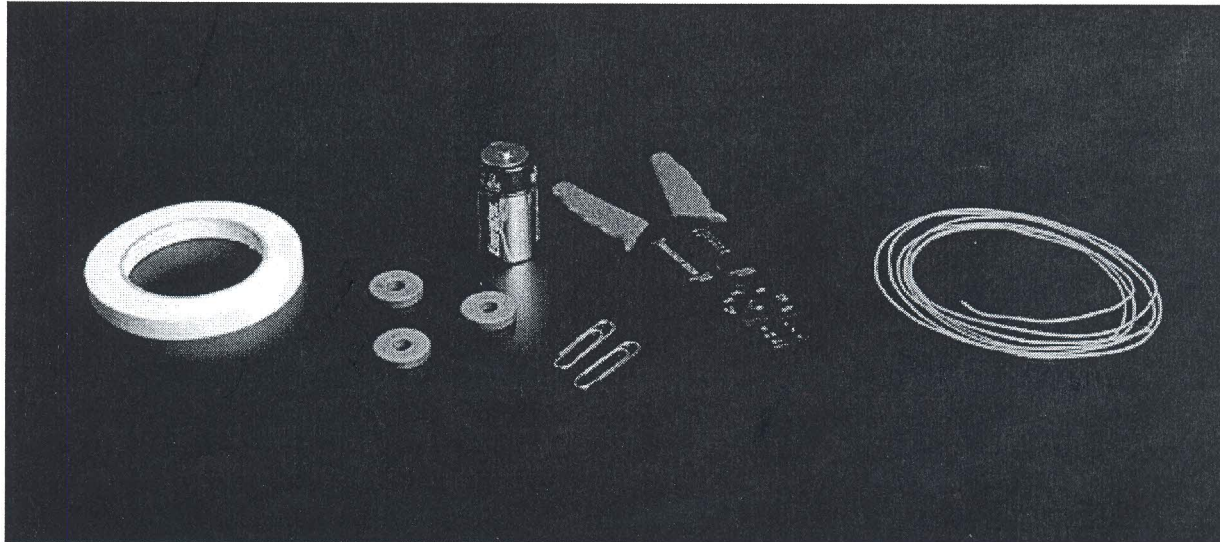


# Museum of Science and Industry

## Build an Electric Motor

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### Step 1 of 11:



#### Here's the Materials You'll Need:

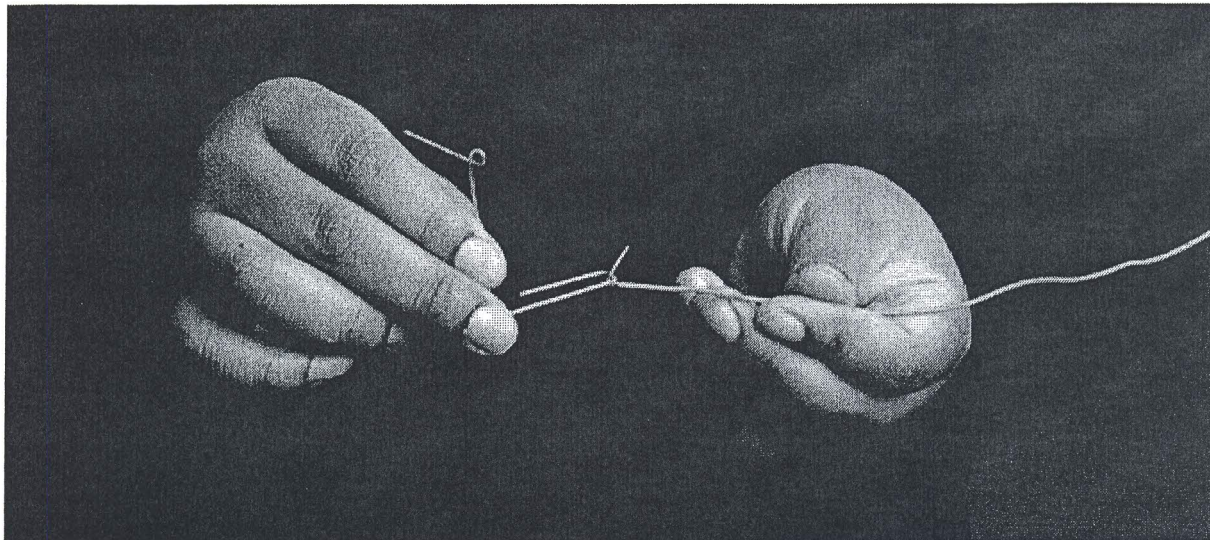
- Three ring-shaped magnets
- Insulated wire (about 4 feet is needed)
- Wire cutters / strippers
- ~~One~~ <sup>Two</sup> D-size battery
- Two large paper clips
- Tape

