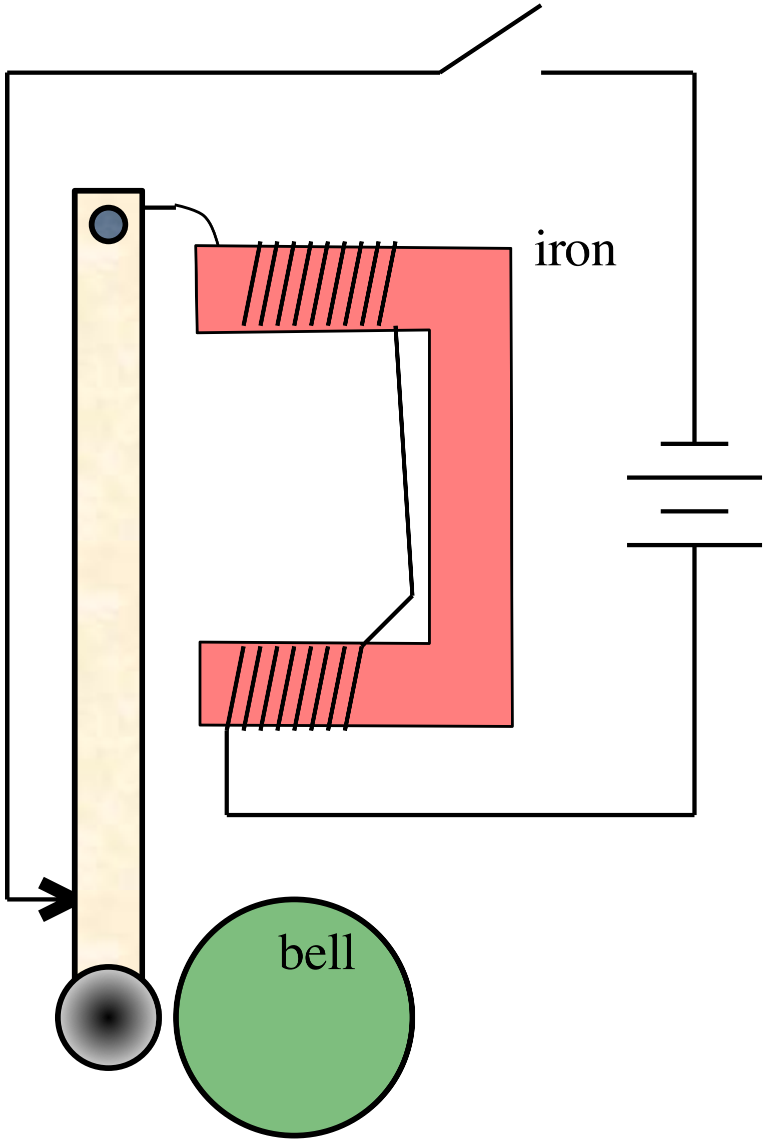
What is it?

What you are looking at here is the circuit for an old-fashioned door bell. See if you can follow through to see how the mechanism works (note the direction of the magnetic field in the green horseshoe electromagnet, and the direction of the induced magnetic field in the blue bar opposite the poles of the horseshoe magnetic, when the current flows).



Ms. Dunham's Version of a doorbell!

What does pushing the button at the door directly do?

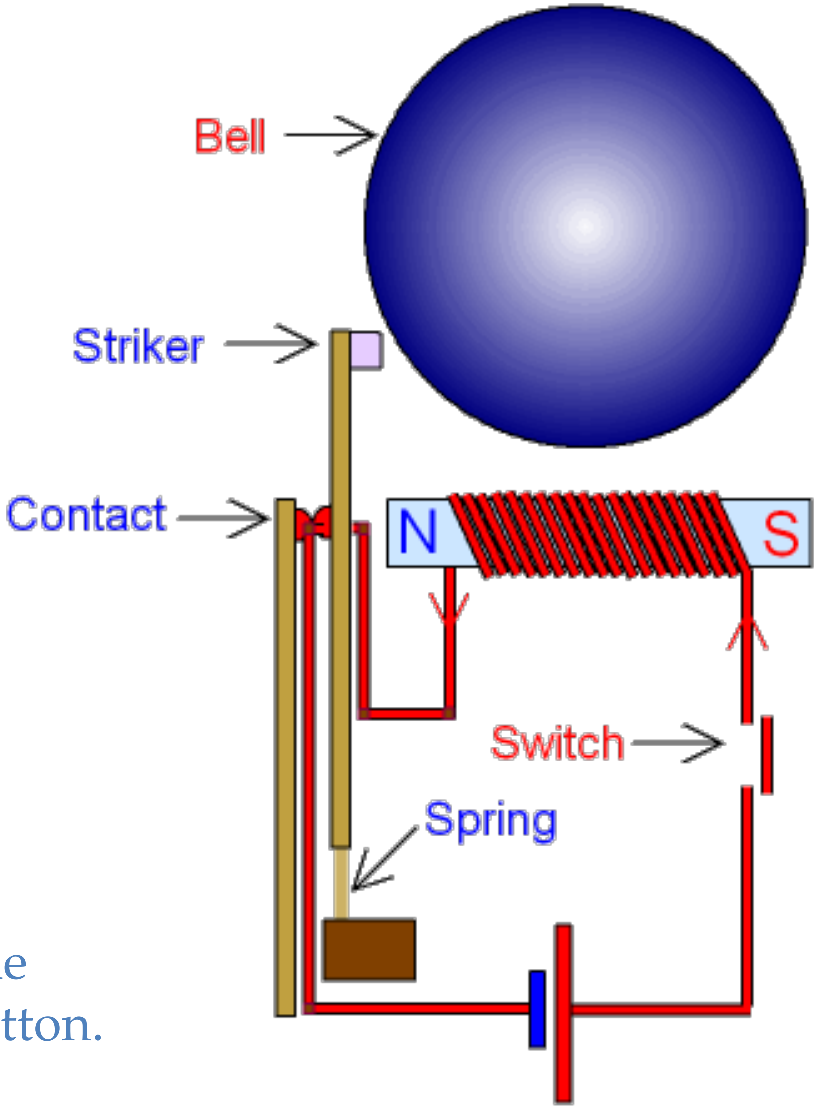
Closes the switch, allowing current to flow

- What does this cause to happen in the solenoid and the striker?

The current in the solenoid magnetizes the metal core, which attracts the striker. As the striker moves and hits the bell, it breaks contact, so the current stops flowing

- Why does it keep ringing?

