Synchronous motor

Physics > Electricity & Magnetism > Electric generator, motor, transformer

Difficulty level	Group size	Preparation time	Execution time
easy	1	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/617aaaad8e47ed0003a82b0f

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Teacher information

Application

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Deutsche Bahn ICE powered by electric motors

Electric motors are used to convert electrical energy into mechanical energy. Here, the electrical currents in a stationary part (stator) generally interact with those in a rotating part (rotor). Electric motors come in the form of everything from toy motors with a few watts to large electric locomotives with outputs in the megawatt range.

The synchronous motor belongs to the rotating field motors. Here, the magnetic field in the stator rotates at a certain frequency, which can be at most equal to the frequency of the operating voltage. In a general synchronous motor, the rotor consists of a permanent magnet or an electromagnet excited with direct current which rotates synchronously with the field of the stator operated with alternating current.

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Other teacher information (1/2)

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Previous

Students should already have thoroughly studied and understood the basic principle of a DC electric motor.

Principle

The basic principle of the electric motor is based on the attractive and repulsive forces that magnetic fields with different or the same polarity exert on each other. This principle applies to motors operated with direct current as well as with alternating current. In a general synchronous motor, the rotor (permanent magnets or electromagnets excited with direct current) rotates synchronously with the field of the stator operated with alternating current.

Other teacher information (2/2)

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Learning

This experiment is intended to show the pupils that electric motors can be operated with both direct and alternating current. In addition, the experiment teaches the functioning of the synchronous motor.

Tasks

The students build an electric motor that is to be operated with alternating current. The AC motor to be produced should initially consist of an electromagnet as the stator and a permanent magnet as the rotor. The motor is then to be modified so that the rotor and stator of the first variant are swapped.

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

ATTENTION!

Students may well not be able to get the experiment to work immediately if they do not push it at the correct speed. Care should be taken to ensure that the voltage of 12 volts is only **maximum 2 minutes** is applied. If necessary, the test must be interrupted briefly to allow the coil to cool down.

Implementation Notes:

Before starting this experiment, it is advisable to lubricate the rotor at the bearings with a little oil at the beginning, as the motor must be able to move very quickly.

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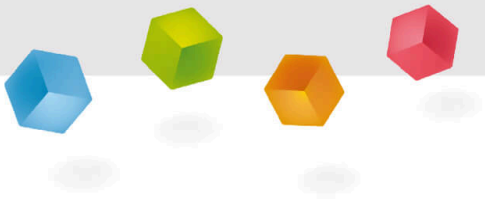

Student Information

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Motivation

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Deutsche Bahn ICE powered by electric motors

As you have already learned in detail, electric motors are very important drive components in all areas of technology. You have already studied the basic principle of the electric motor in detail. However, the previous experiments were limited to motors operated with direct current. In general, however, only alternating current is available via the mains voltage.

Electric motors can also be operated with alternating current. The advantage of operating an electric motor with alternating current is that the polarity of the motor's electromagnet does not have to be constantly reversed mechanically. In this experiment, you will investigate how electric motors can also be operated with alternating current.

Tasks

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In this experiment you will deal with the functional principle of the so-called synchronous motor.

For this purpose you will build an electric motor with:

1. a permanent magnet as rotor and an electromagnet as stator
2. an electromagnet as rotor and a permanent magnet as stator

and try to drive them with alternating current.

Notice:

Make sure the rotor is well lubricated with a little oil so that the rotor will turn as easily as possible.

