Electrical Technology
(EE-101-F)

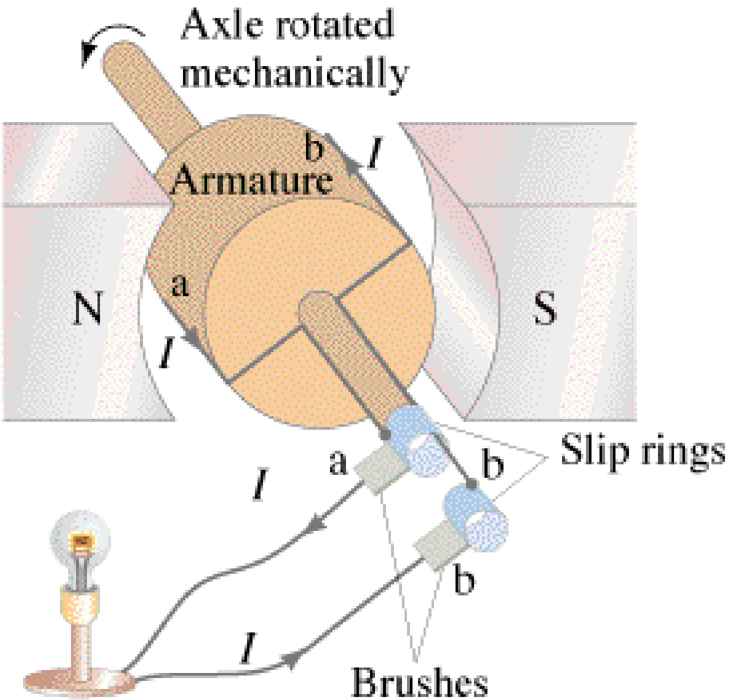
Contents

Electric Generators

- Convert mechanical energy into electrical energy
- A direct result of Faraday's work on induction
- Basically, the inverse of the electric motor which converts electrical energy to mechanical energy

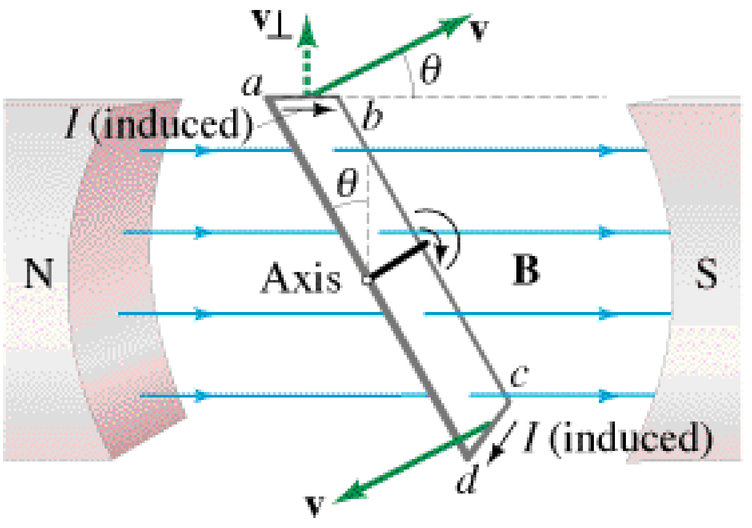
AC Generator

- We will look at a simple version



The output current is alternating and changes direction each half revolution.

AC Generator

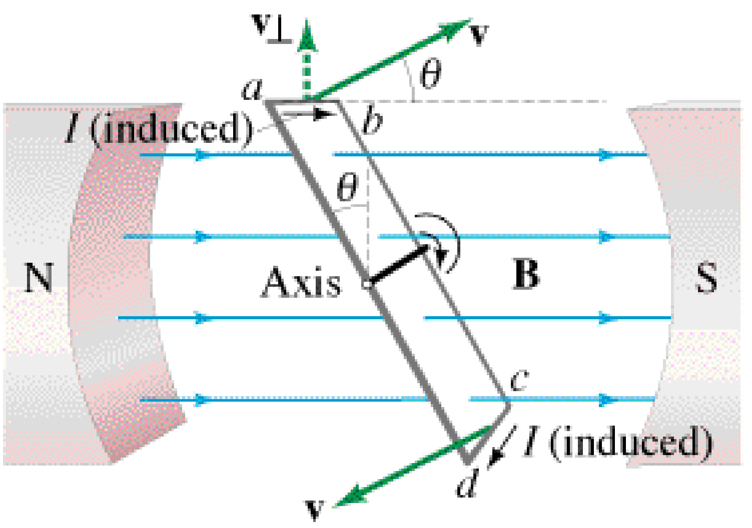


We saw earlier that we can consider Faraday's Law or we can just calculate the forces on the individual electrons making up the current. We'll do the latter here.

All the action takes place in the wire segments *ab* and *cd*.