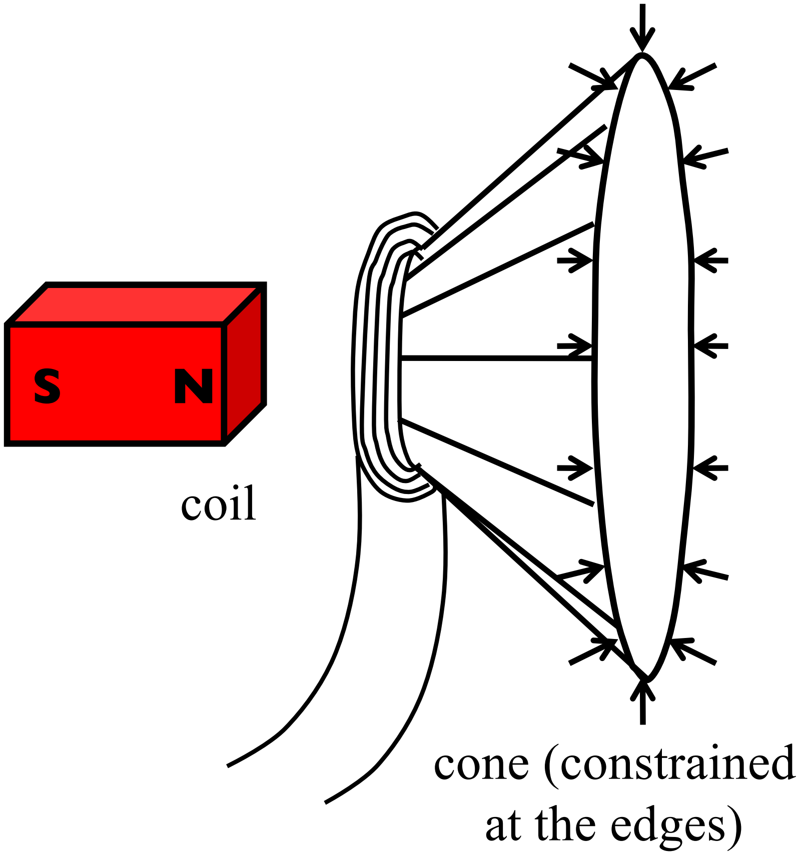
When the current stops, the striker falls back into position, reconnecting the circuit and repeating the cycle - as long as the person keeps pushing the button.



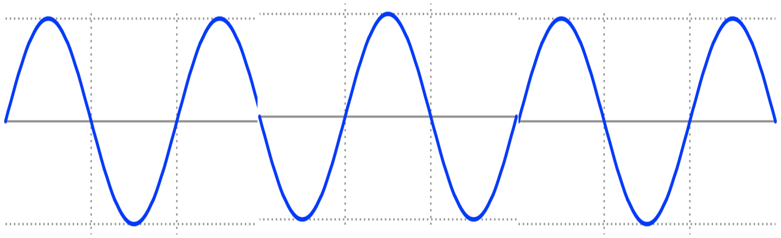
http://www.gcsescience.com/pme6.ht

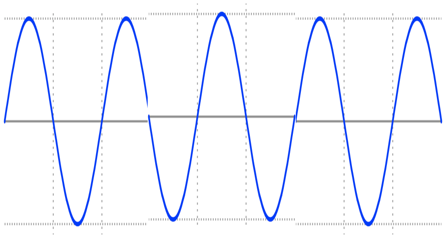
What is it?

This is the design for a loud speaker (actually, the coil and magnet are usually switched in real line). This is how it works:



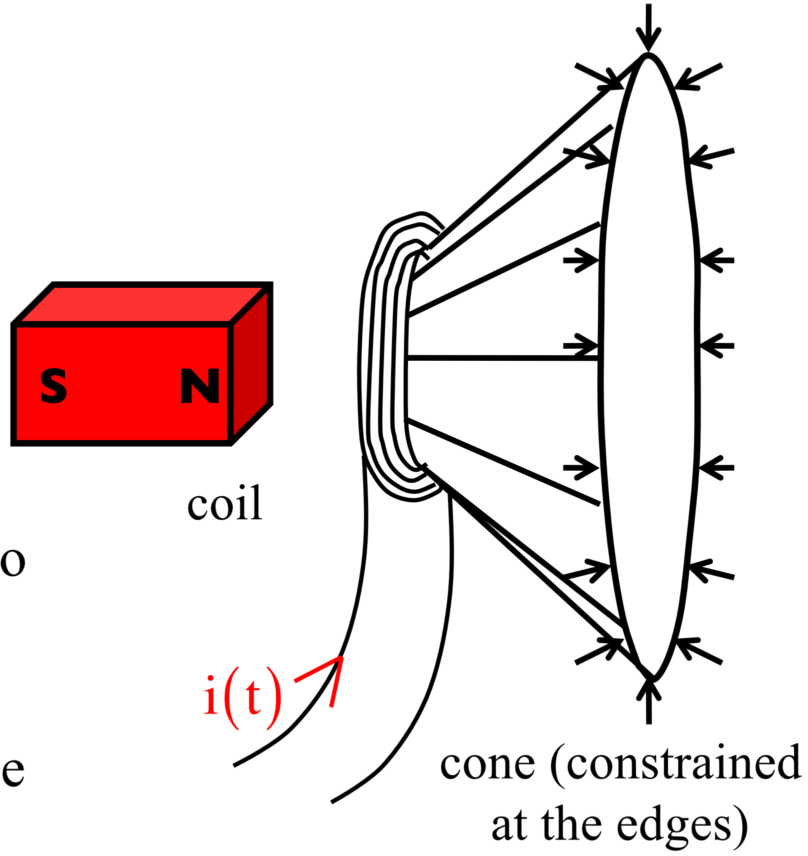
a.) Let's assume we want to project a 256 Hz (middle C) sound wave into the room. The signal would look like the sine wave shown below.





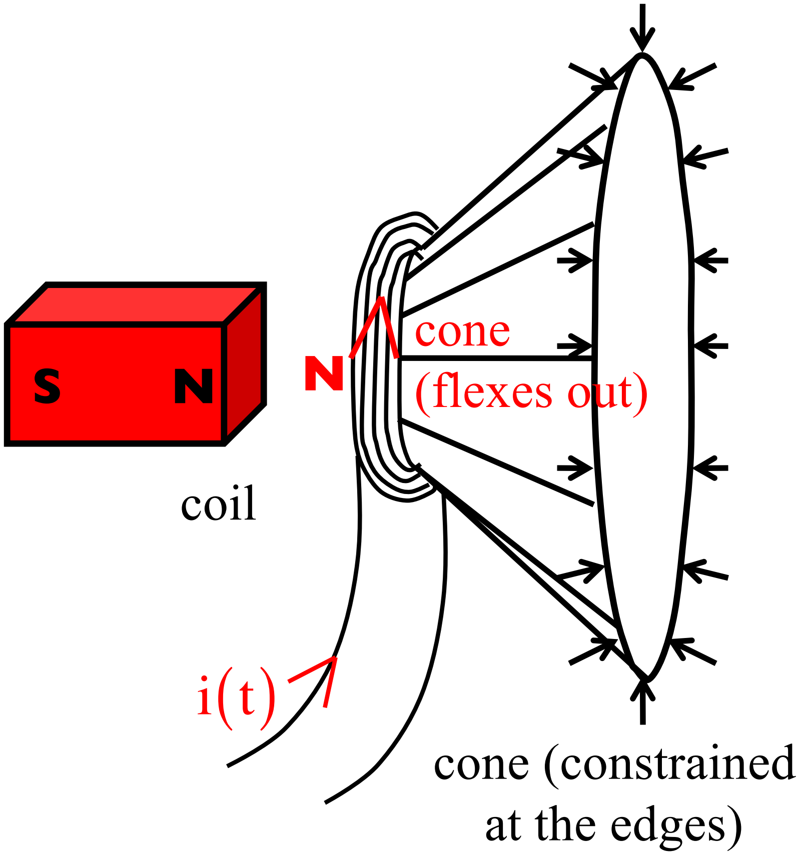
b.) During the first half of the cycle, let's assume the direction of the time-varying current through the coil is directed as shown on the sketch. There are two things to note:

i.) Being sinusoidal, the current will increase to a maximum, then will drop back down to zero whereupon the direction will change and the current will again increase to a maximum in the opposite direction, then proceed back to zero. This pattern will continue through time.



ii.) With the current moving in the direction noted, the direction of the induced magnetic field in the coil (alternate right-hand rule) will leave the side of the coil closest to the permanent magnet a North Pole (see sketch).

