The Series Motor (Demo) (Item No.: P1433405)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 16-19
Topic: Electricity
Subtopic: Electric generator, motor, transformer
Experiment: The Series Motor (Demo)

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

Additional Requirements:

- Demonstration multimeter
- Power Supply

Experiment Variations:

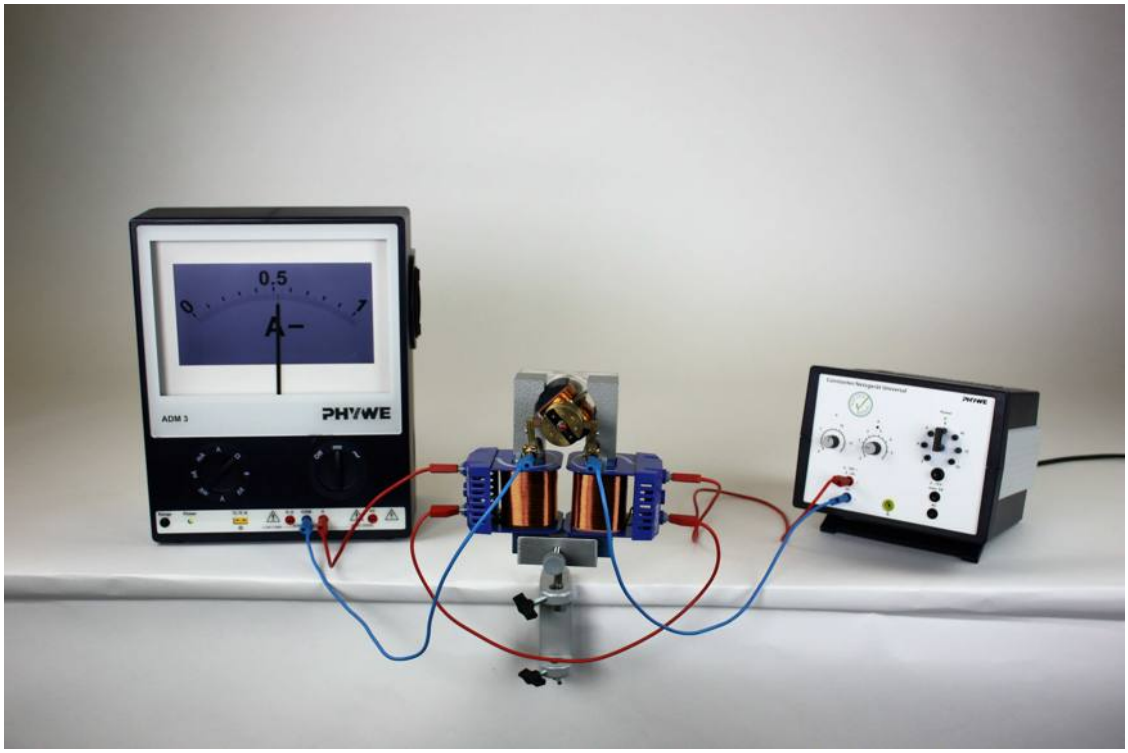
Keywords:

DC electric motor, electric motor, universal motor

Informations for teachers

Introduction

An electromotor can also be operated with an electromagnet besides a permanent magnet. If armature coils and field coils are connected in series, then this is called a series-wound motor. The properties of this motor are studied by observing the direction of rotation and measuring the electric current.



Equipment

Position No.	Material	Order No.	Quantity
1	Bench clamp expert	02011-00	1
2	Holder for U-magnet	06509-00	1
3	Iron core, U-shaped, laminated electric steel	06501-00	1
4	Coil, 300 turns	06513-01	2
5	Motor set	06550-00	1
6	Double-T armature	06554-00	1
7	Cord pulley	06558-00	1
8	Connecting cord, 32 A, 750 mm, red	07362-01	3
9	Connecting cord, 32 A, 750 mm, blue	07362-04	2
10	PHYWE Demo Multimeter ADM 3: current, voltage, resistance, temperature	13840-00	1
11	PHYWE power supply, universal DC: 0...18 V, 0...5 A / AC: 2/4/6/8/10/12/15 V, 5 A	13504-93	1

Safety information

For this experiment, the general instructions for safe experimentation in scientific teaching apply.

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Introduction

Application and Task

In case of the series-wound motor, the electromagnet is connected in series to the motor. The series-wound motor does not require a permanent magnet, which makes it suitable for many home appliances. In this experiment, the series-wound motor will be examined.

Theory

The attraction and repulsion of magnetic fields create a rotational movement in the motor. The external magnetic field is generated by the series-connected coils. The T-armature also forms a magnetic field, which will be reversed using a commutator at the right time.

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Setup and procedure

Setup

- The motor set is put together according to Fig. 1.
- Slide the axis [1] of the double-T armature in the bearing drill hole [3] of the motor set and fasten tightly with the cord pulley [2].
- Attach the contact brushes [4] of the motor set to the interrupted brassring [7] (Fig. 2), pull the knurled screw [5] slightly upward and twist tightly so that the lever arm is clamping due to the tensioned spring. This will cause the contact brushes to press firmly onto the brass ring. The electrical contact is created between the armature coils and the connectors [6].

