A03-521E-Y01

Primary and Secondary Coils

Purpose

Through the relative motion between the magnetic bar and the coil, we can observe the direction of the induced current. Verify Lenz's law.

Theory

In 1831, Michael Faraday concluded from many experiments that there are two methods to generate induced current. The first method indicates that the coil generates induced currents when there is a relative motion between the magnet and the coil. This method can be divided into two situations: a) The coil generates induced current when the pole of the magnetic bar approaches or leaves the coil. b) The coil generates induced current when the magnetic bar stays still and the coil moves. The second method indicates that the coil generates the induced current when there is a change in the magnetic field of the coil.

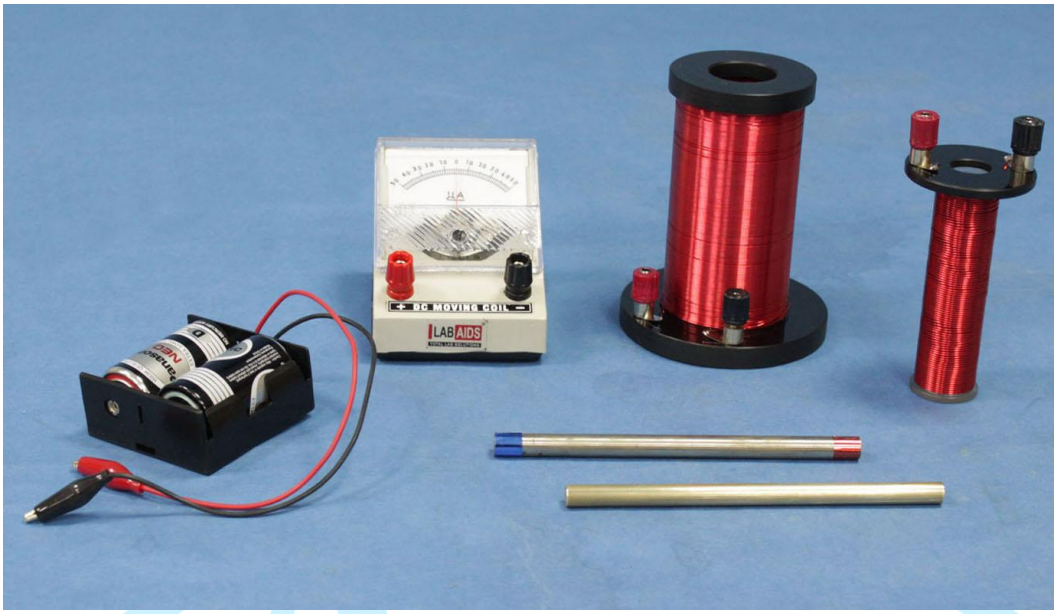
In 1833, Lenz pointed out that in a relative motion of a coil and a magnet, the direction of the induced current is the magnetic field of the coil which stops the relative motion. This is called Lenz's Law. When the magnet N pole moves to the coil, the coil generates an upward magnetic field to stop the coil from getting close. When we observe the experiment from the top, the direction of induced current of the coil is counter clockwise.

Norman introduced the concept of induced emf in 1845. In which induced emf in the coil which in turn causes current to flow, the same as current produced in circuit when there is emf in batteries. Induced current can't be produced if it's not a closed circuit, even though induced emf does exist. This is also the induced emf ε of the coil which equals to the change rate of the magnetic flux ϕ_B in the coil with time t. This is also called Farady's law. The formula can be expressed as:

$$\varepsilon = -\lim_{\Delta t \to 0} \frac{\Delta \phi B}{\Delta t} \qquad (1)$$

