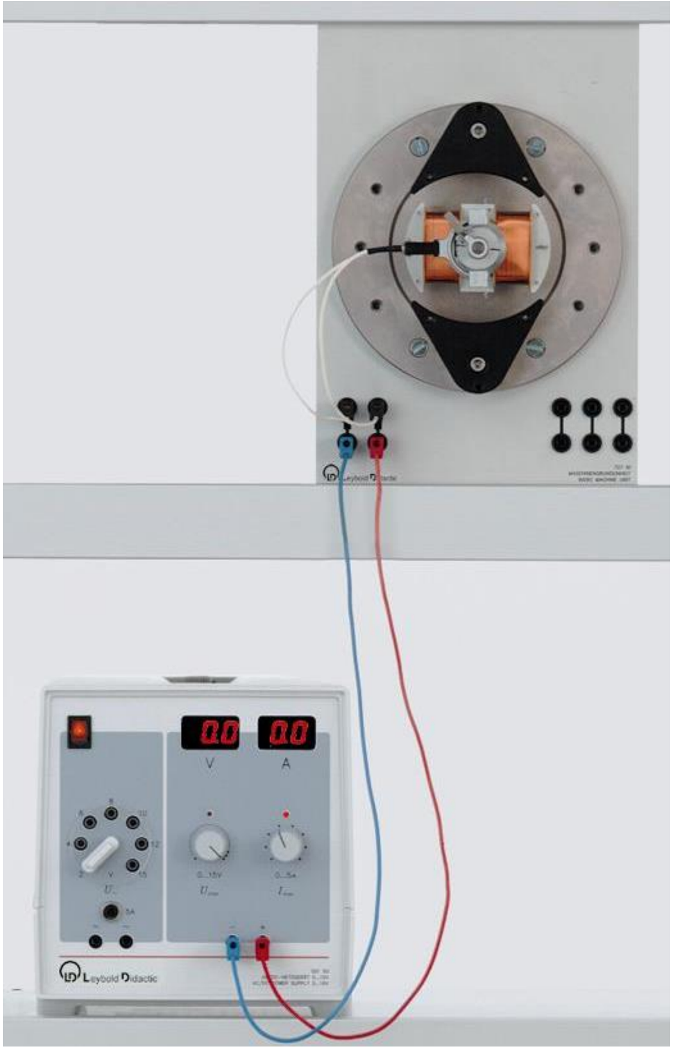
Motors and generators
Motors

Simple DC motors
Motor with two-pole rotor

D 3.6.3.1.a
Physics experiments
Secondary

Object of the experiment
1. Investigate the function of a DC motor with a two-pole rotor

Setup


Apparatus

1 Basic machine unit	727 81
1 ELM two-pole rotor	563 22
1 ELM brush holder rack	563 18
2 ELM brushes	563 13
2 ELM pole pieces for magnets	563 091
1 Pair of magnets, 35 mm diam.	510 48
1 ELM centring disc	563 17
1 Allen key	563 16
1 AC/DC power supply, 0…15 V/0-5 A	521 501
1 Pair of connecting leads, 19 A, 50 cm	501 45
1 Demonstration panel frame	301 300
1 Equipment shelf	301 310
1 Profile rail	301 311
2 Bench clamps with pin	301 05

Procedure
- Use the power supply as a constant current source. To do this, turn the voltage limiting knob to its maximum.

Without commutator:
- Lay the brushes against the slip ring of the rotor and connect them to the DC output of the power supply.
- Align the rotor such that it is perpendicular to the magnetic field of the stator.
- Set the current *I* via the adjustment knob to a value of about 0.8 A and observe the rotor.
- Align the rotor such that it is parallel with the magnetic field of the stator and repeat the experiment.
- Afterwards, push the rotor with your hand and observe the motion.

With commutator:
- Place the brushes in contact with the commutator and align the rotor such that it is again perpendicular to the magnetic field of the stator.
- Set the current *I* via the adjustment knob to a value of about 0.5 A and observe the rotor.
- Align the rotor such that it is parallel to the magnetic field of the stator and repeat the experiment.
- Push the rotor with your hand and observe the motion.

Observation
Without commutator:
The rotor turns through an angle of 90°.
If the rotor is parallel to the magnetic field of the stator, it cannot be set rotating, even when you push it.
With commutator:
If the rotor is perpendicular to the magnetic field of the stator, once the rotor current is set, it rotates and keeps on rotating.
If the rotor is parallel to the magnetic field of the stator, once the rotor current is set, it stays still.
If the rotor is given a push, it then continues to rotate within the magnetic field of the stator.

Evaluation
When an electromagnetic rotor (two-pole rotor) is in the magnetic field of a stator, a force acts upon it.
This force results from the attractive forces between the unlike magnetic poles of the rotor and stator and repulsion forces between like poles.
Unless the rotor is perpendicular to the magnetic field of the stator, it will start to rotate until the unlike poles of the rotor and stator are opposite one another. Due to the direction of the force between the magnetic poles of the rotor and stator, it is no longer possible for the rotor to rotate.
This rotor position is known as the “dead point”.

Continuous rotation of the rotor can be achieved with the help of a commutator.
Once the rotor is already rotating within the magnetic field of the stator, it has enough momentum to rotate beyond the “dead point”.
At that point, the commutator results in the current in the coils of the electromagnetic rotor being reversed. The change in current direction also leads to the magnetic poles at the ends of the rotor becoming reversed.
The rotor can then continue rotating.

If the electromagnetic rotor (two-pole rotor) is parallel to the magnetic field of the stator, it needs to be given a push in order for it to start rotating continuously.

A motor in which an electromagnetic rotor revolves within the magnetic field of a stator is called a DC motor.
Such a DC motor is a rotating armature/stationary field motor.
DC motors are used in practice, for example, for driving electric trains or toy cars.

Remark:
In a DC motor, the magnetic field of the stator can be provided by permanent magnets or electromagnets.

LEYBOLD DIDACTIC GMBH · Leyboldstrasse 1 · D-50354 Hürth · Phone (02233) 604-0 · Fax (02233) 604-222 · e-mail: info@leybold-didactic.de