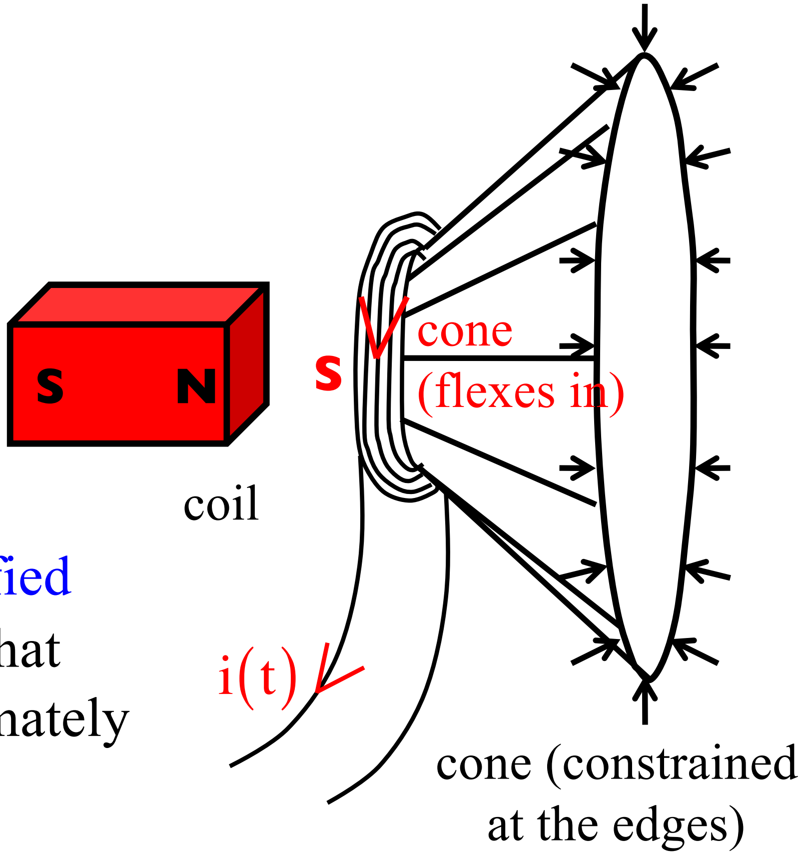
c.) The north pole of the *permanent magnet* will interact with the induced north pole of the current carrying coil, and the net effect will be a repulsion experienced by both the coil AND the cone. As the cone is fixed at it's outside edge, this will flex the cone outward with the amount of flex being dependent upon the size of the current at the given instant.



d.) As the cone flexes outward, it will compress air into a high pressure region. That pressure ridge will travel away from the cone at approximately 330 m/s, or the speed of sound in air.

e.) As the current proceeds down toward zero, the cone will relax, pulling back.

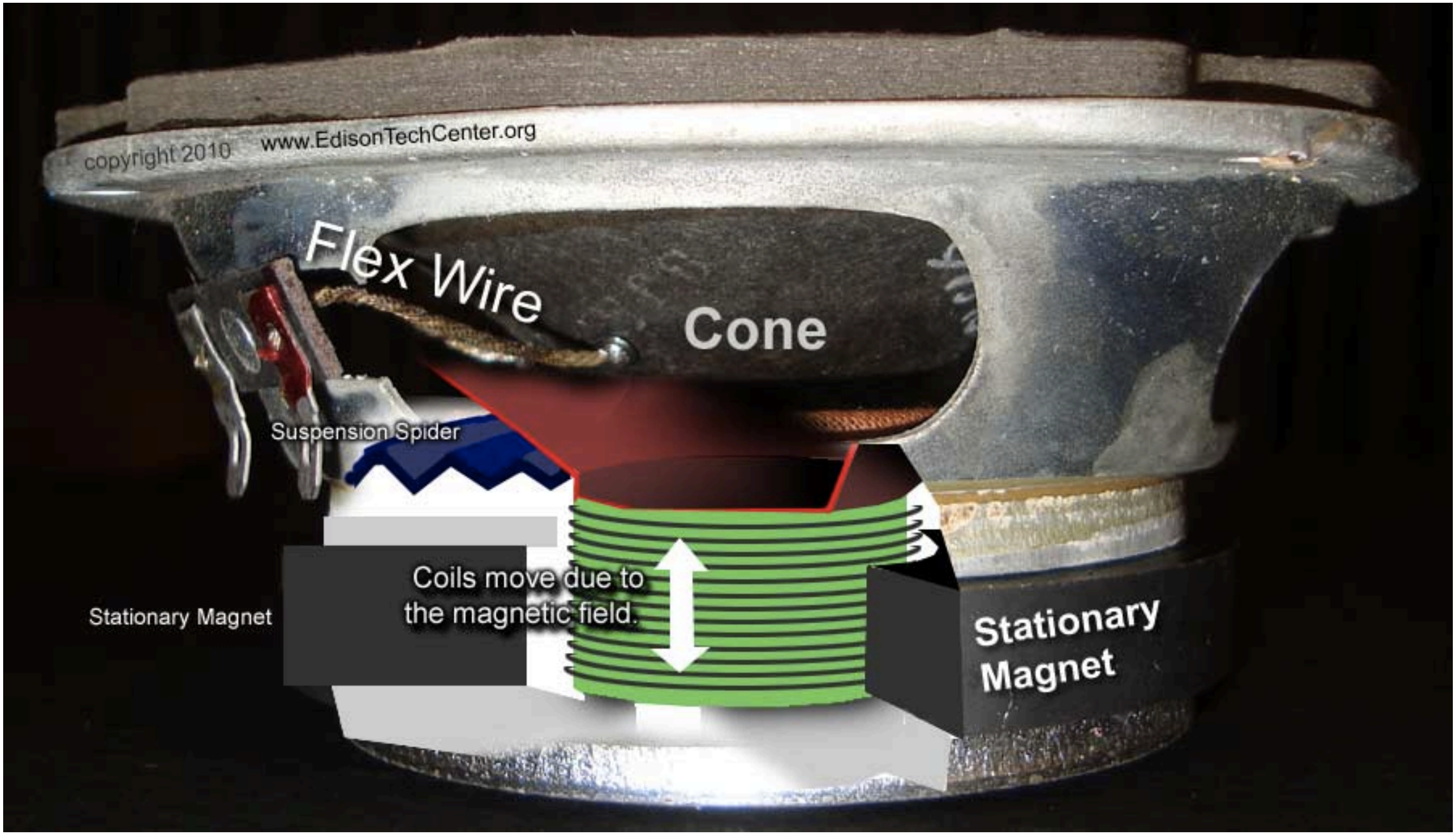
f.) When the current direction changes, the direction of the induced magnetic field in the coil will change and the "pulling back" will proceed through equilibrium and into a flexing inward. The degree of flexing will, again, depend upon how much current to moving through the coil at a given instant.



g.) As the cone flexes inward, it will create a rarified region of air generating a low pressure region. That region will travel away from the cone at approximately 330 m/s, or the speed of sound in air.

