Ring Launcher

- The Ring Launcher illustrates Faraday's laws of electromagnetic induction and Lenz's law
- Remote control of the launch for safety
- Self-contained, mains powered unit
- Designed for use in school/college laboratories
- Detachable IEC mains lead
- Robust metal case with screen printed guidance

Apparatus description

The ring launcher unit consists of the base unit and built-in vertical solenoid of thick copper wire. A removable core composed of thin iron spokes is placed inside the solenoid whenever the experiment is performed. If the core is not inserted, the unit will not function, thus avoiding damage due to an accidental launch.

On the front panel, a switch prepares the launch, which is then triggered by pressing the remote switch from a safe distance. The solenoid is energized by a brief high current pulse.

A variety of rings are supplied with the launcher: solid aluminium, aluminium with a split and a plastic ring.
The rings fit over the top of the solenoid and an adjustable collar sets the launch position of the ring.

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Guide to the apparatus

1 Iron core (removable)

2 Ring launcher base unit

3 Adjustment collar

4 Plastic collar (core holder)

5 Plastic ring

6 Aluminium ring with split

7 Aluminium ring

8 Coil with low voltage bulb

9 Remote control

IEC mains lead (not shown)

Demonstrations can show:

Lenz's Law and induced current in a ring
the transformer principle the induced voltage lighting a low voltage bulb
that induced current flows only when there is complete circuit
that current can only be induced in a conductor.

SAFETY FIRST!

- The launcher should always be used under adult supervision.
- Do not operate the launcher without the iron core in place. Doing so can lead to overheating and a blown fuse.
- Individuals with internal electronic devices, such as pacemakers and certain types of hearing aid, should stay well clear of the apparatus.
- The current drawn by the launcher can affect the local supply voltage and possibly interrupt computers and other electrical equipment.
- The ring is projected upwards suddenly with considerable force, so make sure that the space above the launcher is clear.
- Allow sufficient free height for the ring's trajectory - up to 4 metres.
- The launcher should never be operated in wet or damp conditions.

Assembly

The only assembly required for the ring launcher is to slide the adjustment collar onto the solenoid (Fig-1), fit the iron core (Fig-2), and add the plastic collar (Fig-3) which centralises the core in the solenoid.

Fig-4 shows an aluminium ring being fitted and lowered onto the adjustment collar.

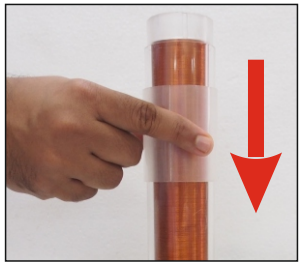

Fig-1

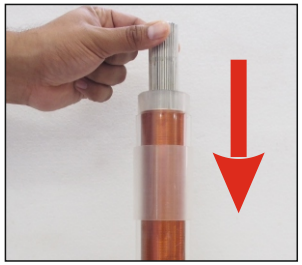

Fig-2

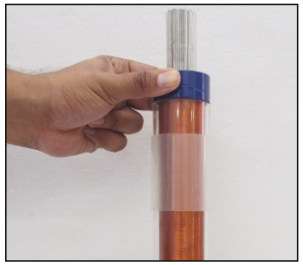

Fig-3

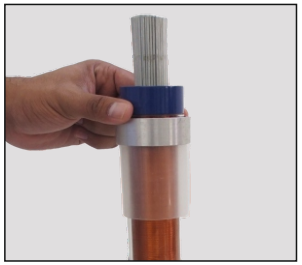

Fig-4

Control panel

Power ON/OFF switch and LED indicator.

Core Present LED: this LED indicates whether the core is inside the solenoid or not.

ACTIVATION SWITCH:
When this button is pressed the unit is activated for the upcoming launch. At the same time, a built-in speaker gives a warning message and the **Activate Status LED** is turned on.

The remote button can only be pressed after the Ring Launcher has been activated.

