
LESSON 13

Building a Spinning Coil Motor

Overview

In this lesson, students build a simple, working motor out of inexpensive materials. They learn to troubleshoot and to gain confidence in their manipulative skills. This lesson provides a conceptual transition from the spinning compass motor of Lesson 13 to the more sophisticated motor investigated in Lessons 14 and 15.

Objectives

- Students build a working electric motor and investigate further how a motor works.
- Students express their ideas about motors and their uses.

Background

The first working motors were built in the 1830s and performed only limited amounts of work. They were fascinating devices that incorporated automatic switching so that the motor would run by itself as long as electricity was supplied to the electromagnet. Today's motors still operate on the same principles.

In Step 2 of the **Final Activities** in Lesson 12, students were challenged to think about ways to switch on and off automatically the electricity flowing through the coil. In this lesson, the motor they build uses automatic switching, but how it works will not be obvious. What happens is that the bouncing of the coil, as it spins, interrupts the flow of electricity and provides an automatic on/off switch that causes the coil to keep spinning. Do not expect all of your students to understand this immediately. One purpose of the next several lessons is for students to develop a concept of how a motor works. You will have an opportunity to assess their thinking about this in **Appendix A**, the Post-Unit Assessments.

Materials

For each student

- 1 student notebook
- 2 pieces of #20 bare copper wire, each 20 cm (8 inches) long
- 2 rubber bands, No. 16
- 1 plastic cup and lid
- 2 alligator clips
- 1 battery and battery holder

- 1 switch
- 3 pieces of #22 coated hook-up wire, each 20 cm (8 inches) long
- 1 piece of #28 enameled copper wire, 65 cm (25 inches) long
- 1 piece of sandpaper, 5-cm square (2-inches square)
- 1 flexible magnet, 25 x 20 x 5 mm (1" x ¾" x 3/16"), with a 5-mm (3/16-inch) hole in the center

For the class

- 6 screwdrivers

Preparation

1. Prepare the materials for distribution. You may want to enlist the aid of students in cutting the sandpaper and wires into the dimensions specified in the materials list. Information on how to make and repair alligator leads is given in **Appendix F**. This activity could be incorporated into the lesson.
2. If you have not conducted this lesson before, you may want to set up a motor for yourself and try out the activities ahead of time.

Procedure

1. Begin by leading a discussion about physical work. Ask the students to tell the class about the hardest physical work they have ever done. How could an electric motor be used to help do some kinds of hard work? What else are motors used for? Make a list of the students' ideas.
2. Next, distribute the materials to the students and ask them to follow the instructions for building a working motor on pgs. 47 through 49 in the Student Activity Book (pgs. 86 through 88 of the Teacher's Guide). Encourage the students to be patient and to keep trying. Encourage students to take some time to figure out how the electricity gets switched on and off automatically. Many students will be challenged by this activity. Resist the temptation to build the motor for them. Offer suggestions, such as "Bend the ends of the wire a little more" or "Bend this part so that it will not bump into the wire."
3. As students work, the Student Activity Book asks them to think about the following questions and to write about them in their notebooks:
 - How is the electricity switched on and off automatically?
 - Where do you think the electricity flows in this circuit? Draw a picture in your notebook to help you explain.
 - Do you think the coil is magnetic? Why do you think that?
 - How can you make the coil spin faster or change direction? Try out your ideas!
 - How does this motor compare to the spinning compass motor? How are they alike? How are they different?
4. Encourage the students to talk with each other about what they are observing. Ask those who are successful quickly to share their ideas with students who request help, but caution them not to build the motor for them.

5. Before asking the students to dismantle their motors and return the materials to the storage area, choose one assembled motor to save for use as a demonstration for **Appendix A**.

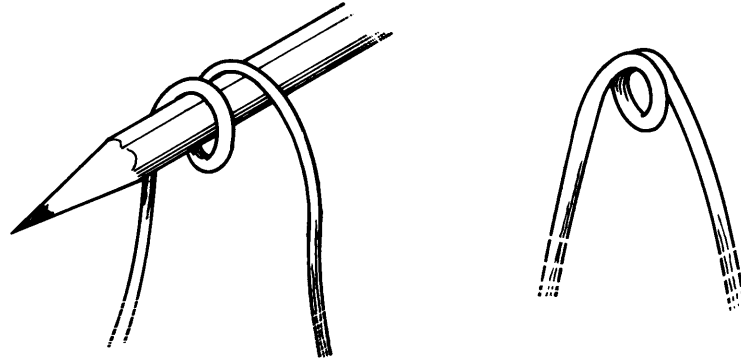
Final Activities

Tell students that in the next lesson they will be taking apart a different kind of motor that someone else put together.