Return all materials!

Tap <sup>1</sup> batteries together  
(works better)

### Step 2 of 11:

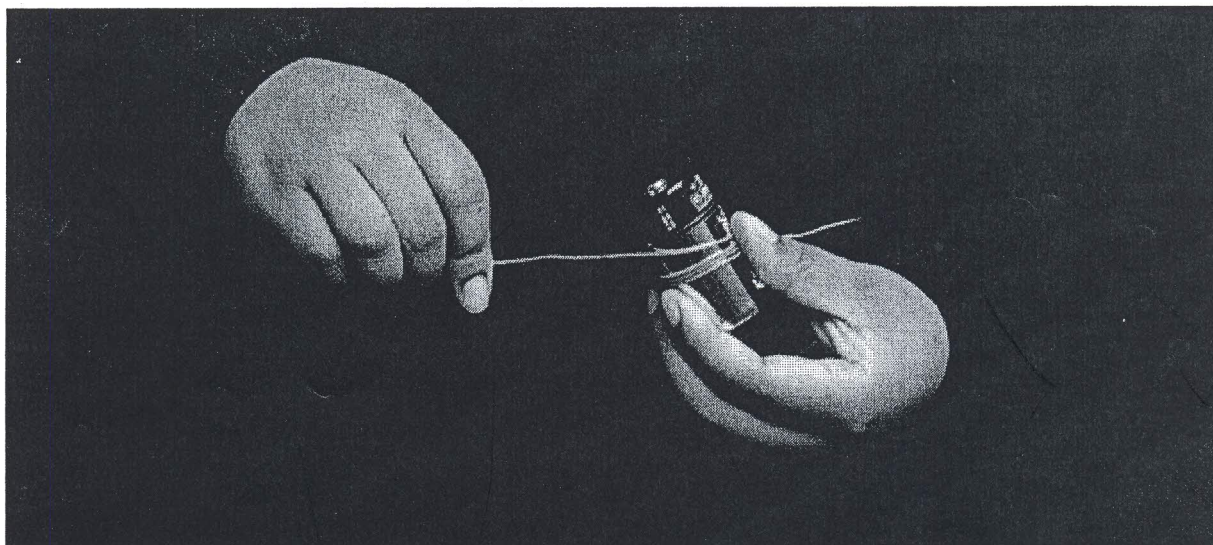
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Cut the wire into three pieces: one that is about 18 inches long, and two that are about 12 inches long. Strip about an inch of insulation off the ends of all three pieces of wire. On the longest piece of wire, blacken the top half of the stripped wire with a permanent marker.

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### Step 3 of 11:

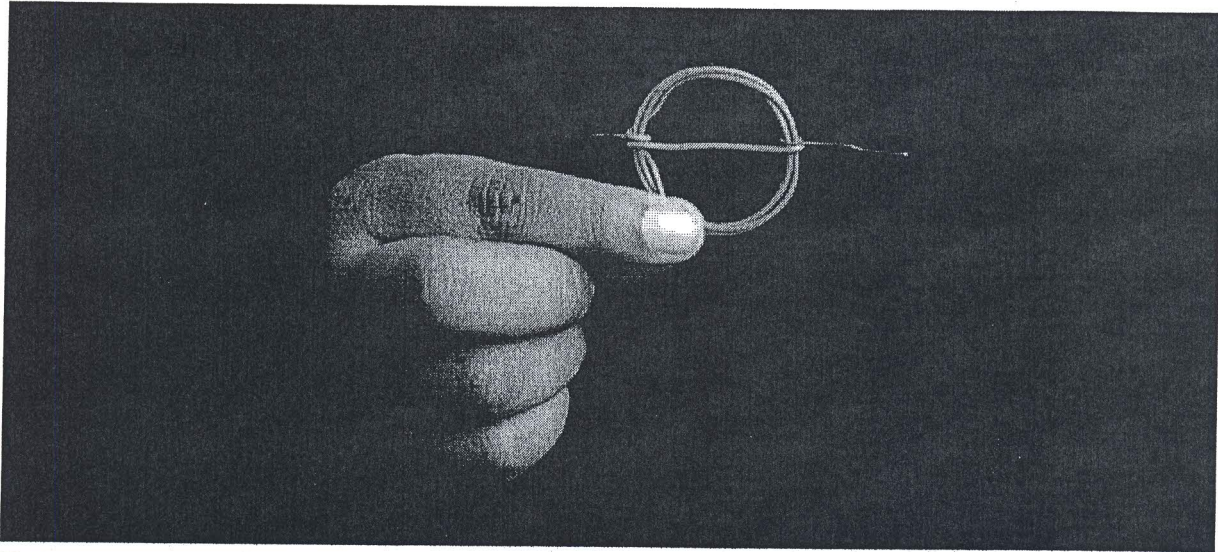


Take the large piece of wire. Starting about 2 inches from the end, wrap the wire around two fingers (or the battery) to create a coil. The coil should be about the size of a quarter.

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### Step 4 of 11:

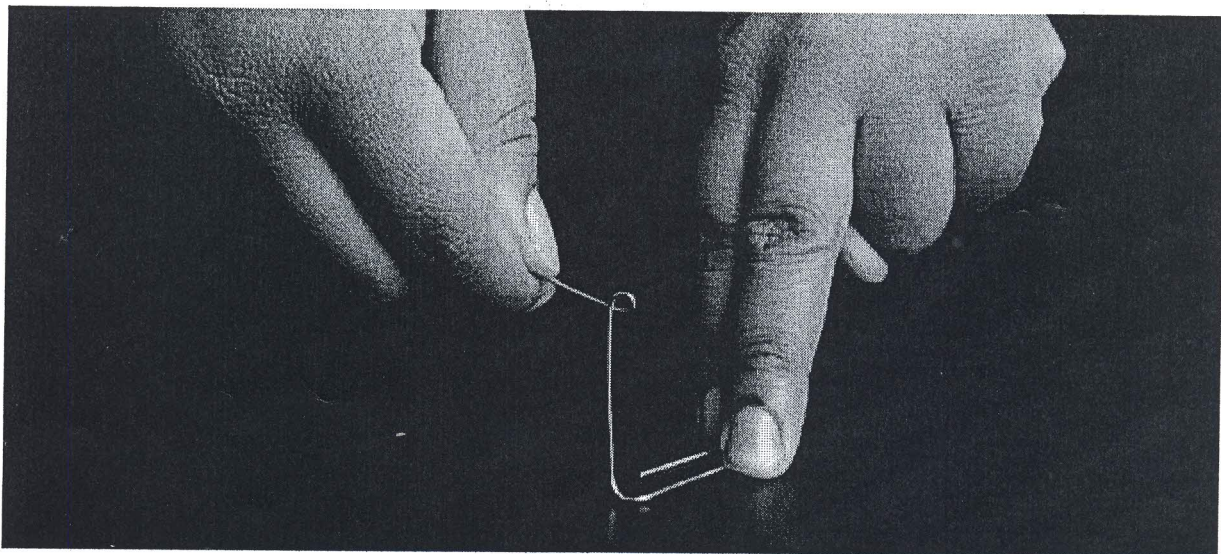




Take the long end of the wire, bisect the coil and wrap it once around the opposite side of the coil. Take the other loose end of wire and wrap it once around its side of the coil. The two "arms" should be directly opposite each other.

