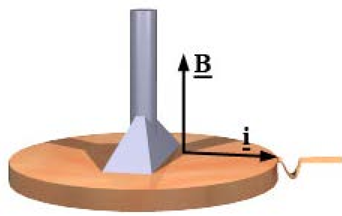
Homopolar Motors & Homopolar Generator

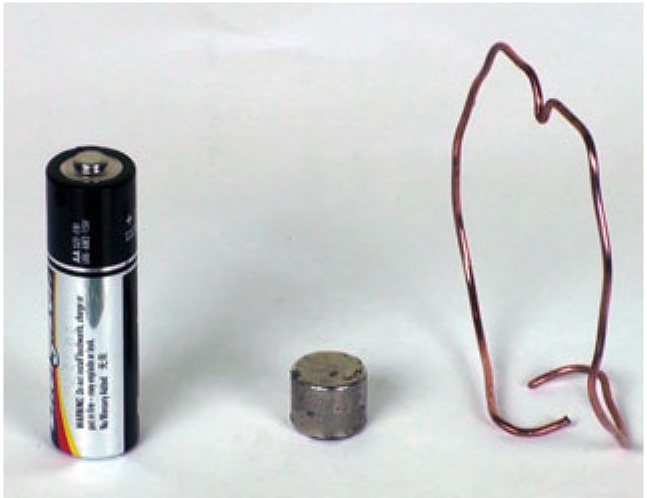
Homopolar Motors:

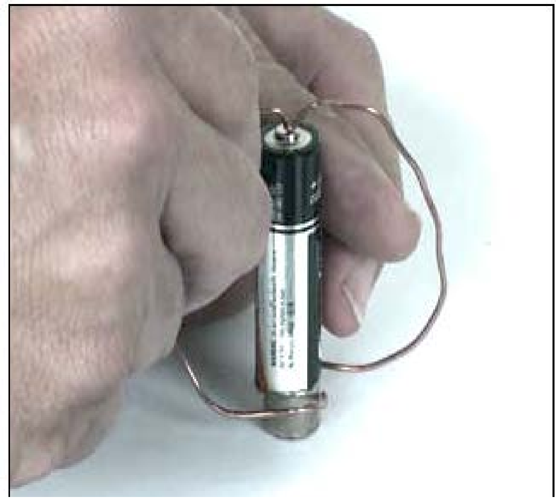


The permanent magnet in the animation (at left) produces a magnetic field **B** that is vertically upwards through the conducting disk. The cell provides current that flows through one brush to the central shaft, then outwards to the right towards the brush on the rim. The (conventional) current **i** is subjected to a force in the direction **i** X **B**, which is forwards, towards us. (Revise Vectors.) This force is transmitted to the disk, which rotates in the sense shown at left.

Because there is always a current path between the brushes (or at least there would be if they were ideal), the resultant torque is steady. Note that (in this version) there is only one current-carrying path, compared with many in a typical multipolar motor. On the other hand, the current could be large if the brushes had low resistance.

In a simple design for a very simple homopolar motor, the magnet itself (or its coating) touches the cell and is used as the contact for the brushes. In this design, the rotor is not a disk, but just a piece of wire with two current carrying paths (for balance). The piece of wire includes all three brushes. It uses a 1.5 V cell, one of whose terminals is the contact for one brush (the middle point on the wire), and a cylindrical rare earth magnet, whose circumference is the contact for the other two.

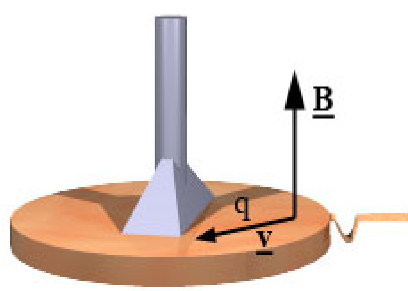




Safety warning: Because the battery is short-circuited by a piece of copper wire, this motor should only be run for very short times: it not only uses the battery very quickly, but also could heat it up, which is a potential safety hazard.

Homopolar Generators

In the simple schematics below, we've made a homopolar generator by replacing the cell that drove the homopolar motor with a voltmeter. Whereas the homopolar motor converts electrical energy (supplied by the cell) into mechanical energy, the homopolar generator does the reverse: we provide mechanical energy to turn the disk and obtain an emf and (if a current path exists) an electric current.



The diagram above shows a mobile charge q travelling with the disk, and thus with velocity **v** at the point and time shown above. The charge is subject to the Lorentz force q**v** X **B**, which is towards the axle. This gives rise to an emf as indicated by the voltmeter (and a current if the circuit is complete).

Again, a homopolar generator is conceptually a little simpler than its multipole cousins but, because there is only one current path, the emf is small. (On the other hand, ideal brushes would in principle allow a large current.)

In our generator (above), one handle (left) turns the rotor and another (right) turns the magnet, which is the black block in the middle, just to the right of the two blue wires. The axis of rotation is horizontal, whereas that in the animation is vertical. The multimeter is reading mV DC.

Source: http://www.animations.physics.unsw.edu.au/jw/homopolar.htm#motors