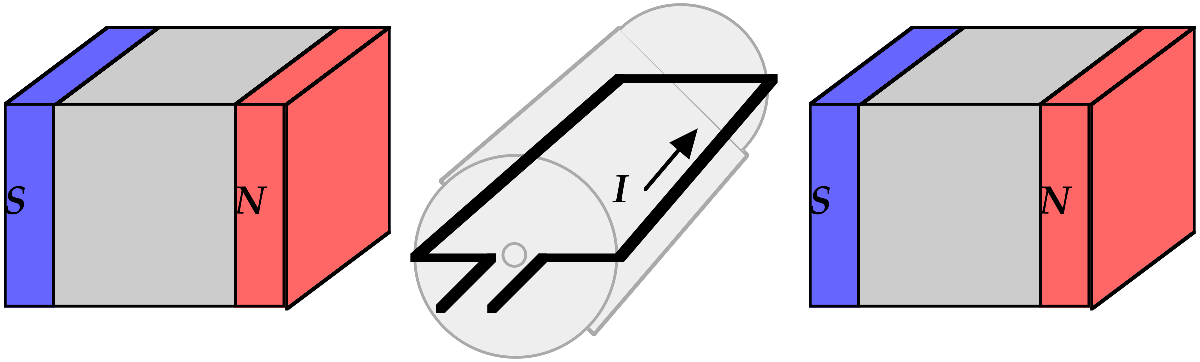
h.) This flexing outward, then inward, then outward will occur at the current frequency, or 256 Hz in our example, and the pressure variations will pass by your ear at a frequency of 256 Hz. That, in turn, will wiggle the little hairs in your ears creating electrical impulses that your brain will interpret as sound. Clever of nature, eh?

Anatomy of a real speaker



Basic electric motor

Electric motors convert electrical energy to kinetic energy, and are created by placing a current-carrying loop in an external magnetic field. There are a number of different ways of doing this, but here is one common type:

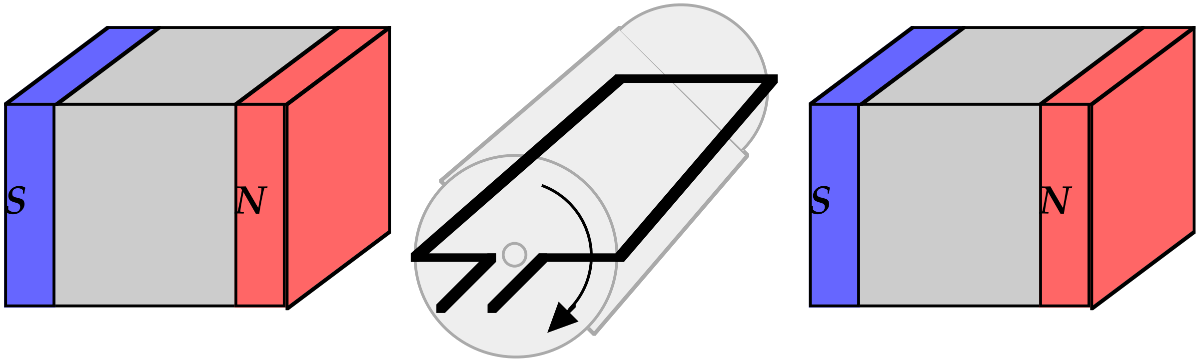


So, for a motor, current in creates rotation!

Thanks to Mr. White and Mr. Fletcher for these and the following images

Basic electric generator

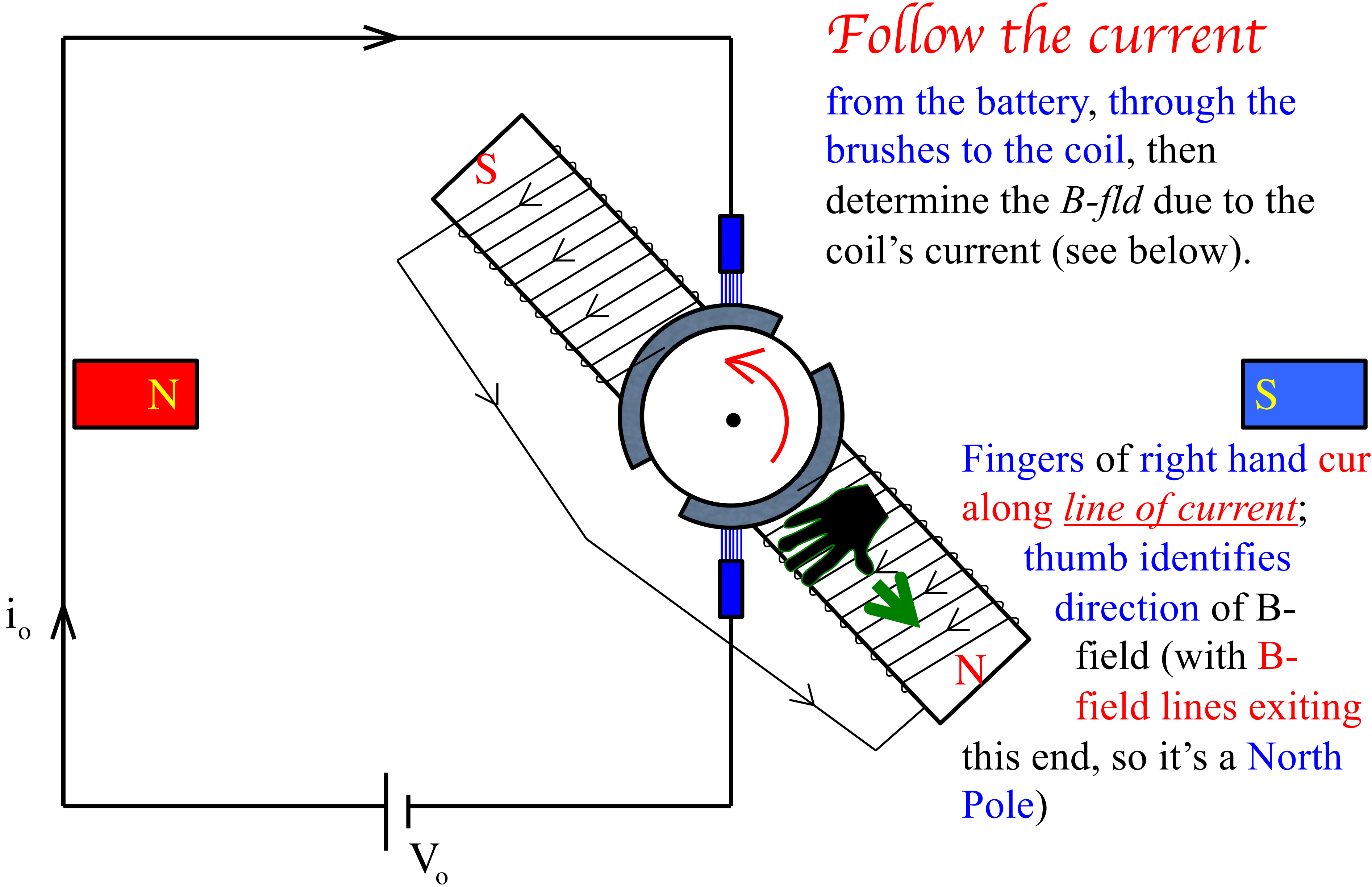
Electric generators convert mechanical energy (work provided by an external source) to electrical energy. Motors and generators, in most cases, have the same physical structure. (In other words, as far as energy conversion goes, a *motor* is just a *generator* run "in reverse.")