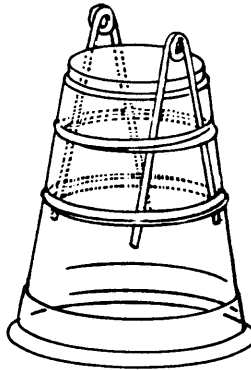
Student Instructions for Building a Motor

Use the directions and the pictures on these two pages to build an electric motor. If the motor does not work, try changing one thing at a time until it operates. That way, you will know what the trouble was. As you learned in Lesson 5, this kind of problem-solving is sometimes called **troubleshooting**.

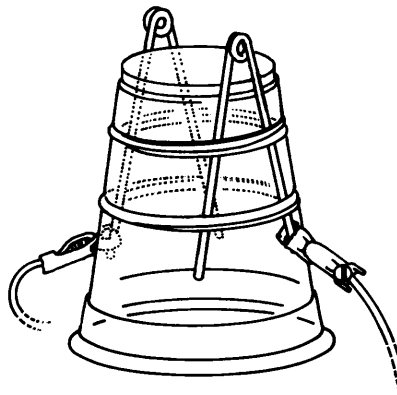
1. Start by making a loop in the middle of each of the two bare copper wires. Wrap them around a pencil, then slide the loop off the pencil.



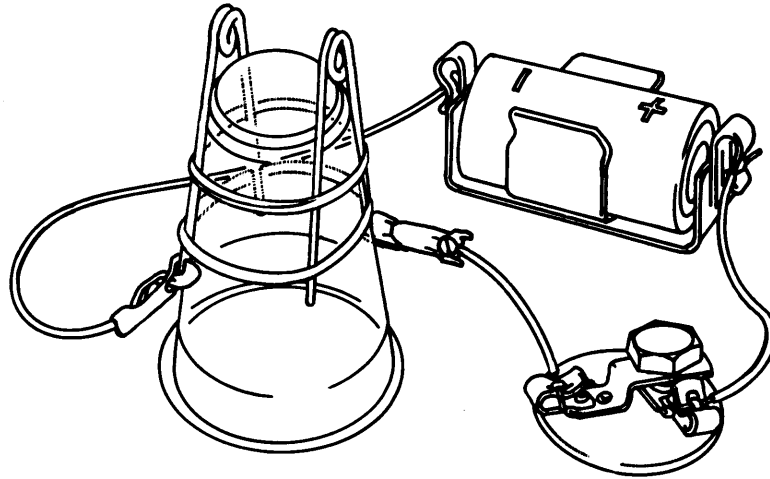
2. Use the two rubber bands to attach the bare copper wires to the plastic cup.



