The thomson jumping ring (Demo) (Item No.: P1434705)

Curricular Relevance

Area of Expertise: Physics

Education Level: Age 16-19

Topic: Electricity

Subtopic: Electromagnetism

Experiment: The Thomson jumpin ring (Demo)

Difficulty

Easy

Preparation Time

10 Minutes

Execution Time

10 Minutes

Recommended Group Size

1 Student

Additional Requirements:

- power supply

Experiment Variations:

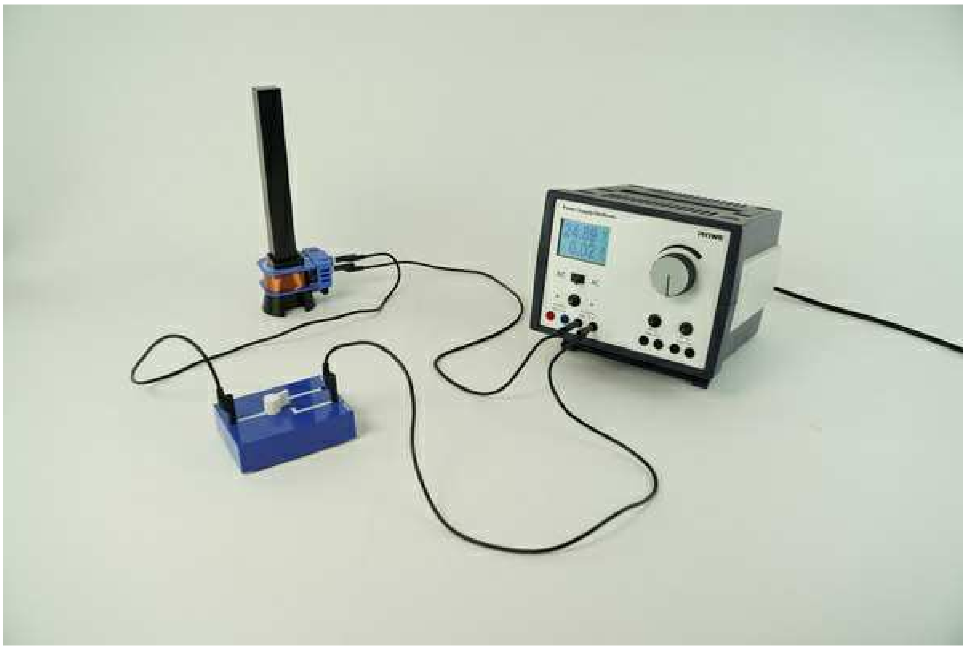
Keywords:

Eddy current, Induction

Informations for teachers

Introduction

Thomson's interlaboratory test impressively demonstrates electromagnetic forces. Magnetic induction accelerates the ring upwards. With higher power, the short-circuit ring can of course be catapulted even higher.



Equipment

Position No.	Material	Order No.	Quantity
1	Iron core, I-shaped, laminated, L=300mm	06504-01	1
2	Base for iron cores	06508-01	1
3	Coil, 150 turns, short	06520-02	1
4	Short-circuit ring	06565-00	1
5	Short-circuit ring with slit	06565-01	1
6	Two-way switch, single pole	06030-00	1
7	Connecting cord, 32 A, 750 mm, black	07362-05	3
8	PHYWE variable transformer with digital display DC: 0...20 V, 12 A / AC: 0...25 V, 12 A	13542-93	1

Safety information

For this experiment, the general instructions for safe experimentation in scientific teaching apply.
No objects should be above the iron core during the experiment. It is important to keep a certain distance from the core.

Introduction

Application and Task

This experiment gives a good impression of the forces that can arise during induction. The short-circuit ring is catapulted upwards by induction.

Theory

Lenz's rule:

$$\oint_{\delta A} \vec{E} \cdot d\vec{s} = -\int A \frac{\delta B}{\delta t} \cdot d\vec{A}$$

Currents are induced in the short-circuit ring by the magnetic field of the coil. The currents in the short-circuit ring induce a magnetic field of opposing direction. Thus, the coil and the short-circuit ring can be understood as opposite magnets that repel each other.

Setup and procedure

Setup

Set up the experiment as shown in Fig. 1. Connect the power supply, the coil and the open switch in series. Place the coil on the iron core holder. Place the short circuit ring on the coil.

