Eddy current retarder (Demo) (Item No.: P1434505)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 16-19
Topic: Electricity
Subtopic: Electromagnetism
Experiment: Eddy current retarder (Demo)

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

Additional Requirements:

- Power Supply
- Demonstration multimeter
- Stopwatch
- Tripod material

Experiment Variations:

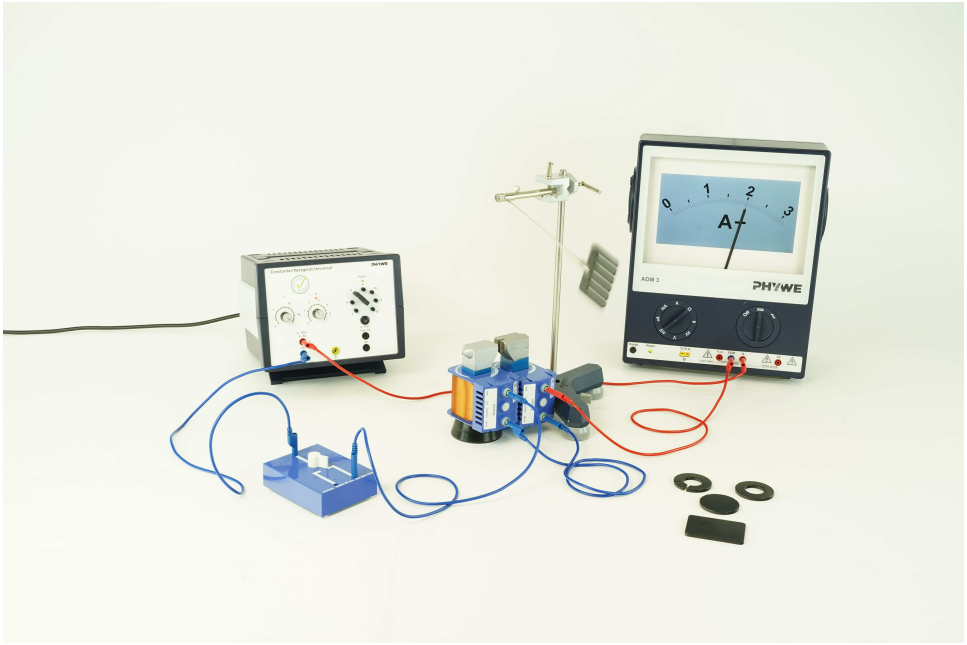
Keywords:

Pendulum, eddy currents, Lenz' law, Eddy current brake, induction brake, electric brake

Information for teachers

Introduction

When a massive body made of electrically conducting material moves through a magnetic field, eddy currents are induced.



Equipment

Position No.	Material	Order No.	Quantity
1	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
2	PHYWE Demo Multimeter ADM 3: current, voltage, resistance, temperature	13840-00	1
3	Tripod base PHYWE	02002-55	1
4	Support rod, stainless steel, 500 mm	02032-00	1
5	Stop clock, demo.; diam. 13 cm	03075-00	1
6	Coil, 600 turns	06514-01	2
7	Iron core, U-shaped, laminated	06501-00	1
8	Pole pieces for iron core, U-shaped	06493-00	1
9	Two-way switch, single pole	06030-00	1
10	Pendulum plates, set of 5	06456-00	1
11	Pendulum rod	06457-00	1
12	Bolt with pin	02052-00	1
13	Right angle clamp expert	02054-00	1
14	Connecting cord, 32 A, 750 mm, red	07362-01	2
15	Connecting cord, 32 A, 750 mm, blue	07362-04	3

Safety information

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

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

Introduction

Application and task

Eddy current brakes are known from trains and from the "free fall" at a fun fair. Eddy current brakes have almost no abrasion, which makes them very durable.

Observe the pendulum oscillation of different objects through a magnetic field.

1. Brake the oscillation by switching on the current.
2. Compare the braking time for different pendulum bodies.
3. Compare the braking duration of one pendulum body for different currents.