The forces on electrons in *ad* and *bc* are sideways the the electrons don't move along the wire due to these forces.

AC Generator

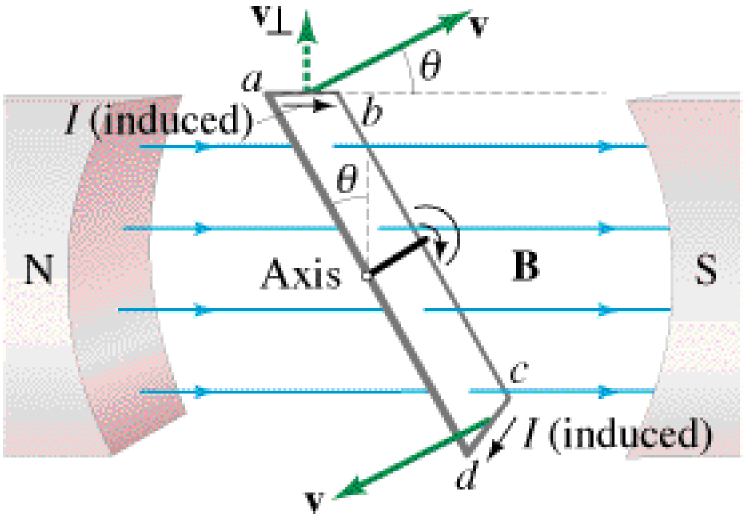


The direction of current in *ab* is from *a* to *b*. At the bottom it is from *c* to *d*. Thus current will flow in the loop.

Last time we saw that the EMF causing this current in one wire is just $Blv_{\text{perpendicular}}$. Since we have two wires, the EMF is just twice this amount. If our coil has N turns then

$$\varepsilon = 2NBlv\sin\theta$$

AC Generator



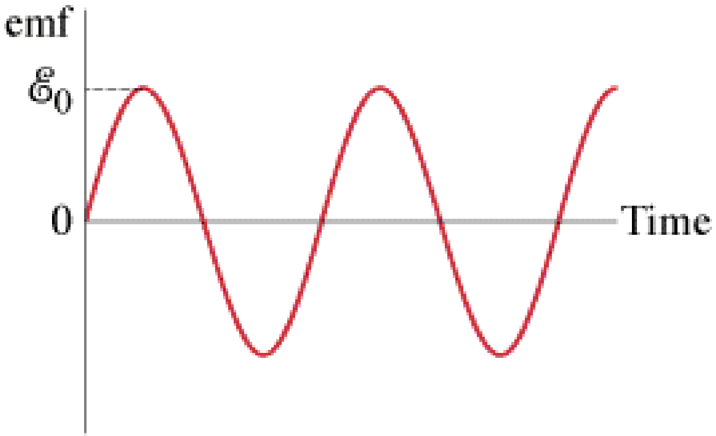
$$\varepsilon = 2NBlv\sin\theta$$

$$\theta = \omega t \text{ and } v = \omega r = \omega(h/2)$$

$$\varepsilon = 2NBl\omega(h/2)\sin\omega t$$

$$\varepsilon = NBA\omega\sin\omega t$$

$$\varepsilon = NBA\omega\sin 2\pi ft$$



Problem

A simple generator has a 720 loop square coil 21.0 cm on a side. How fast must it turn in a 0.650-T field to produce a 120-V peak output?

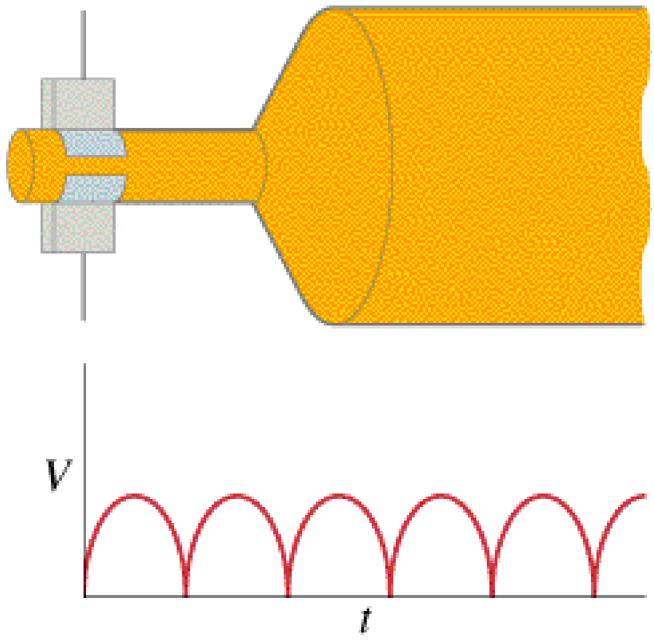
$$\varepsilon = NBA\omega \sin \omega t$$