So, for a generator, rotation produces a current! (more on this in next unit…)

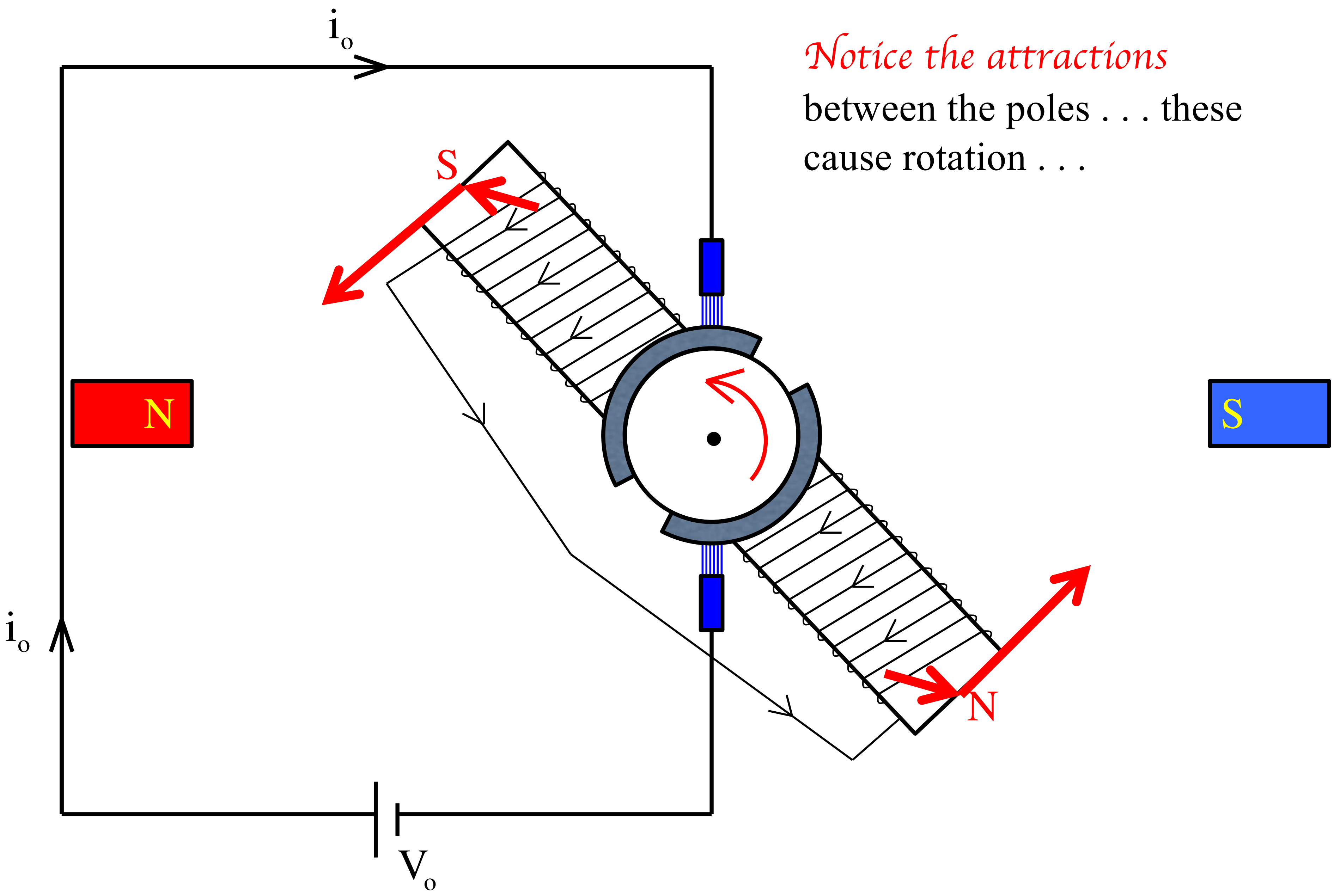
On the following slides is an example of a slightly more complex motor, which may become clearer next unit as well...

Follow the current

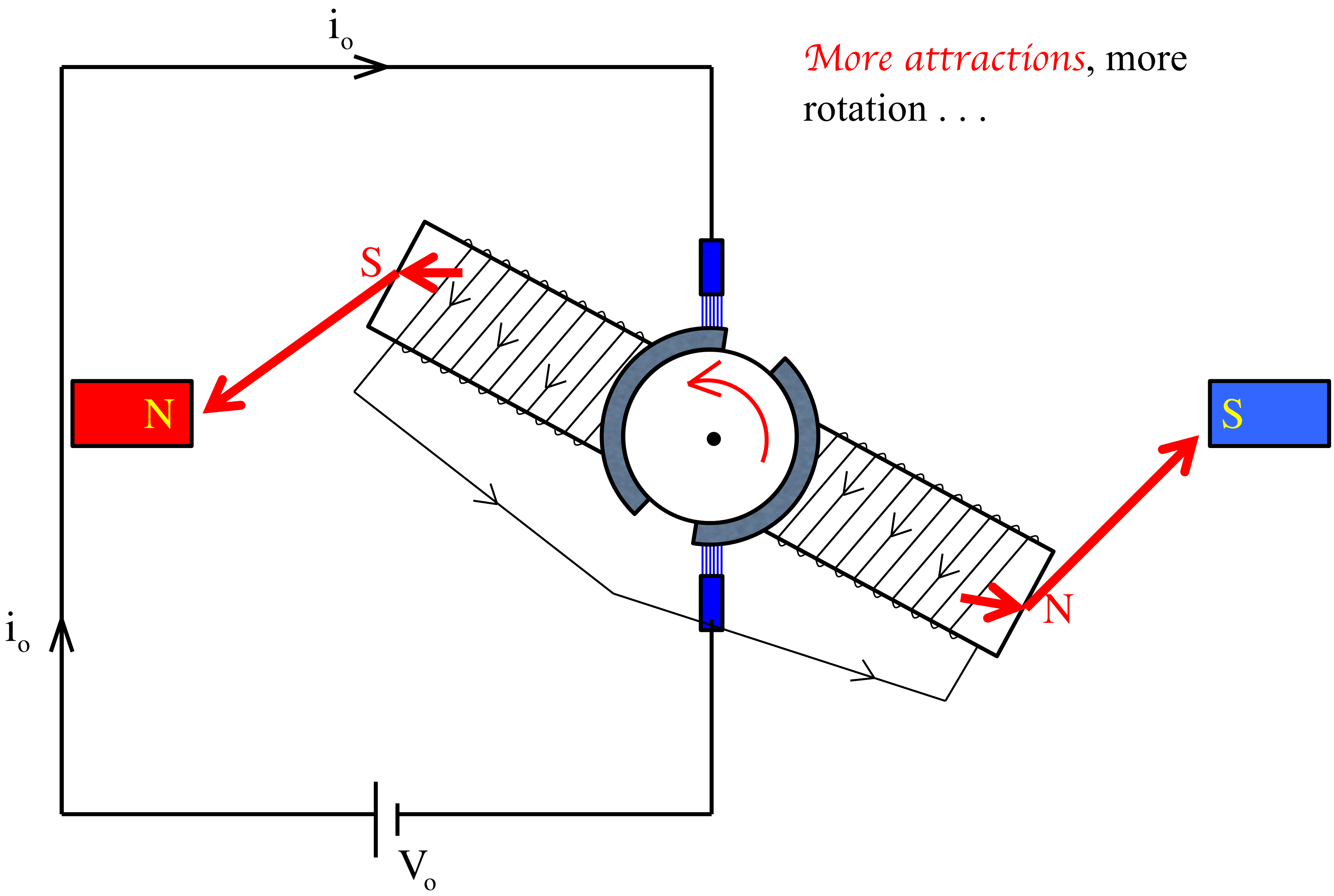


from the battery, through the brushes to the coil, then determine the *B-fld* due to the coil's current (see below).