3. Clamp an alligator clip to one end of each of the bare copper wires.

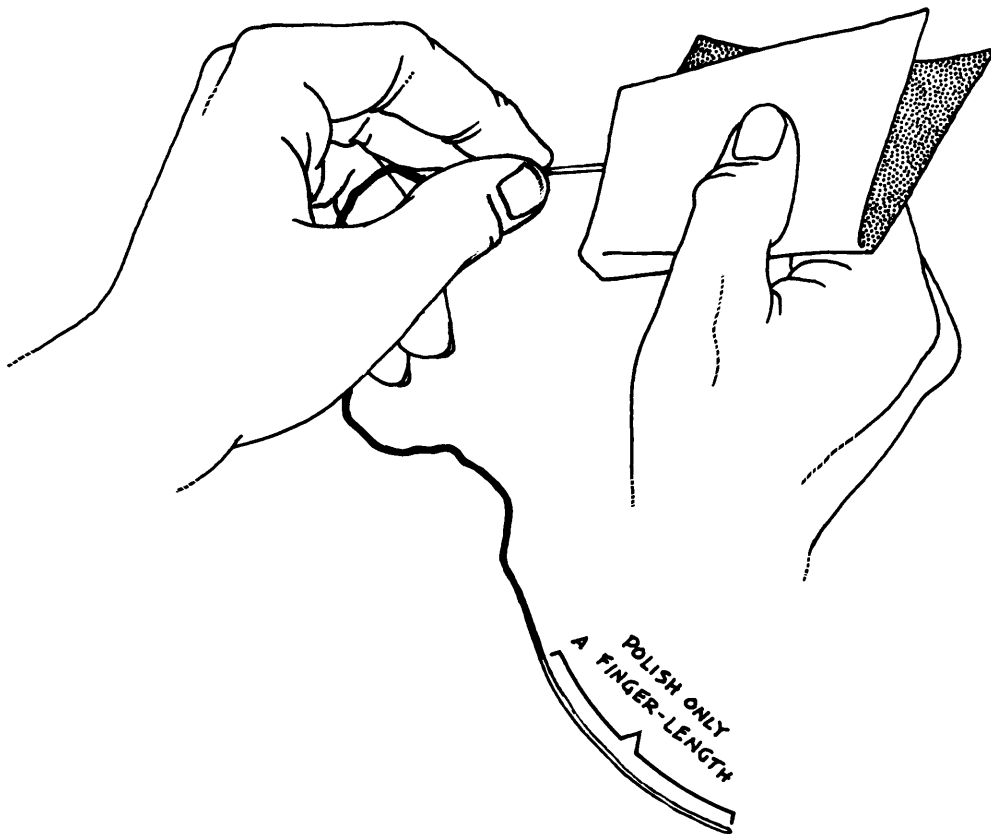


4. Hook up the rest of the circuit by connecting the battery and the switch to the alligator clips with the three pieces of #22 wire. **Appendix F** tells you how to make alligator leads.

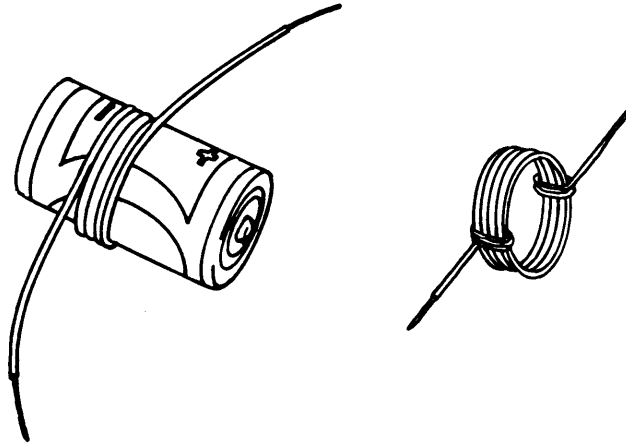


5. Next, begin to make the moving coil from the #28 wire. The wire has a thin coating of insulation on it called enamel, so you will need to sand off the insulation at the ends. This is so that the electricity can flow from the bare copper wire through the thin wire to the other bare copper wire.

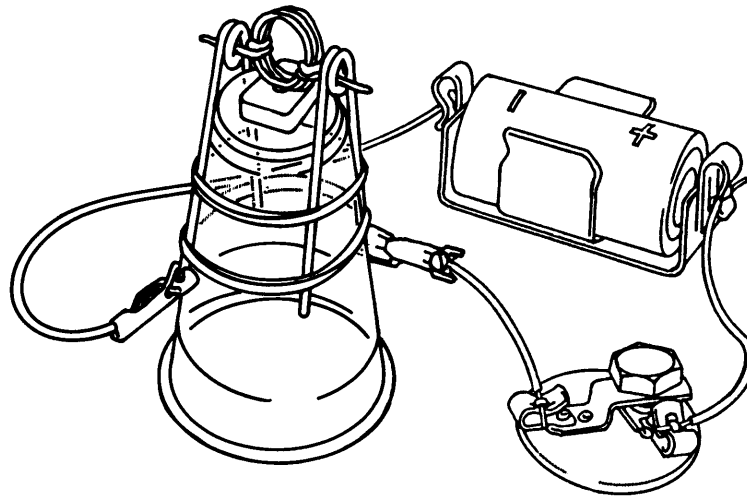
Sand about one finger-length of insulation gently off each end of the wire. You can do this by folding the sandpaper in half and pulling the ends of the wire carefully between the two sides of the sandpaper.



6. Now, wrap the wire around the battery several times. Leave the bare ends sticking out of the coil. Slip the coiled wire off the battery. Wrap the bare ends three or four times around the coil, to hold it in a circular shape. Then bend the ends of the wire so that they stick straight out on opposite sides of the coil.



7. Next, place the ends of the coil through the loops in the bare wire on each side of the cup. If necessary, bend the coil and adjust the loops so that the coil can spin freely, without hitting anything.



8. Place a magnet on the top of the inverted cup, underneath the coil. Turn the switch on and blow gently on the coil to help get it started.

If the coil will not spin continuously, try putting the magnet somewhere else, turning it over, or bending a few wires a little.