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### Step 5 of 11:

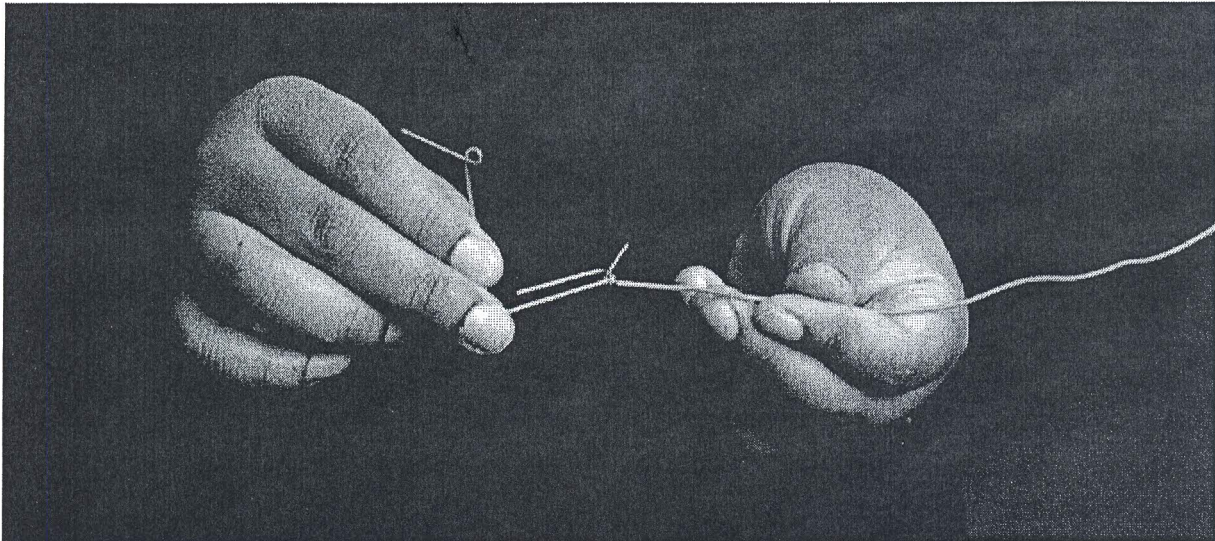


Bend the large paper clips so that the smaller bend becomes the base and the larger bend is made into a loop. These are the holders for the coil.

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### Step 6 of 11:

