

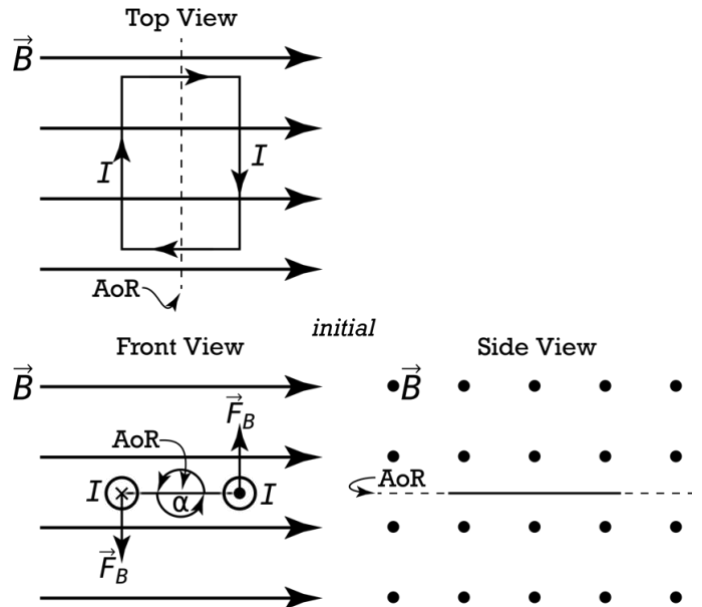


We already walked through how this is an example of a [basic electric motor](#). Now let's look at how the magnetic flux changes from the initial to final positions.

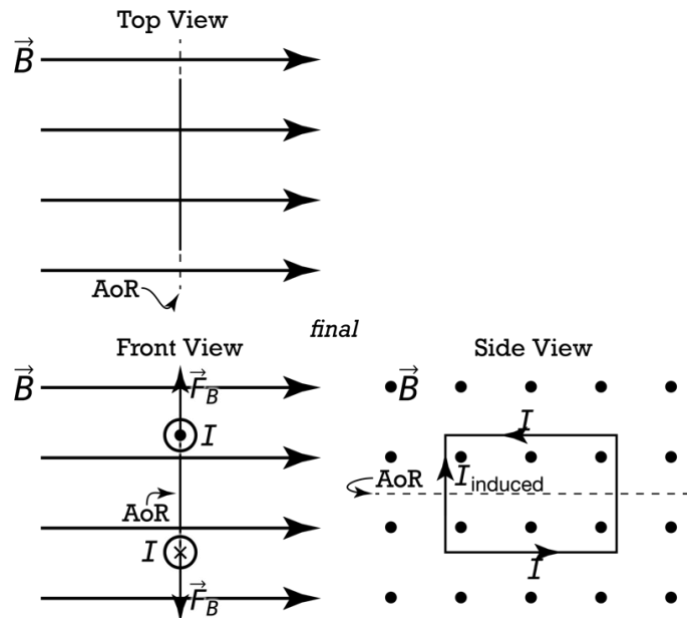
The initial magnetic flux through the loop is zero. The final magnetic flux through the loop is nonzero. The magnetic flux through the loop changes, which means there is an induced magnetic field, an induced emf, and an induced current in the loop. We need to use Lenz's law to determine the direction of the induced current.

In the side view, the magnetic flux is out of the page and increasing. In order to resist this change in magnetic flux, the induced magnetic field is into the screen (in the side view). According to the alternate right-hand rule, the fingers curl into the screen in the direction of the induced magnetic field inside the loop, thumb points clockwise (in the side view) in the direction of the induced current in the loop.

In other words, in electric motors, there is an induced emf and an induced current caused by the change in the magnetic flux in the loops of the motor, and that induced current is opposite the direction of the current placed in the loops to cause the loops to rotate. This induced current decreases the current in a turning electric motor. This concept is called *back emf* and is present in all electric motors when they are rotating.



Realize this back emf is not present when the electric motor is not rotating. In other words, when an electric motor is first starting up, the current through the electric motor is larger than when the electric motor is running at a constant angular velocity. This lack of back emf when an electric motor is not moving can cause lights which are on the same circuit to dim when an electric motor is first starting up and can even cause a circuit breaker to trip if something suddenly binds the electric motor causing it to stop rotating which brings the back emf to down zero and suddenly increases the current in the circuit above the maximum current allowed through the circuit breaker.¹



¹ Yes, I have done this. ☐