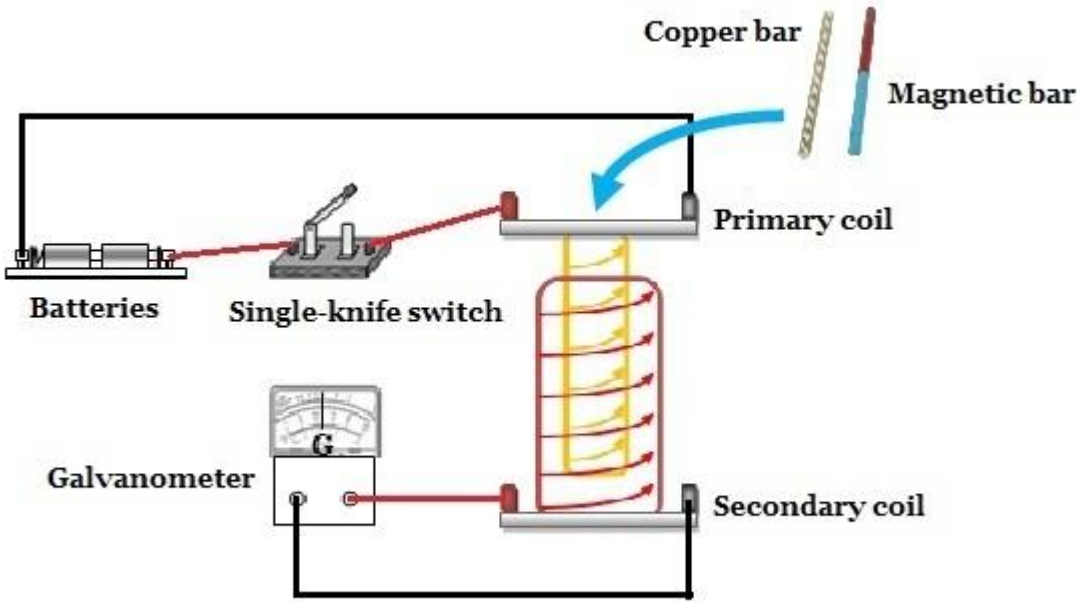
In the formula, the minus number is the induced current of the induced emf. This magnetic field repels the change in the flux. Lenz's law: the direction of the induced current of the induced emf repeals the direction of the change in the flux. In the picture, when the magnet is near the coil, the magnetic flux increases to right and the coil generates an upward induced current which causes the left-turning induced magnetic field to repeal the magnet.

Instrument



No.	Accessory	Qty	No	Accessory	Qty
1	Galvanometer	1	2	Induced coil set: Primary coil: (est 200 rounds)	1
3	Induced coil set: Secondary coil	1	4	Magnetic bar	1
5	Copper bar	1	6	Connecting wire	1
7	Battery holder	1	8	Single-knife switch	1

Procedure (Experiment set-up as below figure)



1. Connect primary coil, batteries and single-knife switch in series. Connect secondary coil and galvanometer in series. Insert the primary coil into the secondary coil and switch on the single-knife switch.

2. Observe the deflecting direction the moment the power is connected. Record the direction of the induced current of the secondary coil by looking over from top to the bottom.

When the galvanometer is back to zero, observe the deflecting direction of the galvanometer at the instant of turning on the power and record the induced current direction of the secondary coil.

3. Connect to the batteries; keep the original coil in the power-on state. Quickly insert the coil inside the secondary coil and observe the deflecting direction of the galvanometer. Record the direction of the induced current of the secondary coil by looking over from top to the bottom.

When the galvanometer is back to zero, quickly take out the original coil and observe the deflecting direction of the galvanometer. Record the induced current direction of the secondary coil.

4. Replace the original coil with magnetic bars. Quickly insert the bar and remove it from the secondary coil and observe the deflecting direction of the galvanometer pointer. Record the direction of the induced current of the secondary coil by looking over from top to the bottom. Use the opposite end of the magnetic bar to repeat the experiment steps and record.

5. Change the magnetic bar to copper bar and repeat step 4.

Experiment Results

	Power switch control	Direction of induced current of secondary coil from top to the bottom
Original coil inside the secondary coil	Power-on state	
	Power-off state	

Object inside the secondary coil	Control of the movement direction	Direction of induced current of secondary coil from top to the bottom
Original coil	Insert	
	Remove	
N pole of the magnetic bar	Insert	
	Remove	
S pole of the magnetic bar	Insert	
	Remove	
Copper bar	Insert	
	Remove	

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