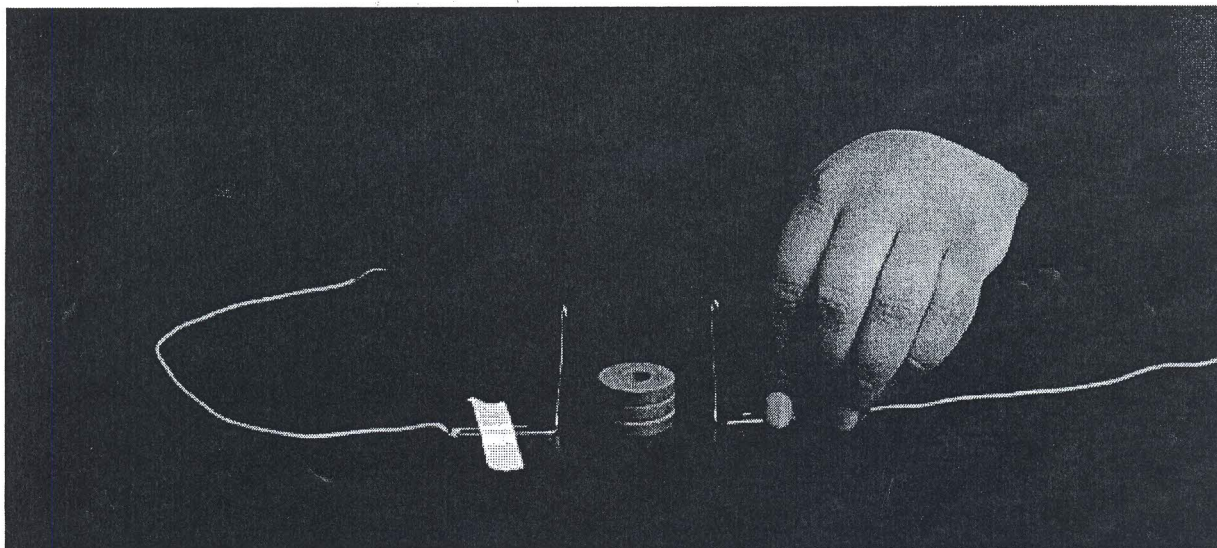




Attach one short wire to each paper clip by wrapping the end around the base.

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### Step 7 of 11:

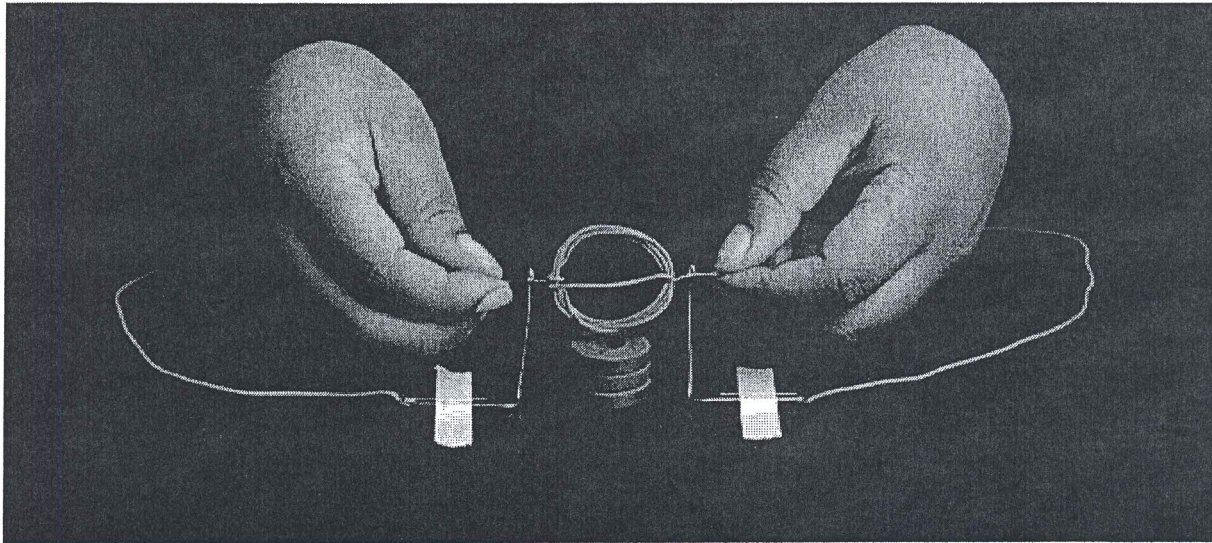


Pile the three magnets on the table. Place a paper-clip holder on each side of the magnet pile, with the paper-clip bases extending away from the magnets. Tape the paper-clip bases to the table.

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### Step 8 of 11:

