Homopolar Motor Lab Book

Background / Theory

What is a homopolar motor and how does it work?

A motor is a machine that is powered by electricity or combustion to produce motion, such as a motor in a car. A homopolar motor is named as such due to its key component; a magnet. The word “polar” refers to the magnetic poles of the magnet, while “homo” (meaning “same”) refers to the unchanging magnetic field produced by the magnet. This specific device was one of the first electric motors ever built, first reported by Michael Faraday in 1821.

The homopolar motor works by taking advantage of the force created by a magnetic field due to the presence of an electrical current within it. The way we figure out which direction this force is directed is done by using the right-hand-rule (RHR). The right-hand-rule goes as follows: (**Figure 1**)

1) Point your thumb in the direction of the current;
2) Point your index finger in the direction of the magnetic field;
3) Point your middle finger in the direction that the palm of your hand is facing. This is the direction of the applied force due to the magnetic field.

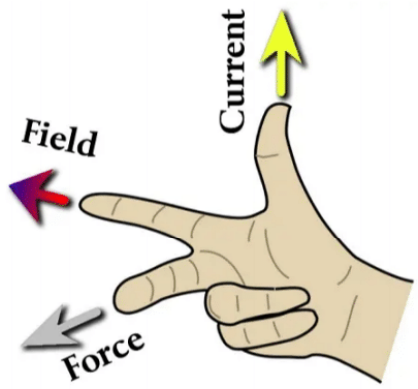


Figure 1

Figure 2 demonstrates the direction of the force on a current-carrying wire due to a magnetic field.

F: Force

B: Magnetic field line

I: Current

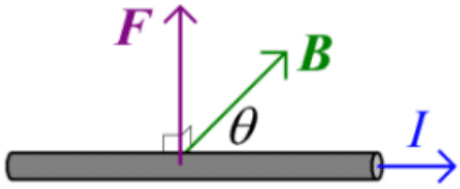


Figure 2

Figure 3 shows a homopolar motor with a magnet placed at the bottom of the battery. The north pole of this magnet points up, and the magnetic field lines of the magnet are shown in red here.

We can see that the current-carrying wire is in the magnetic field. Because of this, there is a horizontal force applied to both sides of the wire: on the left, the force is directed away from you; on the right, the force is directed towards you. The combination of these forces causes the wire to spin around the battery.

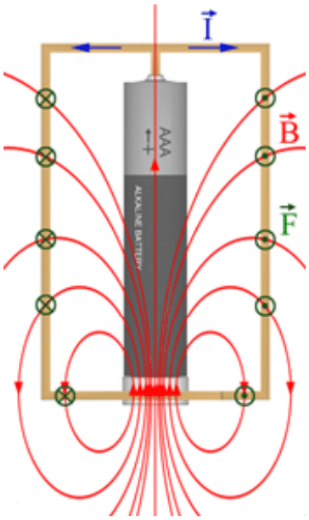


Figure 3

Materials

- 1 AA Battery
- 1 Aluminum/Copper Wire
- 1 Round Neodymium Magnet

How to build a homopolar motor

1. Connect your round neodymium magnet to the negative terminal of your battery (the negative terminal is the **flat side** of the battery, while the positive terminal is the side with a small bump)

2. Bend your aluminum wire into shape. There is more than one way to do this; the main idea is that we want the wire to connect the positive terminal to the negative terminal. In doing so, this will allow a current to flow through the wire. The wire **must** be touching both the positive terminal of the battery and the magnet/negative terminal in order for the circuit to be complete, and therefore for the current to exist.
   Here are two possible shapes that you can make (it may be easiest to make The “Square”):

i. The “Spiral”

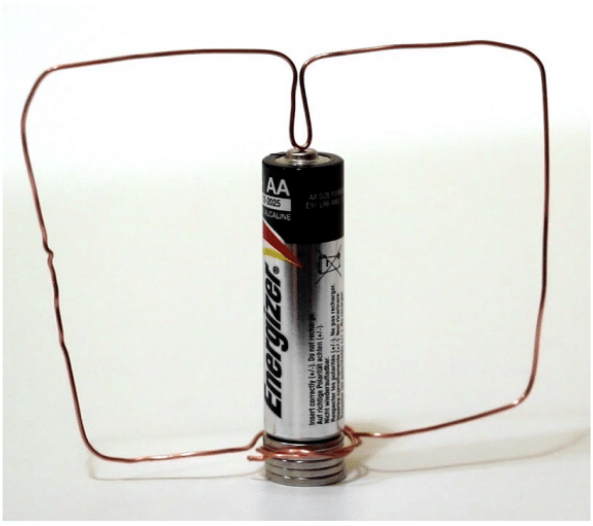
How to make:

Wrap your wire around a cylindrical object in a spiral fashion. Make sure that the cylindrical object is slightly wider than a AA battery, such as a highlighter marker. Leave 2-4 cm of the wire unbent.

Place your wire over your battery with the unbent portion of the wire at the top of the spiral. Now, bend it so that the wire connects to the positive terminal of the battery.

The bottom of the spiral should be lightly touching the magnet. If it is too loose, simply wrap the bottom of the spiral a little tighter so that the wire is in contact with the magnet to complete the circuit.

ii. The “Square”



How to make:

Fold your wire in half. About ½ to 1 centimetre above the fold, bend each side of the wire such that the wire is in a ‘T’ shape, with the vertical part of the ‘T’ being the small fold, and the horizontal part of the ‘T’ being the long portions of the wire.

The fold will be the part of the wire that connects to the positive terminal of the battery, as shown in the diagram to the left.

Now, bend the wire in the shape of a square (or rectangle) as seen in the diagram. Make sure that each end of your wire overlaps each other at least 1 centimetre.

Place the first fold to the positive terminal, and place each end of your wire on opposite sides of the battery, with both ends of the wire lightly touching the magnet at the bottom.

3. If you have done everything correctly, your wire should sit nicely on your battery, with one part of the wire connected to the positive terminal and another part lightly touching the magnet/negative terminal. Now, watch as the wire spins around the battery!

Results / Discussion

What happened when you assembled the motor?

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What happens to the motion of the wire when you flip the magnet upside down? Why do you think this motion changes?

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What would happen if we used a stronger magnet or a bigger battery?

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