99 Motors and Generators

Purpose

To observe the effects of electromagnetic induction

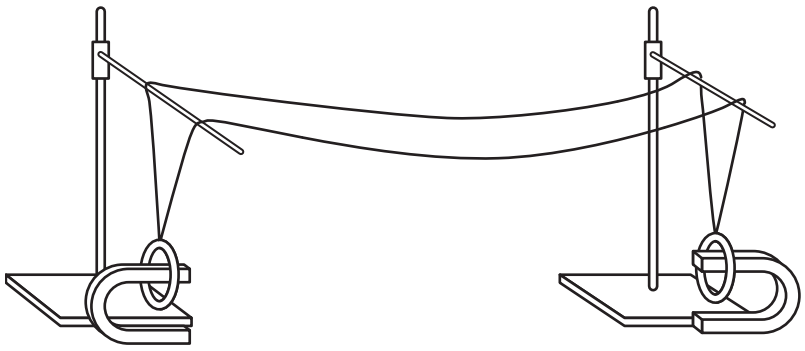
Required Equipment/Supplies

2 Genecon hand-crank generators
DC power supply; 3–6 volt
voltmeter (digital or analog)
stopwatch
2 large demonstration horseshoe magnets
2 coils of magnet wire
1 Farad capacitor (optional)

Discussion

Generators and motors are similar devices with input and output reversed. Both involve wire loops in a magnetic field. The input in a motor is electric current, which is deflected as it enters the magnetic field inside the device. This deflection turns the wire loop and mechanical energy is the output. In a generator, the wire loop is forced to rotate by mechanical means. Initially, static charges in the wire are deflected to produce an electric-current output.

In a generator, the wire loop is rotated through a magnetic field. The wire loop provides a conducting path for the charges as they are deflected at right angles by the magnetic field.



Procedure

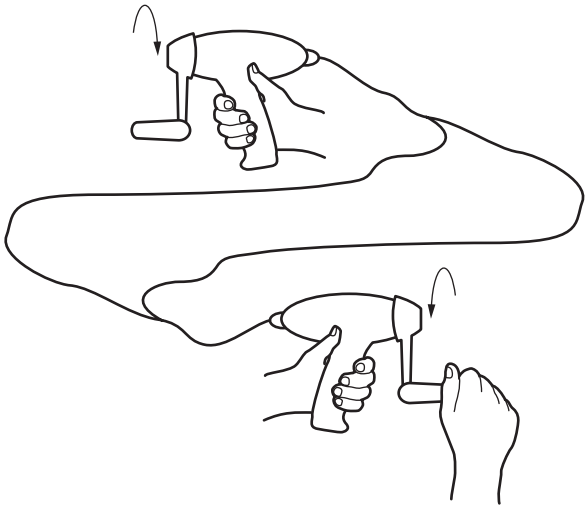
Step 1: Set up the magnets and the wires as shown. Move one coil to one side and then back again.

1. What happens to the other coil? Explain.

2. Does the same thing happen if the coils are not connected to each other?

3. What happens if the poles of the other magnet are reversed?

Step 2: Study the construction of a Genecon. Note that it consists of a DC motor whose armature shaft is connected to the hand crank via gears. Adjust the range of a DC power supply so that voltage output is a maximum of 5 volts. Attach the leads of the Genecon to the power supply. Hold the Genecon so that its handle is free to rotate. Slowly increase the voltage of the power supply and observe the operation of the Genecon. Reverse the polarity of the leads and repeat.



4. What did you observe?

Step 3: Connect the leads of one Genecon to the leads of another. Have your partner hold one Genecon while you turn the crank on the other.

5. What happens to the other Genecon when you turn the crank on yours:

a. in the clockwise direction?

b. in the counterclockwise direction?

c. fast?

d. slowly?

e. with the leads reversed?

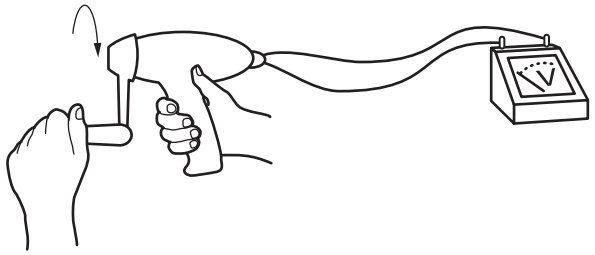
Analysis

6. Does the Genecon behave any differently when connected to another Genecon rather than a power supply? What is the principal difference in this case?

Going Further—Efficiency

Step 4: Attach the leads of the Genecon to a voltmeter whose range is set to a maximum of 10 volts. Crank the handle at various speeds. Observe the readings on the voltmeter.

Attach the leads of a Genecon to the terminals of a single bulb in a socket. Attach the leads of a voltmeter to the same terminals of the bulb. The voltmeter should be adjusted so that the full-scale reading is 5 or 10 volts. Turn the handle of the Genecon at a steady fixed speed so that the voltmeter reads 0.5 volt. Have your partner time you for ten seconds as you count the number of turns of the crank. Record your data in Data Table A.



Data Table A

Number of Turns	Voltage

Repeat this procedure up to 4 volts in 1/2-volt increments. Observe the intensity of the light bulb.

Step 5: The speed at which the armature moves through the magnetic field inside the generator is proportional to the number of turns per second. Use your data to make a graph of Voltage (volts) vs. Speed (turns/s).

Analysis

7. How does the intensity of the lamp vary as you increase the crank speed?

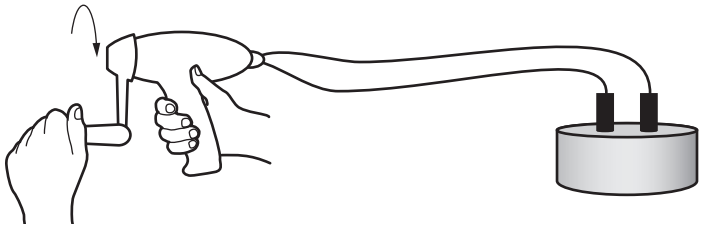
8. How does the voltage of the generator vary with the speed of the armature as it moves through the magnetic field?

9. What is the optimum speed required (that is, the speed after which there is very little increase in voltage with an increase in crank speed) to generate voltage using this generator?

10. Where does the energy to light the bulb originate?

Going Even Further—Increasing Your Capacity

A capacitor is an electronic device that stores electric charge and electric energy. The flash attachment for cameras uses a capacitor to store the energy needed to provide a sudden flash of light. Capacitors are used to smooth out alternating current ripples in a direct current voltage supply such as those used to power your calculator or radio.



Step 6: Attach the leads of a Genecon to a large capacitor—a 1.0 farad capacitor. Crank the Genecon briskly for a minute or so. Feel and observe the force required to turn the crank as you go. Then, after a minute or so, disconnect one of the leads to the capacitor (either one is OK). Predict what will happen when you re-connect the crank.

Prediction:

11. Does the crank rotate? If so, does it rotate in the same direction you had been cranking or in the opposite direction? Are you surprised? Why? Can you explain why it rotated the way it did?