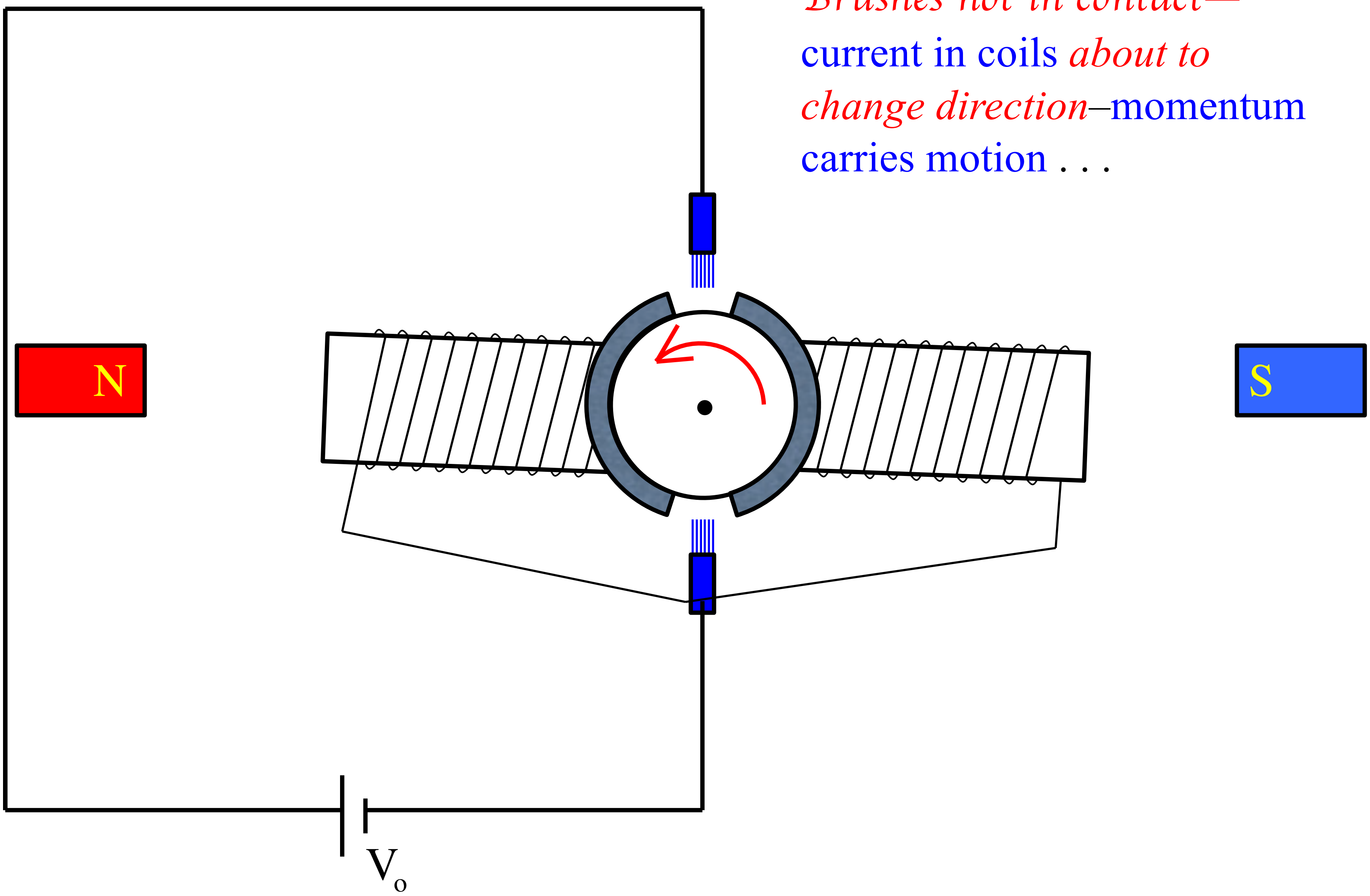
Fingers of right hand curl along *line of current*; thumb identifies direction of B-field (with B-field lines exiting this end, so it's a North Pole)



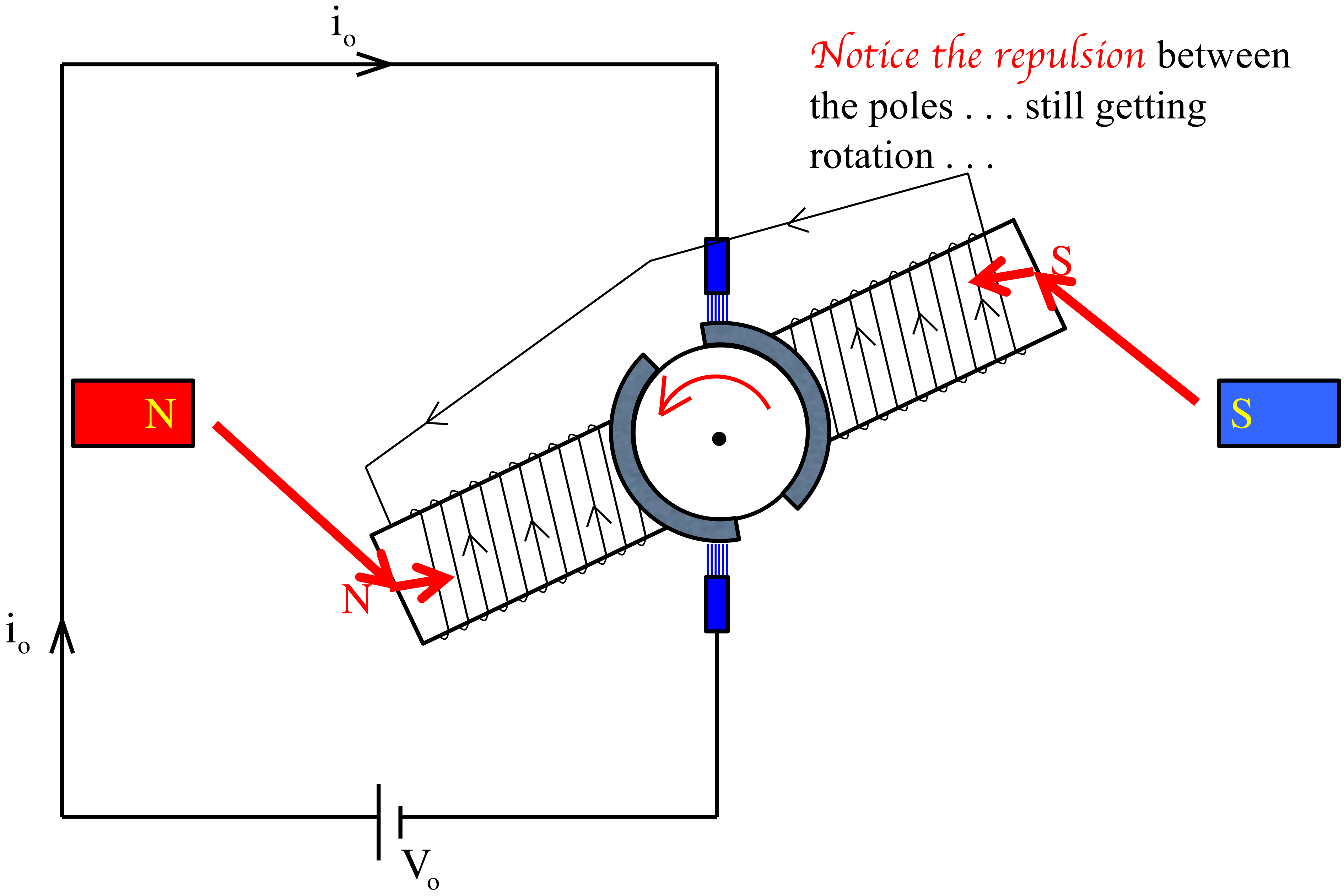
Notice the attractions between the poles . . . these cause rotation . . .



More attractions, more rotation . . .

