

615-4650 (10-140) Primary Secondary Coil

Warranty and Parts:

We replace all defective or missing parts free of charge. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse, or normal wear and tear.

Introduction:

An induction coil raises the voltage of direct current electricity. Like a transformer, it has two coils - primary and secondary - on the same core. It also has a means of rapidly interrupting the primary circuit. When you move a magnet into or out of a coil, the wires cut magnetic lines, and current flows *if the circuit is closed*. If you disconnect both ends of wire and so open the circuit, the current is zero.

Whether the circuit is open or closed, cutting magnetic lines *always* induces a voltage or electromotive force which depends upon:

- number of windings on coil
- how many magnetic lines each turn cuts per second

To induce a high voltage, use a coil of many turns and let each turn cut many magnetic lines per second.

Additional Materials Needed:

- Battery *such as 10-171 Battery Kit*
- Galvanometer
- Switch



Experiments

*For experimental purposes, the **primary coil** is defined as the coil connected to the power source. The **secondary coil** is defined as the coil **not** connected to the power source.*

1. Set up as series circuit connecting inner coil, switch and battery.
2. Set up series circuit connecting outer coil and galvanometer.
3. Close switch and observe what happens on galvanometer.
4. Open switch and observe what happens on galvanometer.

Question: *When the switch is opened or closed on the primary, the galvanometer on the secondary indicates a current. When the switch is closed, the galvanometer shows no current. Why?*
Answer: *If the switch remains closed, there is a steady current in the primary coil. This means there is a steady magnetic field around it and the secondary. Since there is no change in the field around secondary, electromagnetic induction will not occur.*

5. Replace battery and switch connected to primary circuit with an alternating current source. You have now built a simple trans-

former for increasing or decreasing voltage by means of electromagnetic induction.

6. Voltages can be stepped up (increased) or stepped down (decreased) with a transformer.
7. In a step-up transformer, the secondary coil has a greater number of turns of wire than the primary. The secondary's voltage will be higher than the primary's.
8. In a step-down transformer, the secondary coil has fewer number of turns of wire than the primary. The voltage in the secondary will be lower than in the primary.

To calculate the new voltage, compare the number of turns of wire in primary and secondary. If the secondary has twice as many turns as the primary, the voltage induced will be twice as great. If the secondary has five times as many turns, then five times the voltage will be induced. If the secondary has half as many turns as the primary, then the voltage induced will be one half as great.

Caution:

A maximum of 6 volts AC may be applied to the primary coil for 15 minutes only. (This device generates high voltages. A shock hazard may result. 6 volts applied to the primary develops 30 volts on the secondary.)

Conversely, a maximum of 30 volts AC may be applied to the secondary for 15 minutes only

When used as a transformer, this device performs better with a bundle of fine wires than with the iron core.

Theory:

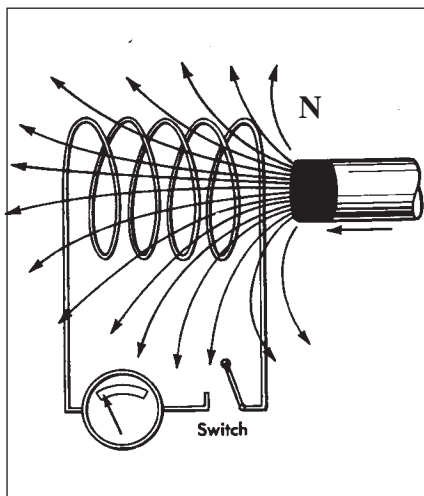
Two statements are important in understanding the induction of electric and magnetic fields.

1. **Faraday's Law** states that an

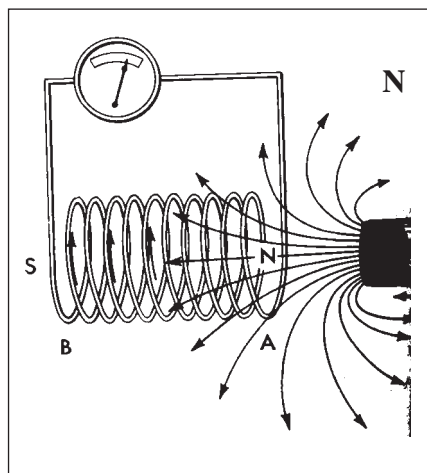
electric field is induced in any region of space in which a magnetic field is changing with time.

2. A second effect, symmetrical in nature to Faraday's Law, states that a magnetic field is induced in any region of space in which an electric field is changing with time.

When a current passes through the primary coil, a current also occurs in the secondary coil, even though there is no direct contact between the coils. This phenomena can be understood in light of the two statements made above. When an electric current passes through the primary coil, changes occur in the magnetic field around it. These changes extend to the magnetic field around the secondary. Then, in accordance with Faraday's Law, an electric current is induced in the secondary coil.



Cutting magnetic lines induces voltage. Move the magnet into the coil to cut magnetic lines with the wire. This cutting always induces voltage. Current will flow if circuit is closed. Cutting the lines may or may not induce a current.



Induced current opposes the motion. Current is induced as you move the magnet into the coil. The induced current produces a north pole at the end of the coil and therefore is opposite in charge to and repels the motion.

Questions:

1. How can the voltage in a wire coil be transferred to a nearby wire without direct physical contact?
2. What does a transformer truly transform - voltage, current or energy?
3. How does the relative number of turns on the primary and secondary coil in a transformer affect the voltage produced in the secondary?

10-140 Specifications

Number of Turns in Primary:

320 turns in 2 layers of .67 mm diameter wire

Number of Turns in Secondary:

1340 turns in 4 layers of .38mm diameter wire

Primary inner diameter: 3 cm

Secondary inner diameter: 3.4 cm

Diameter of core: 20 mm

Maximum current in primary: 12 volts

Primary resistance: 2.3 Ω

Secondary resistance: 2.4 Ω

How To Teach with Primary/Secondary Coil

Concepts: Electromagnetic

Induction; Faraday's Law of Induction; Lenz's Law of Induction. Right-hand Rule; Induced Current & Induced Magnetic Field. Mutual Inductance: Step-up and Step-down Transformers. Induction of Current vs. Induction of Voltage.

Curriculum Fit: Physics Sequence/ Electricity & Magnetism. *Moving Charge & Magnets. Grades 9-10.*

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