Remote Pulse LED: This LED indicates receipt of the signal from the remote.

Launch Pulse LED: This LED indicates the launching of ring.

IEC mains lead

This is protected by a standard 13A 250V fuse in the mains plug.

Remote control battery: 2 x 1.5 AAA cells

Instrument fuse in the back panel
This is a slow blow 32 x 6.3 mm T-12.5 A fuse

Power input:	Standby: 10 VA Launch: 2500 VA (max. 2 second)
Dimensions:	400 x 270 x 190 mm
Weight:	4.7 kg
Temperature range:	5 to 40°C
Humidity range:	0 to 80% RH

WEEE directive
This symbol indicates that the electronic equipment should not be disposed of in the normal waste. It should be recycled in accordance with the WEEE directive.

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Using the Ring Launcher

1 Place the Ring Launcher on a stable level surface.
2 Check it has been assembled as described above.
3 Connect the launcher to the mains and switch on. The Core Present LED will indicate the presence of core.
4 Fit the plain aluminium ring onto the solenoid tube, so that it rests on the adjustment collar.
5 Slide the adjustment collar upward so that the aluminium ring is close to the top of the solenoid.
6 Make sure the space above the launcher is clear of obstructions and people.
7 Press the ACTIVATION SWITCH.
8 Step back at least 1 metre from unit.
9 After a moment, the Activation Status Green LED will light.
At the same time the launcher will give a warning message.
10 Press remote to launch the ring.

Re-fit the aluminium ring and slide the adjustment collar down by 2cm.
Repeat steps 6 to 10. How is the launch height different? Why?
The ring will go higher, because it is affected by the solenoid's magnetic field over a longer distance/time.

Fit the aluminium split ring. Repeat steps 6 to 10. What happens and why?
The ring will not be launched in this case. It is not a complete ring so any induced current cannot circulate.

Use the plastic ring. Repeat steps 6 to 10. What happens and why?
The ring does not launch because it is a non-conductor. No current can be induced in it.

Fit the coil with low voltage bulb. Repeat steps 6 to 10. What happens and why?
The bulb lights briefly, but the coil is not launched upwards. The coil and solenoid act as a step-down transformer.
The high voltage applied to the solenoid becomes a low voltage, suitable for lighting the 5V bulb.
The coil is not launched because the bulb limits the current flowing in the coil, which gives a much weaker magnetic effect. The repulsion between the solenoid and coil is insignificant.

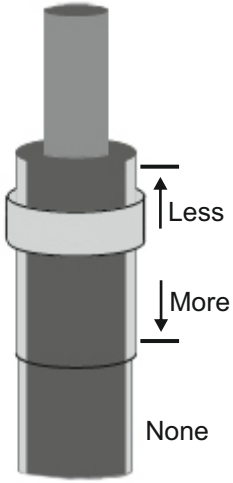
Adjusting the launch height

The height to which the ring is launched can be adjusted by moving the transparent adjustment collar up or down on the coil.

Moving the collar up reduces the launch height, and moving it down increases the launch height.

The minimum launch height is about 0.5m when the collar is flush with the top of the solenoid.
The maximum launch height is between 3 m & 4 m.

Note: when moving the collar down to increase the launch height, the collar must remain above the middle of the coil.
If the ring is too low on the coil, it will not launch, but will instead vibrate and quickly become hot.
Below the magnetic midpoint of the solenoid assembly, the ring is forced downward instead of up.



Maintenance

The ring launcher needs no special maintenance. With normal use, the unit will not overheat.
However, excessive operation (more than 5 launches in very quick succession) might blow the fuse.
If this happens, the unit will not operate. Replacement fuses are available.

Please use a 12.5 A fuse since the unit momentarily draws a large current while launching the ring.
The fuse is located within the round fuse holder in the back panel of the unit.
Make sure that the power is switched off and the unit is unplugged while replacing the fuse.
Turn the fuse holder cap anticlockwise to access the fuse.

