Name: _____
Partner(s): _____
Date: _____

The Electromagnets and Magnetic Forces

(All questions that you need to answer are in italics. Answer them all!)

Purpose

To build a simple working speaker consisting of an electromagnet and a vibrating membrane.

Introduction and Theory

A speaker's job is to turn an electrical signal or current from your radio or CD player into mechanical vibrations at frequencies you can hear. In this problem, you are going to build a simple speaker. Keep in mind that all a speaker has to do is to vibrate at the correct sound frequencies. It doesn't matter if it is your voice box vibrating or a piece of plastic vibrating. If the frequencies are the same, you'll hear the same sound. We're going to use magnetic forces to set a plastic membrane vibrating.

A speaker works like this: we take a surface that is free to vibrate (the lid of a plastic container) and attach a magnet to it (Figure 3). If we bring a magnetic north pole near the bottom of the lid, the magnets will attract and the lid will be pulled down (Figure 3a). If we bring a south pole near the bottom of the lid there will be repulsion and the lid will be pushed up (Figure 3b). By switching the north and south poles of the magnet very quickly, we can get the lid to vibrate up and down.

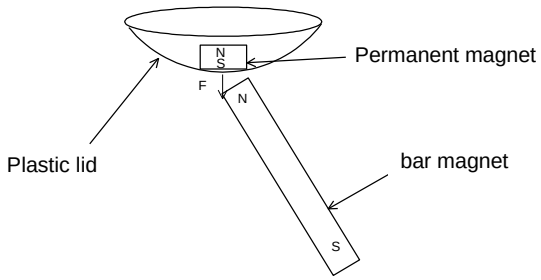

Figure 3a: Magnetic attraction.

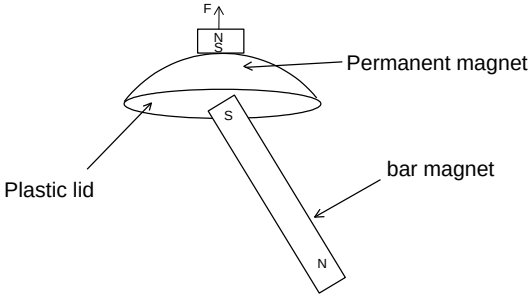

Figure 3b: Magnetic repulsion.

An electromagnet's poles are at its ends, so we position one end close to the lid's permanent magnet. We then connect the electromagnet to a transistor radio that outputs a current that changes direction at the sound frequencies. This changing current will cause the electromagnet to switch the north and south poles at the sound frequencies, thus physically vibrating the plastic lid at those frequencies, and we will hear the sound.

Cool, huh?

Apparatus
~2.5 m of thin wire, a steel screw, plastic container with lid, permanent rare-earth magnet, battery, a steel nail, tape, radio.

Assembly and Procedure

Solenoid: Wrap the wire around the screw many times. (The more turns per unit length a solenoid has, the stronger the magnetic field.) Try keeping all the turns together near the head of the screw – leave at least 2 cm of the screw bare of wire at its pointy end. Also leave about 10-15 cm of wire not wound around the screw at each end (see Figure 4). Strip the insulation for about 1 cm at both ends. This solenoid with the screw core is your electromagnet.

Test your magnet: Connect the battery to the ends of the wire and bring the head of the screw in contact with your steel nail. Slowly try to lift the nail with your magnet. If you can lift one end of the nail a reasonable distance off the table, then you have a good magnet. If not, you will either need to increase the number of turns on your solenoid or you'll need to make the turns closer together.

Speaker assembly: Thread the screw into the hole in the bottom of the plastic container so that the head is a few millimeters below the top rim of the container. Now place the lid on the container and make sure there is some space (a few millimeters) between the lid and the head of the screw.

Tape the permanent magnet to the **outside** of the container lid at its centre. Put the speaker together.

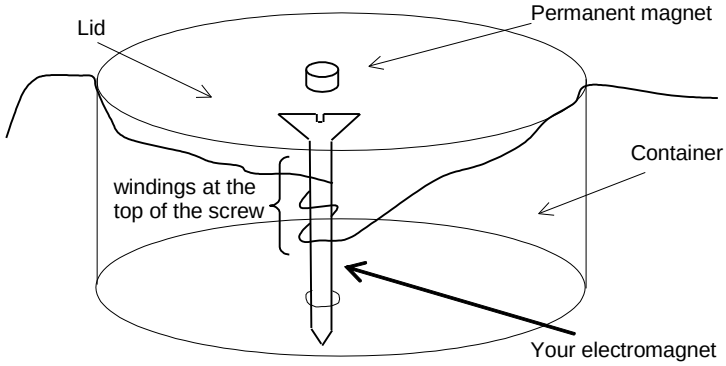

Figure 4: The final product. Connecting the wires to a radio should produce a sound.

Test your speaker: If you hear a clicking noise when you connect the wires coming out of your speaker to the battery, your speaker is probably working. If not, the distance between the permanent magnet and your solenoid may be too large or too small. Adjust the screw position, if necessary.

Final Tests: Once you're confident that you have a working model, take it to the instructor's table for a final test. If your speaker works well, have your instructor or lab demonstrator sign here:

Teacher initial: _____

Discussions

1. *What force causes the plastic lid to vibrate? Be specific about what 2 objects are interacting, explain why there is a force, and why the force can change directions.*

2. *Why can't you see the plastic lid vibrating but you can hear it? Is there another way to prove that the lid is vibrating? Use senses other than vision and hearing.*

3. *List 2 ways you can make a louder speaker.*

When you are done, disassemble your speaker, unwind the wire, and neatly re-pack the kit.