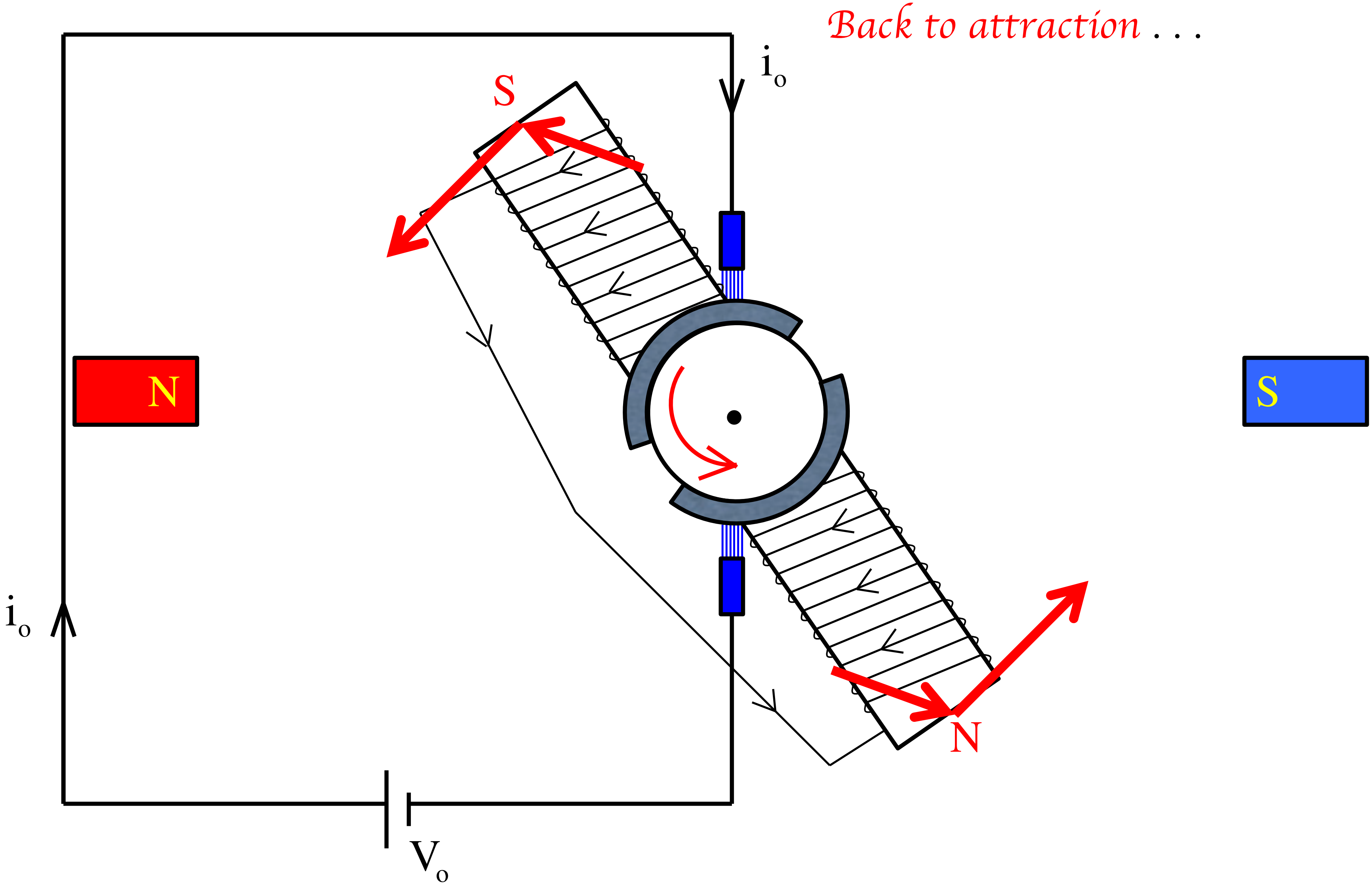


Brushes not in contact— current in coils *about to change direction*–momentum carries motion . . .



Notice the repulsion between the poles . . . still getting rotation . . .

Back to attraction . . .



This is a DC motor. . .

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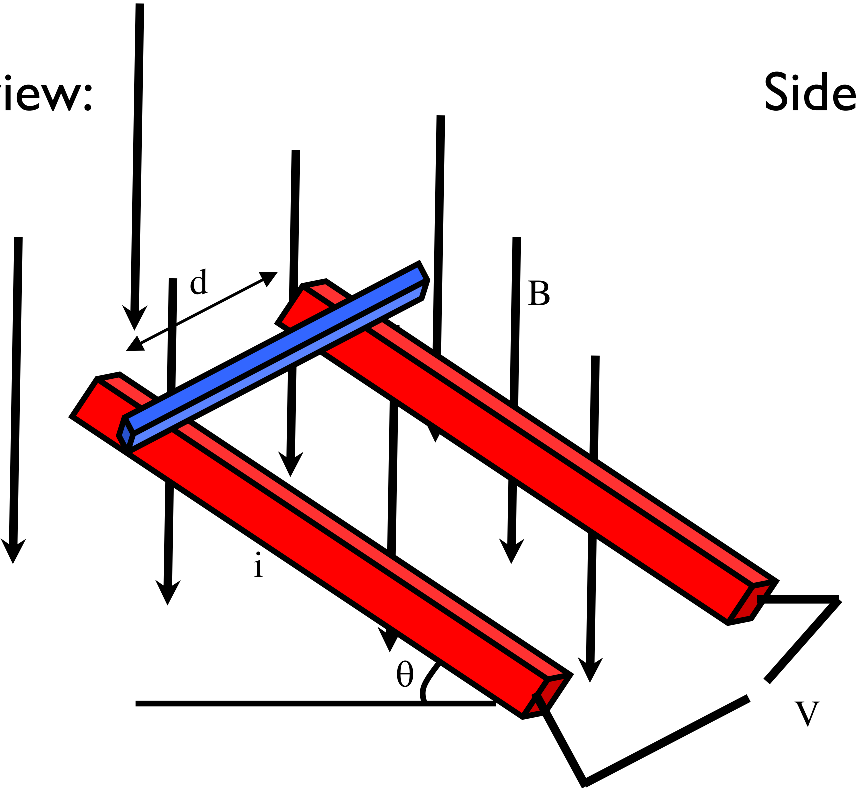
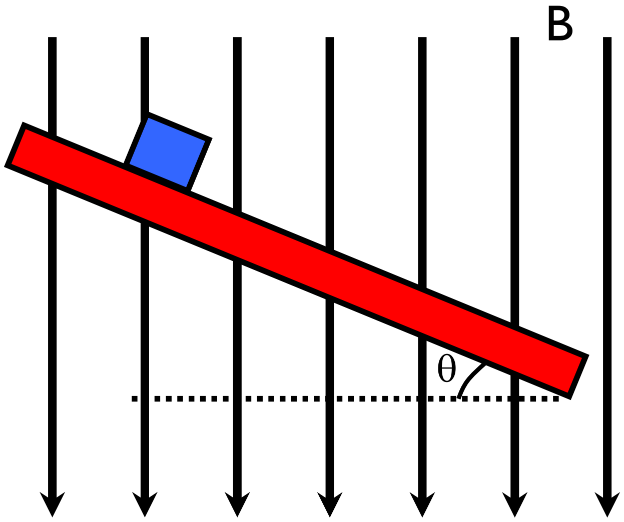
Rod down ramp example

Two metal ramps (red in the sketch) elevated at an angle **θ** are “d” units apart and are bathed in a downward magnetic field “B.” A wire from a battery terminal is connected to each ramp. A metal rod (blue in the sketch) is placed across the ramps so that a current “i” runs through the entire assembly, all as shown below. Assuming the net resistance within the system is “R,” (a.) what current direction (hence battery polarity) will create a magnetic force that will counteract gravity (“i” into or out of the rod on the sketch on the right), and (b.) what voltage will generate a magnetic force that just negates gravity and, hence, keeps the rod stationary?

