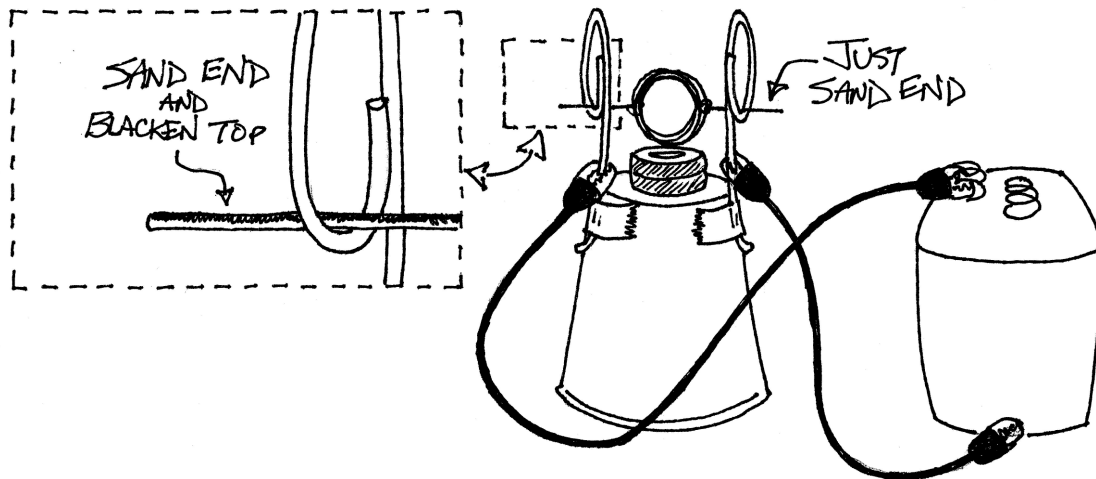


# How to Build a Nearly Useless Electric Motor

## Procedure

1. Cut off a 2 foot piece of 20 gauge enameled wire and wind it into a coil about 1 inch in diameter with at least 5 loops. Wrap the ends of the wire around the coil once or twice on opposite sides to hold the coil together. Leave about 1 ½ inches projecting from each side of the coil, and cut off any extra. See the diagram below.



2. Use sandpaper to completely remove the enamel from both ends of the wire projecting from the coil. Work carefully so that the wire is completely bare from the coil all the way to the each end.
3. Hold the coil in a **vertical** plane and then color the **top** of **one** end black with the marker. **Warning!** The orientation must match the close-up in the diagram exactly, or your motor won't work. Make sure that only the top of the wire is black, and that it is black all the way from the coil to its tip.
4. Turn your cup upside down and place 2 magnets on top and in the center. Attach 3 more magnets inside the cup, directly beneath the original 2. This will create a strong magnetic field and hold all of the magnets in place.
5. Unfold one end of each paper clip and tape them to opposite sides of the cup, with their unfolded ends down (as in the diagram). Rest the ends of the coil in the cradles formed by the paper clips. Adjust the height of the coil and the clips until the coil stays balanced and centered while spinning freely on the clips, and so that it just barely (1/16") clears the magnets without touching them. Good balance is important in getting the motor to operate well. You may need to remove, adjust and replace the coil several times to get it positioned well.
6. Attach one wire to each paper clip, but connect **only one** of the wires to the battery. Check that the coil is still positioned and balanced well, and that it still spins freely.
7. Have one person connect the other wire to the battery and then **immediately** give the coil an initial spin to start it turning. If it doesn't keep spinning, try spinning it in the opposite direction. If that doesn't work either, **immediately** disconnect the battery and follow the troubleshooting instructions below. **Warning!** Please do not leave the battery connected to a stationary coil, as it will be drained fairly quickly (lots of power is dissipated because the resistance of a stationary coil is very small.)

## Troubleshooting

1. You should see a small spark when you connect the final wire to the battery. If not, then there's probably a bad connection somewhere.
2. The key to a good motor is a well-balanced coil. Remove the coil and try to get the projecting wires as straight as possible, exactly opposite one another, and dividing the coil exactly in half.
3. Make sure that you've put marker on **only one** of the two projecting ends, that it completely covers its top side (from the coil all the way out to the tip), and that there is absolutely no remaining enamel or marker on the bottom. You may wish to sand off the marker and reapply it.
4. Check the unmarked projecting end to make sure that there is absolutely no remaining enamel on it either.
5. Once you're sick and tired of messing with your coil, then it's time to fool around with the paper clips. Try to get them positioned so that the coil just barely clears the magnets, but doesn't touch them (1/16").
6. Keep making adjustments until you give it a spin and it just keeps going. **Have patience** – this design has eventually worked very well for many students.