Theory

The change in the magnetic field causes a current.
The law of induction defines the following relation:

$$rot\vec{E} = -\frac{\delta\vec{B}}{\delta t}$$

This means that as soon as an object swings through a magnetic field, the magnetic field changes relatively for the object and this results in eddy currents. The eddy currents in turn also generate a magnetic field. As the eddy currents enter and leave the body, the direction of rotation is such, that the induced magnetic field slows down the object.

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Setup and procedure

Setup

Setup the experiment as shown in Fig. 1.

The coils of the electromagnet must be connected in series, the large end planes facing each other.

Mount the pendulum rod onto the bolt with pin so that no clamping friction will occur.

The pendulum together with the support material has to be placed such, that the pendulum can swing through unhindered.

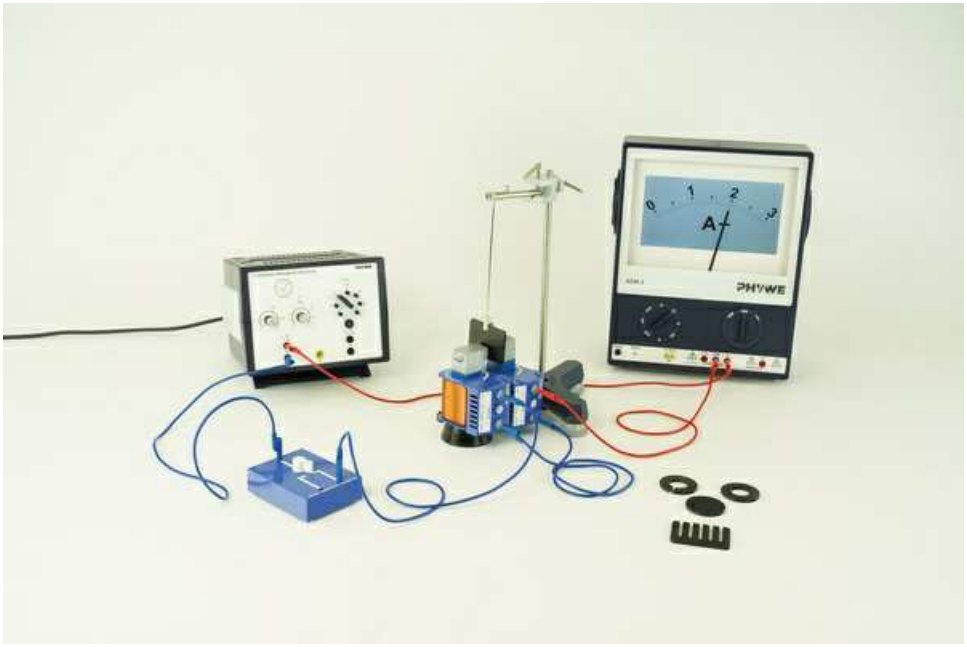

Fig. 1

Procedure

1. Switch off the current and set the pendulum with the rectangular disc without slits to swing. Switch on the current after some few cycles. The pendulum will come to rest quickly.
2. Compare the durations for different pendulum bodies for the braking process from start of the oscillation until complete stop. Therefore, the pendulum bodies have to be released from the same height, when the current has been switched on.
3. Compare the braking time for one pendulum body, e.g. the rectangular disc with slits, for different currents: e.g. in steps of 0.5A.

Evaluation

Observation

Some pendulum bodies are easier to brake than others. Pendulum bodies with slits are hardly slowed down.

The higher the set current, the more the pendulum bodies are braked.

Result

According to Lenz's law, the body is then subjected to a force which is opposed to the cause of the eddy currents, i.e. the motion of the pendulum. The braking action increases with the strength of the magnetic field.

If slits are cut into the body (or if insulating layers are added), this reduces the generation of the eddy currents.

Technical applications of the damping effect of induced currents are for example the reduction of oscillations in measuring systems (moving coil measuring instrument, reflecting galvanometer, scale) or the eddy current brake.

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