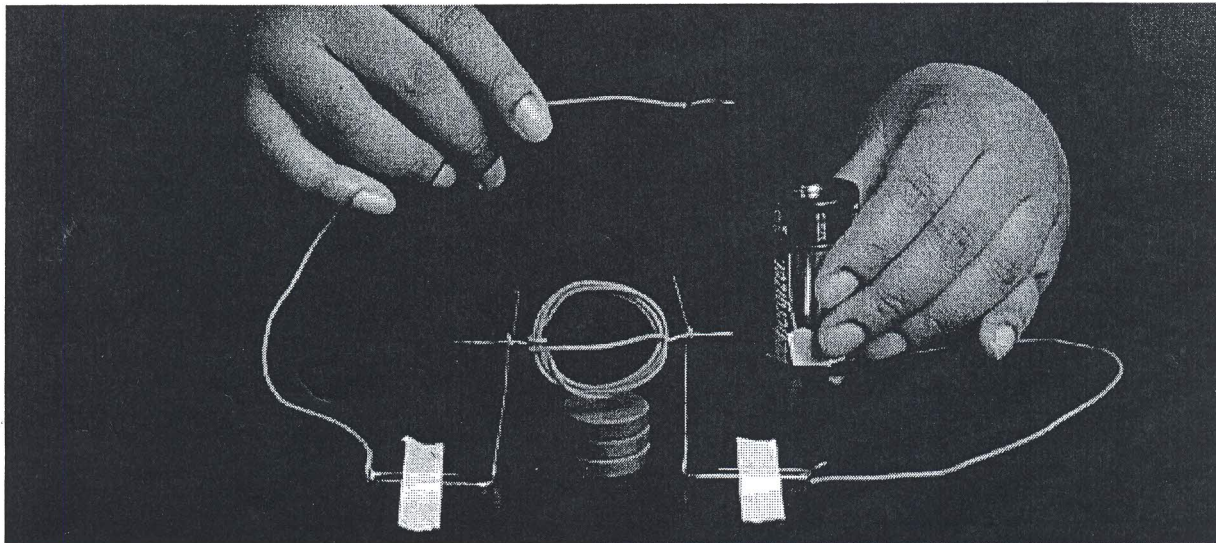




Position the coil above the magnets, with its arms resting in the loops of the paper-clip holders. When the coil is turned vertically, the bottom of the coil should be about 1 centimeter above the magnet pile. That's why large paper clips are needed for the holders.

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### Step 9 of 11:

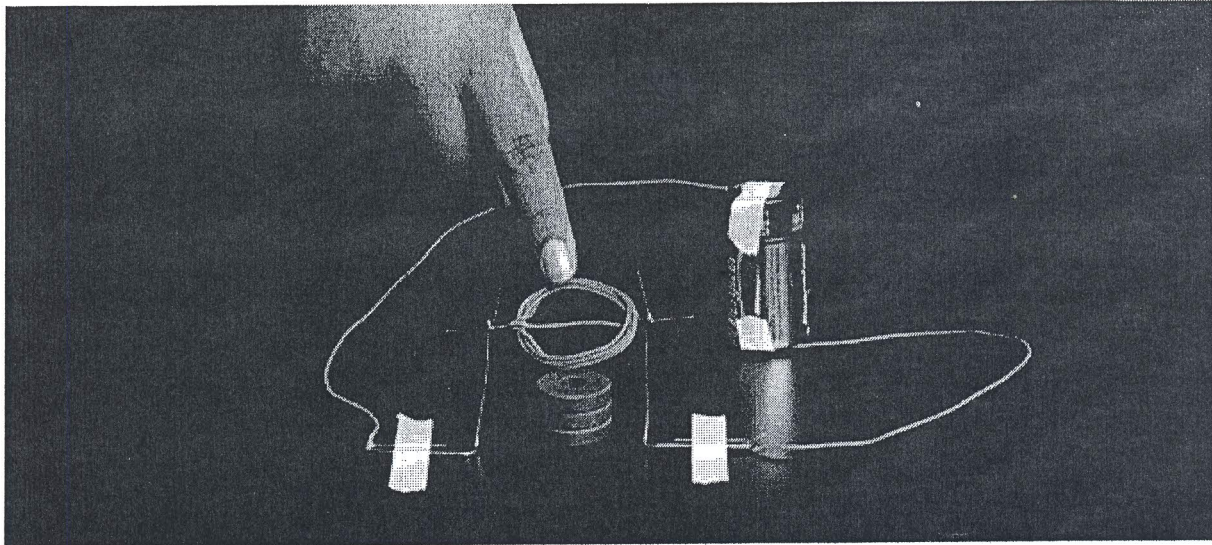


Take the free ends of the wires that are attached to the paper-clip holders and tape them to each end of the battery.

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### Step 10 of 11:





Give the coil a gentle spin, and watch what happens. Warning: Disconnect the electric motor when not using, or after a few minutes of use because the circuit will get hot.