3-d view:

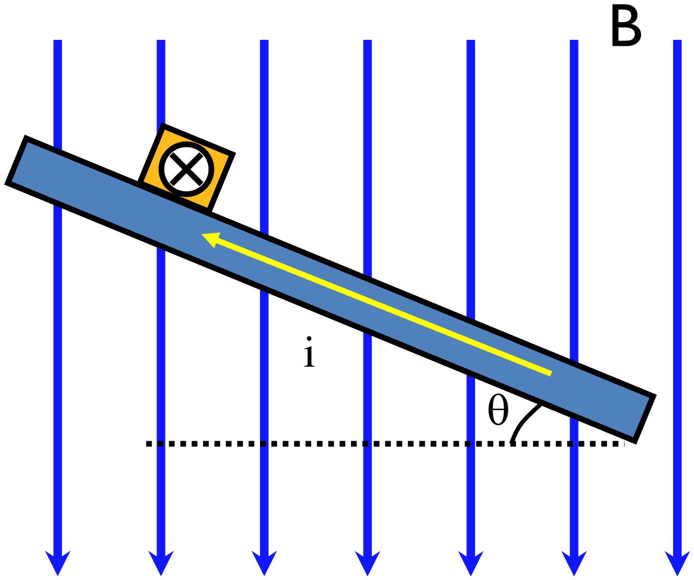


Side view:

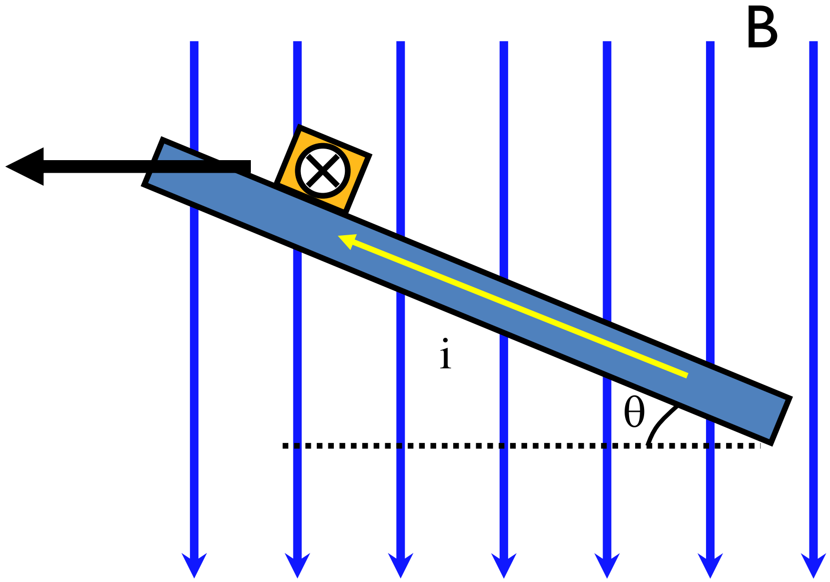


Using F = iLxB, a current INTO the page will produce a magnetic force in the horizontal to the left, where L = d as defined in this case (look back to the original statement of the problem).

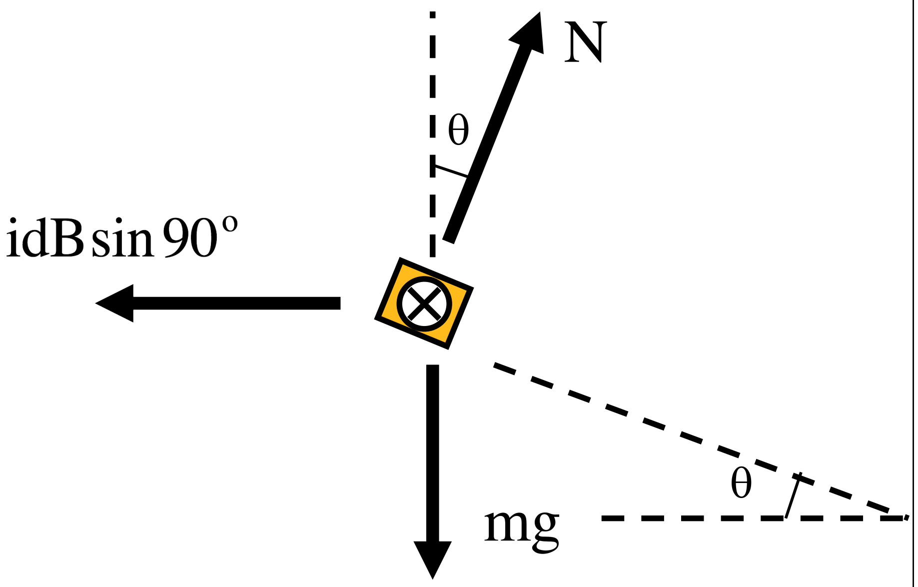
(Additionally, this current direction means the high voltage terminal of the battery should be on the left side of the battery as viewed on the previous page.)



With the magnetic force on the rod as shown in the sketch to the right, a f.b.d. on the rod is shown on the next page.



Breaking things into their component parts, using N.S.L. and noting that the accelerations will all be zero as we are looking at an equilibrium situation, we can write:



$$\sum F_y :$$

$$-mg + N\cos\theta = 0$$

$$\Rightarrow \quad N = \frac{mg}{\cos\theta}$$

$$\sum F_x :$$

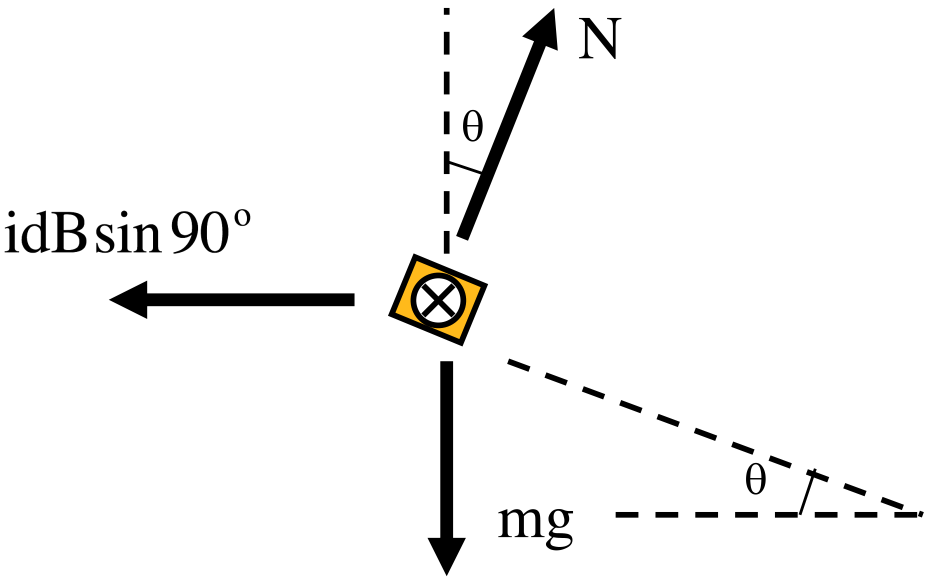
$$-i\,d\,B + N\sin\theta = 0$$

$$\Rightarrow \quad i = \frac{N\sin\theta}{dB}$$

$$\Rightarrow \quad i = \frac{\left(mg/\cos\theta\right)\sin\theta}{dB}$$

$$\Rightarrow \quad i = \frac{mg\tan\theta}{dB}$$

We know from Ohm's Law that the current and battery voltage are related by V = i R, so we can write that the battery voltage to make the rod stay fixed in the system must be:



$$V = iR$$

$$= \left(\frac{mg\tan\theta}{dB}\right)R$$