When the magnet rotates much quicker, then the pointer deflections are smaller.
(5) The pointer deflections are larger than those noted under (2).
(6) When the magnet rotates very quickly, then the filament lamps shines feebly.

Evaluation
1. An alternating voltage is induced.
2. The iron core causes the field lines of the magnet to be more strongly bundled in this coil. The changes in the part of the magnetic field which is contained by the induction coil are therefore greater, and the induced voltage is therefore correspondingly higher.
3. The pointer can no longer quite follow the rapid changes in the direction of the current because of its inertia.
   With technical alternating current, the direction of the current changes at such a high frequency, that the pointer of a direct current measuring instrument would remain at the zero point. The measuring movement could be destroyed.
4. The induced voltage is higher, the more turns which contain the (changeable) magnetic field.

Remarks
Alternating current generators with permanent magnets are only used technically when relatively low performances suffice, e.g. with bicycle dynamos. In higher performance alternating current generators, the magnetic fields are generated by electromagnets, which receive their exciting current via sliding contacts and slip rings.
The observation noted under (4) and the evaluation in question 3 are unnecessary for the understanding of the construction and functioning of an alternating current generator; they are of significance, however, for education on the proper, independent handling of measuring instruments in experiments with alternating current.

(How can alternating current be generated?)

Room for notes