The synchronous motor (Item No.: P1398800)

Curricular Relevance

Area of Expertise:	Education Level:	Topic:	Subtopic:	Experiment:
Physics	Age 14-16	Electricity	Electric generator, motor, transformer	The synchronous motor

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

Additional Requirements:

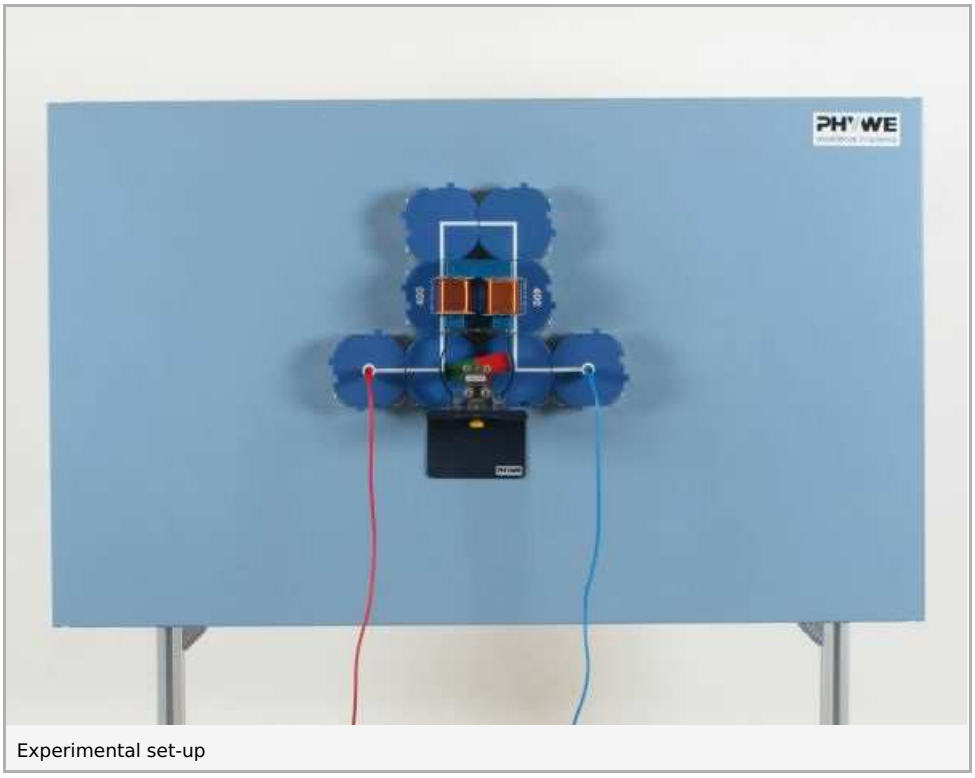
Experiment Variations:

Keywords:

Principle and equipment

Principle

A working model of a motor is to be used to demonstrate the construction and mode of action of a synchronous motor.



Experimental set-up

Equipment

Position No.	Material	Order No.	Quantity
1	Demo Physics board with stand	02150-00	1
2	PHYWE power supply, variable DC: 12 V, 5 A / AC: 15 V, 5 A	13530-93	1
3	Motor model f. magnet board	07850-20	1
4	Coil 400 turns, module DB	09472-01	2
5	Switch, change-over, module DB	09402-02	1
6	U-core	07832-00	1
7	Magn.rotor f.electr.motor model	07850-21	1
8	Junction, module DB	09401-10	2
9	Connector, angled, module DB	09401-02	4
10	Holder f.electr.motor,magn.board	07849-00	1
11	Connecting cord, 32 A, 1000 mm, red	07363-01	1
12	Connecting cord, 32 A, 1000 mm, blue	07363-04	1
13	Connecting cord, 32 A, 750 mm, red	07362-01	2
14	Connecting cord, 32 A, 750 mm, blue	07362-04	1

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

Set-up and procedure

- Set up the experiment as shown in Fig. i; remove the pole shoes from the motor model after loosening the screws, insert the magnetic rotor as armature
- Screw the motor model to the holder; position the holder so on the board, that the poles of the magnetic rotor have the same, short distance to the ends of the U-core
- Set the power supply voltage to 15 V~
- Turn on the power supply; start the motor by turning the countered milled screw on the axis of the rotor and watch what occurs (1)

  Note: Some practice is required to for the motor to reach a suitable revolution speed. The motor also be brought to a high revolution speed by use of a thread wound around the motor disc.
- Change the motor operating voltage; observe the running of the rotor (2)
- Brake the motor by hand to put it under load and observe what happens (3)