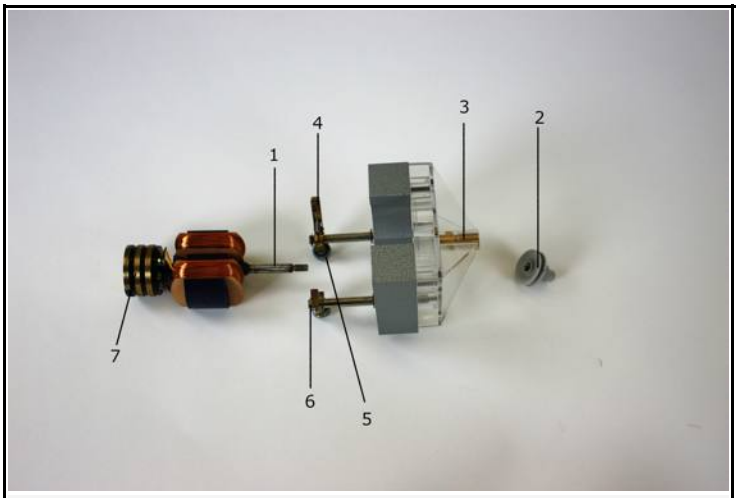

Fig. 1

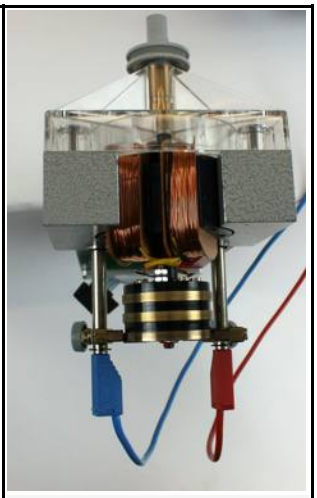

Fig. 2

- Complete the setup according to Fig. 3 and Fig. 4:
- Place the iron core with the holder in the bench clamp.
- Place the coils and motor set on the iron core.
- Adjust the DC-voltage on the power supply to 0 V.
- Connect the field coils and armature coils in series and connect the motor together wit the measuring device with the power supply.

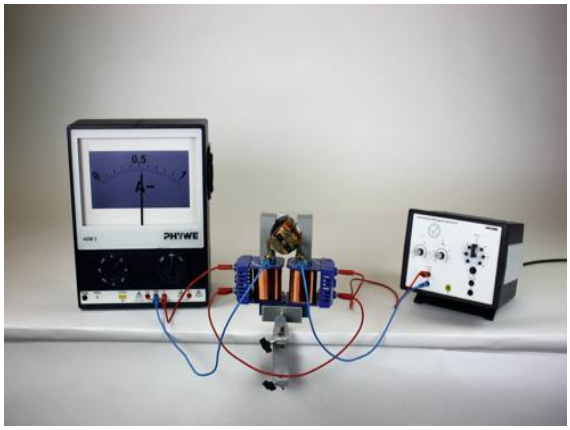

Fig. 3

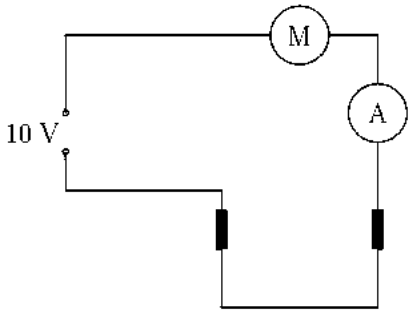

Fig. 4

Procedure

- Adjust the voltage to approx. 10 V, “crank up” the motor eventually by turning.
- Change the voltage, observe the rotational speed, observe the measuring device (Observation (1)).
- Adjust the voltage to 0 V, switch the polarity of the operating voltage at the power supply, increase the voltage and observe the direction of rotation (Observation (2)).
- Adjust the voltage to 0 V, switch the polarity of the voltage at the connections for the armature coils, increase the voltage and observe the direction of rotation (Observation (3)).
- Apply load on the motor by pressing the finger on the cord pulley, observe the rotational speed and the measuring device (Observation (4)).

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Evaluation

Observation

1. The higher the voltage, the higher the rotational speed of the motor. The electric current does not change much.
2. By reversing the polarity of the operating voltage the direction of rotation remains constant.
3. If only the direction of the electric current is changed for the armature coils, then this changes the direction of rotation of the motor.
4. Due to a load the rotational speed of the motor decrease, whereas the electric current increases.

Result

If an electromagnet is used to operate an electromotor, it must create a large enough magnetic field near by the armature. This is why a U-shaped iron core with two field coils is used, where the armature runs between its poles. Armature coils and field coils are connected in series for a series-wound motor (Fig. 4).
When reversing the polarity of the operating voltage the field of the armature coils as well as that of the field coils are reversed, so that the direction of rotation remains the same.
If on the other hand only the direction of the current of the armature coils changes, then only this magnetic field changes its direction and therefore also the direction of rotation changes.
When a load is exerted on the series-wound motor, not only the electric current of the armature coils increases, but also the electric current in the field coils increases due to the connection in series of the coils.

Remarks:

1. A series-wound motor can in pinciple be operated in the same design with AC. Hence the name of the Universal-electric motor. This is due to the reversal of both armature current and excitation current during polarity reversal. Prerequisite is a slightly modified design of the rotor (three-pole).
2. In the armature coils, which rotate in the magnetic field of the field coils, a voltage is induced. The difference of the applied and induced voltage determines the electric current of the armature coils. If a load is applied the rotational speed of the armature decreases, which total subsequently reduces the induced voltage and the electric current becomes greater.
3. Since the armature current and the exciting current increase likewise when a load is applied, a series-wound motor provides a relatively large torque. This is why they are suitable for actuating a tram and as a starter motor in automobiles.
4. The rotational speed of a direct current series-wound motor is greatly dependent on the load. It increases greatly when the load is eased and decreases when the load is exerted. Larger series-wound motors may not be operated without a load, since otherwise the rotational speed would become too large.

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