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Equipment

Position	Material	Item No.	Quantity
1	Student set Electric motor / Generator, TESS advanced Physics	15221-88	1
2	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
3	Connecting cord,15A,25cm, red	07313-01	1
4	Connecting cord,15A,25cm, blue	07313-04	1

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Additional material

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Position	Equipment	Quantity
1	Lubricating oil	

Set-up

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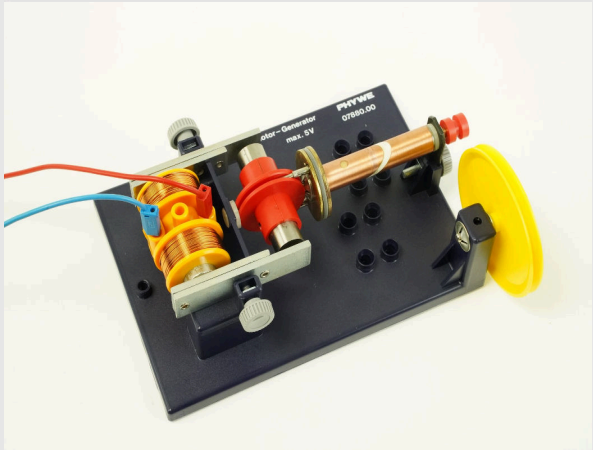

Schematic structure of an electric motor (rotor: permanent magnet, stator: electric motor magnet set)

ATTENTION: A voltage of up to $12\,V$ may only be used for a short time (**2 minutes maximum**) act on the coil. If the rotor does not run until then, you must interrupt the test and repeat it only after the coil with core has cooled down. Use only the two red bushings of the coil.

- Assemble the electric motor as shown in the diagram opposite: Use the permanent magnet as the rotor and the electromagnet as the stator.

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Procedure (1/2)

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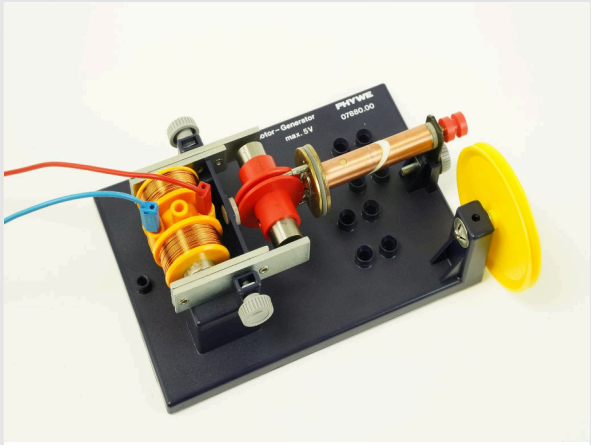

Schematic structure of an electric motor (rotor: permanent magnet, stator: electric motor magnet set)

Experiment 1:

- Apply an AC voltage of $12\,V$ to the coil of the stator.
- Set the rotor into rapid rotation by pushing it hard.
- When you reach the correct speed, the motor will continue to run at a constant speed.
- Afterwards try to fix the rotor with the $6V$ AC voltage to work.
- Does anything change in the speed of rotation?

Procedure (2/2)

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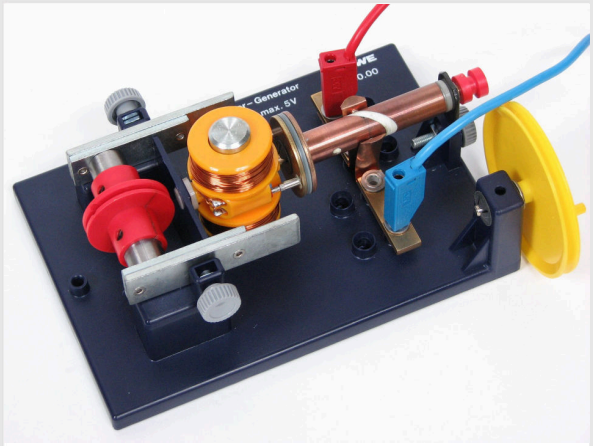

Schematic structure of an electric motor (rotor: electric magnet set, stator: permanent magnet)

Experiment two:

- Now set up the experiment shown in the figure and make it work like the first setup.
- Pay particular attention to the position of the grinding blade springs in this setup.
- Repeat the experiment with a voltage of $6\,V$ and see if there's any change in the rate of rotation.