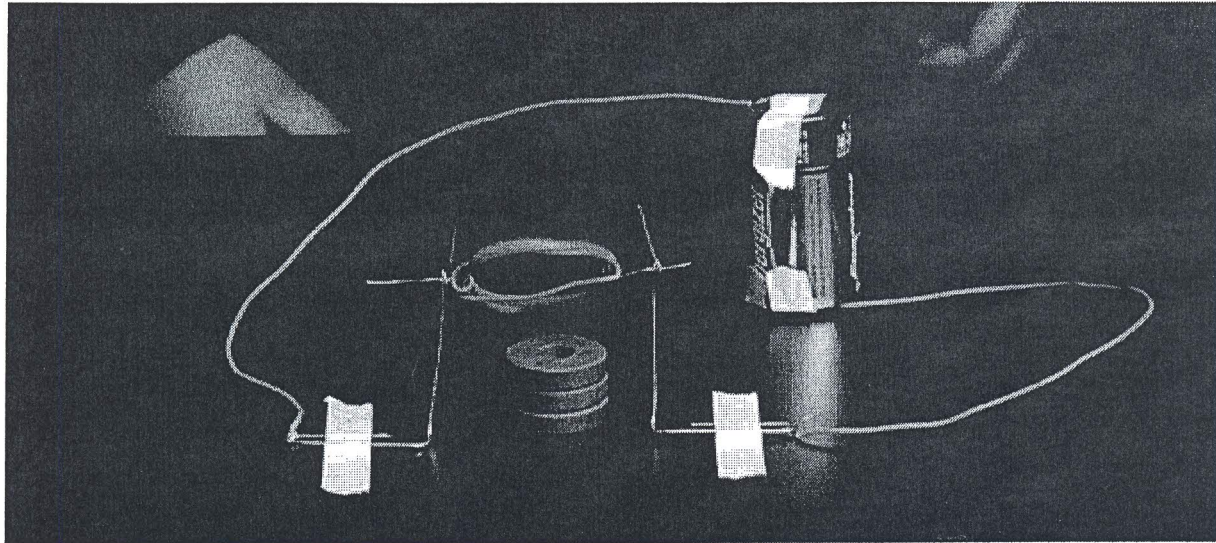
Building an electric motor requires patience and tinkering. If your motor doesn't work, check this:

- Is it on a level surface?
- Is the coil well balanced? It should spin without wobbling.
- Try spinning the coil in both directions. It may work in one direction but not the other.
- Make sure the wires are making good electrical contact with the battery terminals and the paper clips.
- Flip the magnets over so that the opposite pole is facing the coil.
- Make sure the insulation is completely scraped off the arms of the coil.
- Check the clearance between the bottom of the coil and the magnets. It should be about 1 centimeter.
- Make sure the loops in the paper-clip holders are about the same height.

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### Step 11 of 11:





When a current flows through a coil of wire, the coil becomes an **electromagnet**. The direction of the current determines the **polarity** of the **magnetic field**. One side of the coil becomes the north pole, and the opposite side becomes the south pole. As with all magnets, opposite magnetic poles attract and like magnetic poles repel. The magnet pile placed under the coil attracts its opposite pole on the coil and repels its like pole, causing the coil to spin.

Since the arms of the coil only have insulation on one half, electric current only passes through when the uninsulated part of the wire touches the paperclips. When the coil swings around and the insulated part of the wire touches the paperclips, the current is interrupted, stopping the magnetic field for half a turn. When the current flows through the coil again, the two magnetic poles either repel or attract each other once more. After the coil starts spinning, momentum carries it through the part of its cycle when there is no current.

Almost every mechanical movement that you see around you is caused by an AC (alternating current) or DC (direct current) electric motor.

### Key Terms Defined

#### Electromagnet

A magnet that gets its force of attraction from an electric current flowing through a wire

#### Magnetic field

The area around a magnet where its force can be detected

#### Polarity

The two areas (north pole and south pole) of the magnet where the magnetic force is the strongest

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