The ring launcher may be stored with the core in place with all the rings and the coil with the bulb resting over the solenoid as shown here.

Theory

The Ring Launcher experiments illustrate the following laws:

Faraday's Law of Electromagnetic Induction

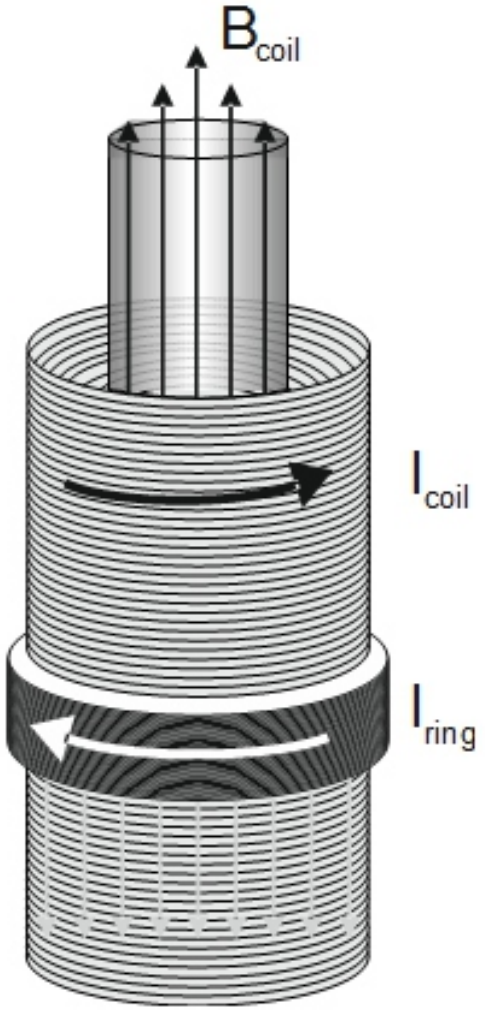
A time-varying magnetic field produces an induced emf in a closed circuit.
The induced emf is directly proportional to the time rate of change of the magnetic flux linked with the circuit.
This statement, known as Faraday's Law of Electromagnetic Induction, can be written as:

induced emf, $\varepsilon \propto \frac{d\Phi}{dt}$ where Φ is the magnetic flux linked with the closed circuit.

Lenz's Law

The direction of induced current in a circuit, is such that it always opposes the cause (i.e change in magnetic flux) which produces it.
That is, the induced current tries to keep the original magnetic flux through the circuit from changing.
The induced emf therefore may be given as:

$\varepsilon = -\frac{d\Phi}{dt}$ the negative sign indicates that the induced emf always opposes change in magnetic flux.



Principles of the demonstration

When the complete ring is placed over the coil, with the iron core in place, and the coil is energized with an increasing ac current (I_{coil}), shown in the diagram, a large magnetic flux builds up on the axis of the coil.
This changing magnetic induction (B_{coil}) generates a large induced current (I_{ring}) in the ring.
According to Lenz's Law, the current (I_{ring}) tends to oppose the changes in (B_{coil}), and so builds up an oppositely directed magnetic induction (B_{coil}).
The repulsion between the two oppositely directed inductions drives the ring off the coil.
The key to this action is the induction of a current in the ring, and so, substituting a ring with a split in it to interrupt the closed conducting circuit should prevent the ring from being thrown off the coil.
Similarly, using a non-conducting plastic ring in place of the aluminum one also shows no motion.

Using the coil with the bulb demonstrates the existence of the induced current.
When the coil is energized, the bulb will be illuminated. This demonstration can also be used to introduce the transformer principle.
The main coil with many turns is energized by 220 volts ac and lights a 5 volt bulb using a coil of few turns.
This small coil also experiences a force tending to throw it off the main coil, but the current is limited by the electrical resistance of the lamp and the force is too small to throw the coil off.