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Report

Task 1

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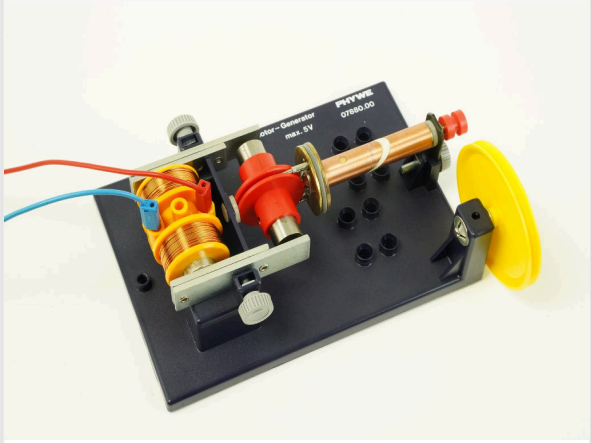

Experimental setup 1

(Rotor: permanent magnet, Stator: electric magnet set)

What was your observation during the 1st experiment? Does anything change in the speed of rotation?

- Yes, the rotor spun slower after the voltage was reduced.
- No, the rotor continued to turn unchanged at a constant speed after the voltage was reduced.
- Yes, the rotor spun faster after the voltage was reduced.

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Task 2

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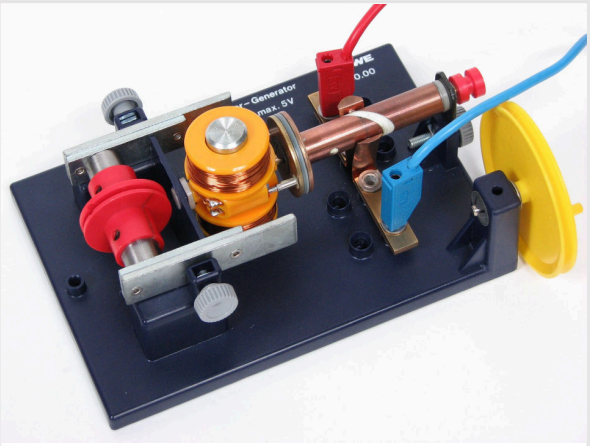

Experimental setup 2

(rotor: electric magnet, stator: permanent magnet)

What was your observation during the 2nd experimentt? Does anything change in the speed of rotation?

- Yes, the rotor spun slower after the voltage was reduced.
- Yes, the rotor spun faster after the voltage was reduced.
- No, the rotor continued to turn unchanged at a constant speed after the voltage was reduced.

Task 3

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Explain the operation of the 1st engine.

The _____, in this case the _____, is energized and thus generates a magnetic field. The field thus generated by the _____ repels that of the permanent magnet (here the _____). This causes the _____ to start rotating.

- rotor
- stator
- electromagnet
- permanent magnet
- coil

Check

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Task 4

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Explain how the 2nd engine works.

The _____ (in this experiment the _____) is energized and thus generates a magnetic field. The _____ thus generated by the electromagnet is repelled by the permanent magnetic field of the _____ (here the _____). This causes the _____ to start rotating.

electromagnet
coil
rotor
stator
alternating field
permanent magnet

Check

Task 5

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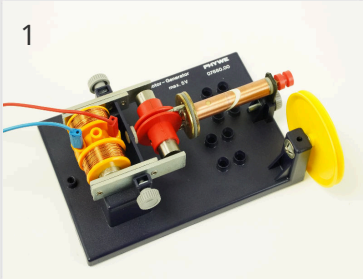
1



2

How do you explain the phenomenon you observed when you changed the voltage? What determines the speed of rotation?

- The speed depends on the frequency of the AC voltage, which has not changed.
- The rotor speed has changed, as it depends on the applied voltage. U is.
- The speed depends on the current of the AC voltage, which has not changed.

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Slide	Score / Total
Slide 15: Observation: Experiment 1	0/1
Slide 16: Observation: Experiment 2	0/1
Slide 17: Functionality 1	0/5
Slide 18: Mode of operation 2	0/6
Slide 19: Conclusion	0/1

Total 0 / 14

Solutions Repeat

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