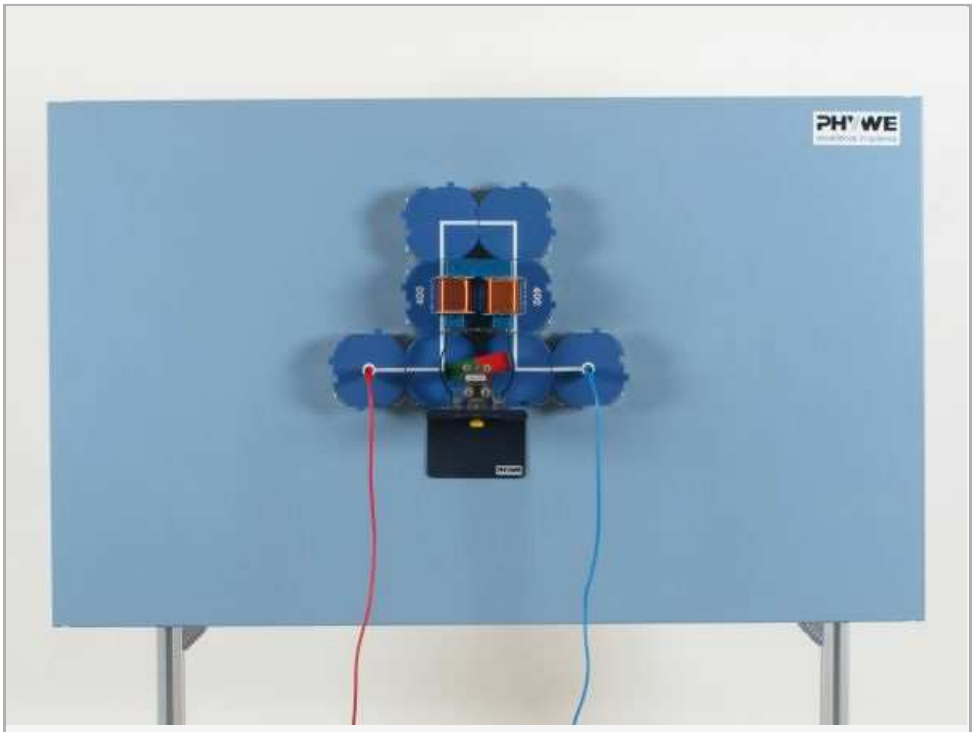


Fig. 1

Observation and evaluation

Observation

1. When the motor is started with a sufficiently high revolution speed, then it maintains this speed.
2. The revolution speed of the motor remains unchanged when the operating voltage (and so the operating current) of the motor is changed.
3. When a mechanical load is applied to the motor, then it stops suddenly at a certain load, without having previously stabilised its run at a lower revolution speed.

Evaluation

Alternating current generates an alternating magnetic field in the field coils of a synchronous motor, whereby the direction of the field reverses with the frequency of the alternating current. A magnet (rotor, armature) that is held so that it can rotate aligns itself to every momentary field direction, and must turn at the same frequency as the alternating field cycle.
Because of its inertia, however, it cannot follow the rapid change in the direction of the magnetic field when it is switched on; it must first be brought to to the same speed of rotation as that of the magnetic field.
Changing the operating current has no effect on the revolution speed of a synchronous motor, it only influences the maximum permissible load. Changes in the load are also without effect on the speed of revolution of the motor, as long as they are kept within certain limits. Under too heavy a load, however, the motor stops; its armature gets ‚out of step".

Remarks

With the model used in this experiment, the armature cannot carry out a complete revolution during the time of one period, because it cannot be accelerated to the required revolution speed by hand. It therefore leaves out a few periods and is then ‚taken with" the magnetic field of one of the following periods. The frequency of the alternating current and the revolution speed of the motor are not concordant with this model. The frequency of the model motor is generally 16 1/3 Hz.

Sychronous motors are often used when the constancy of the revolution speed is of importance. Commercial motors are constructed with several field coil pairs, which are flowed through by the alternating current in alternate directions. During a half-period, the armature need only turn through the correspondingly small angle to the next field coil, and must not be started up. When the universal power supply (13500.93), which has fixed alternating voltage steps, is used instead of an adjustable transformer, then, to change the operating voltage from 15 V- to 12 V- or 10 V-, a switching set-up as shown in Fig. 2 must be used. Changing the operating voltage by means of the power supply bridging plug would result in an interruption in the supply of power which would be too long for the motor. The motor would get ‚out of step".

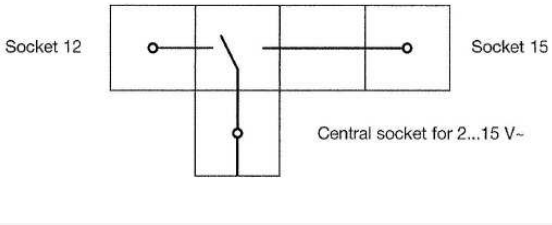


Fig. 1