Using properties of electromagnetism to construct speakers from paper cups

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Abstract

An electromagnet is a soft metal core that demonstrates magnetic properties after passing a current through a coil that surrounds. Modern speakers, which function as a result of interactions between electromagnets and permanent magnets, can be modeled using a paper cup, copper wire, neodymium magnets, a razor blade or sandpaper, an MP3 player, and some other related materials. First, the copper wire must be made into a coil of uniform radius. This is easiest when using a tool like a test tube. After coiling the wire, the coil must be unwinded such that a few inches of free wire are available on either end of the coil. Next, the ends of the wire must be stripped, with a razor blade or sandpaper, until the copper-colored wire turns silver. Using the corresponding materials, the wire must be stripped to reveal silver-colored wire which can pass current from the MP3 player. To replicate the interaction between the electromagnet and permanent magnet, an electromagnet must be induced and paired with a permanent magnet such as the neodymium magnet. Audio connector cables should run from the headphone jack of the MP3 player to the terminal conductor. Two alligator clips, each from separate cables, should then be attached to the conductor, preferably by soldering. The other ends of each cable should be clipped onto the stripped ends of the coiled copper wire. These connections allow the electric current coming from the MP3 Player to pass back and forth through the coil. Passing a current through the copper coil creates an electromagnet by inducing a magnetic field, the direction of which depends on the direction of current flow. The copper coil should be secured to the bottom of the paper cup, preferably using a material such as double-sided tape or glue that does not interfere with the integrity of the coil. If this material dislodges some turns of copper wire from the copper coil, this will cause a muffled sound. For simplicity, the neodymium magnets can be placed on a cake pan. With the copper coil secured to the bottom of the paper cup, the paper cup can be placed onto the stacked neodymium magnets such that the coil hangs over the column of magnets. The magnetic field from the electromagnet will stretch over the neodymium magnets in a helical shape. Such arrangements allow the magnetic properties of a copper coil to interact with the north and south poles of permanent magnets, namely the ones attached to the cake pan. As current passes back and forth through the coil, it is alternately attracted and repelled from the magnets on the cake pan. The resulting force pushes the bottom paper cup back and forth, which in turn pushes the air back and forth to produce sound waves. The cone shape of the paper cup concentrates and amplifies these sound waves.