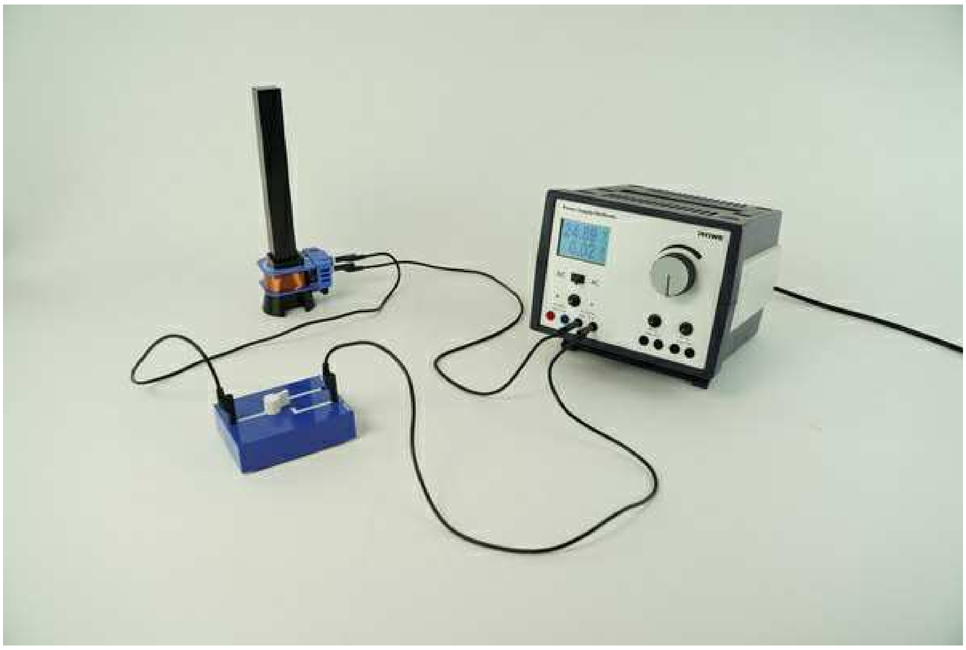


Fig. 1

Procedure

- Set the variable transformer to 25 V AC voltage with the switch open.
- Close the switch and observe the Thomson's short-circuit ring (observation (1.)).
- For demonstration purposes this experiment can be repeated with other voltages (observation (2.)).
- As a first variation of the experiment, the ring is only subsequently attached to the iron core when the switch is closed (observation (3.)).
- As a second variation of the experiment, the Thomson short-circuit ring with a slit is now plugged onto the iron core when the switch is open.
- Close the switch and observe the ring (observation (4.)).

Evaluation

Observation

1. As soon as you close the switch, the short circuit ring is accelerated vertically upwards. Once it is above the iron core, the ring still has a certain speed, but it is not accelerated any further. The ring flies about 40 cm high.
2. The ring flies at different heights depending on the voltage on the primary coil. The height increases with increasing electrical power in the primary circuit.
3. When the short-circuit ring is subsequently placed on the iron core, the short-circuit ring floats. The higher the voltage, the higher the position at which the ring floats. In this case, the ring does not fly off the iron core, as it is brought into the energetic balance of weight force and electromagnetic repulsion from outside. If you then pull the ring towards the primary coil and release it, it will quickly settle back into the equilibrium position.
4. The ring with the slit does not move.

Result

In the Thomson's short-circuit ring, currents are induced by the alternating field of the primary coil, which in turn generates an 'own' magnetic field.

Lenz's rule explains why the magnetic fields of the coil and Thomson's ring are opposite. The force of the opposing magnetic fields causes a vertical acceleration of the freely mounted short-circuit ring. As soon as the short-circuit ring no longer encloses the iron core, it is no longer accelerated because the electromagnetic induction is much lower without an iron core.

Since the strength of the magnetic field and thus the induced current is proportional to the electrical power in the primary circuit, the ring flies higher at higher primary voltages.

The short-circuit ring floats when the magnetic force and the force of gravity are in equilibrium.

In the case of the short-circuit ring with slit, no ring currents can flow and thus no significant magnetic field can be built up in the opposite direction. Consequently, there is no repulsion.