$$\varepsilon_{peak} = NBA\omega$$

$$\omega = \frac{\varepsilon_{peak}}{NBA}$$

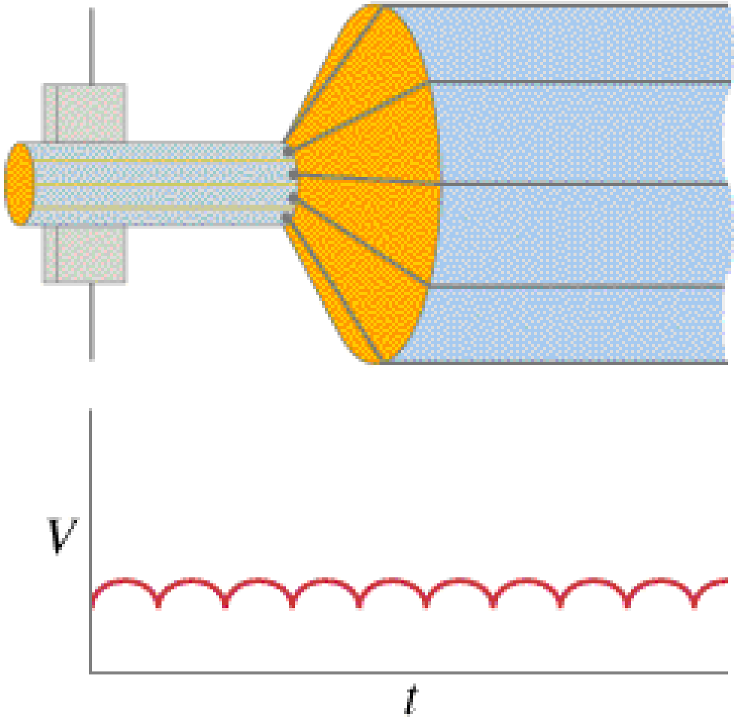
$$\omega = \frac{120}{720 \cdot 0.650 \cdot (0.21)^2} = 5.81 \text{ rad/sec}$$

DC Generators



Replace the brushes with slip rings and you get a DC generator. Notice the voltage is not steady. The coil is shown at the top and bottom of the shaft.

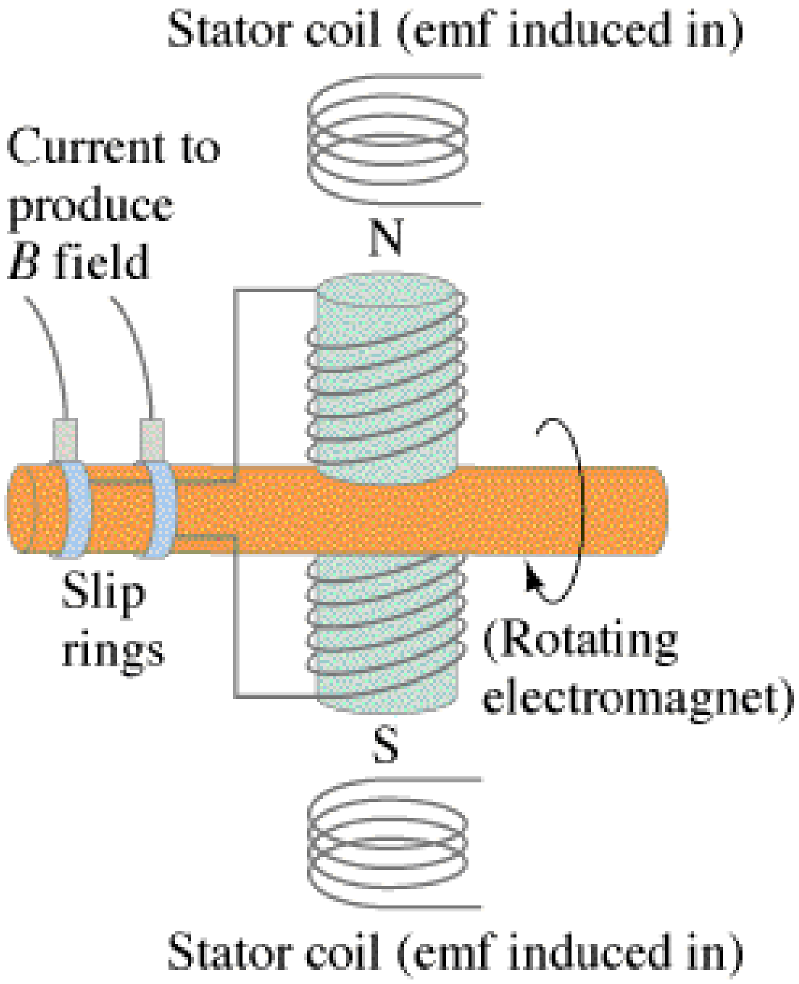
DC Generators



If we increase the number of turns and arrange them as shown, we can smooth out the variations in voltage.

In the old days, autos used DC generators to recharge the battery.

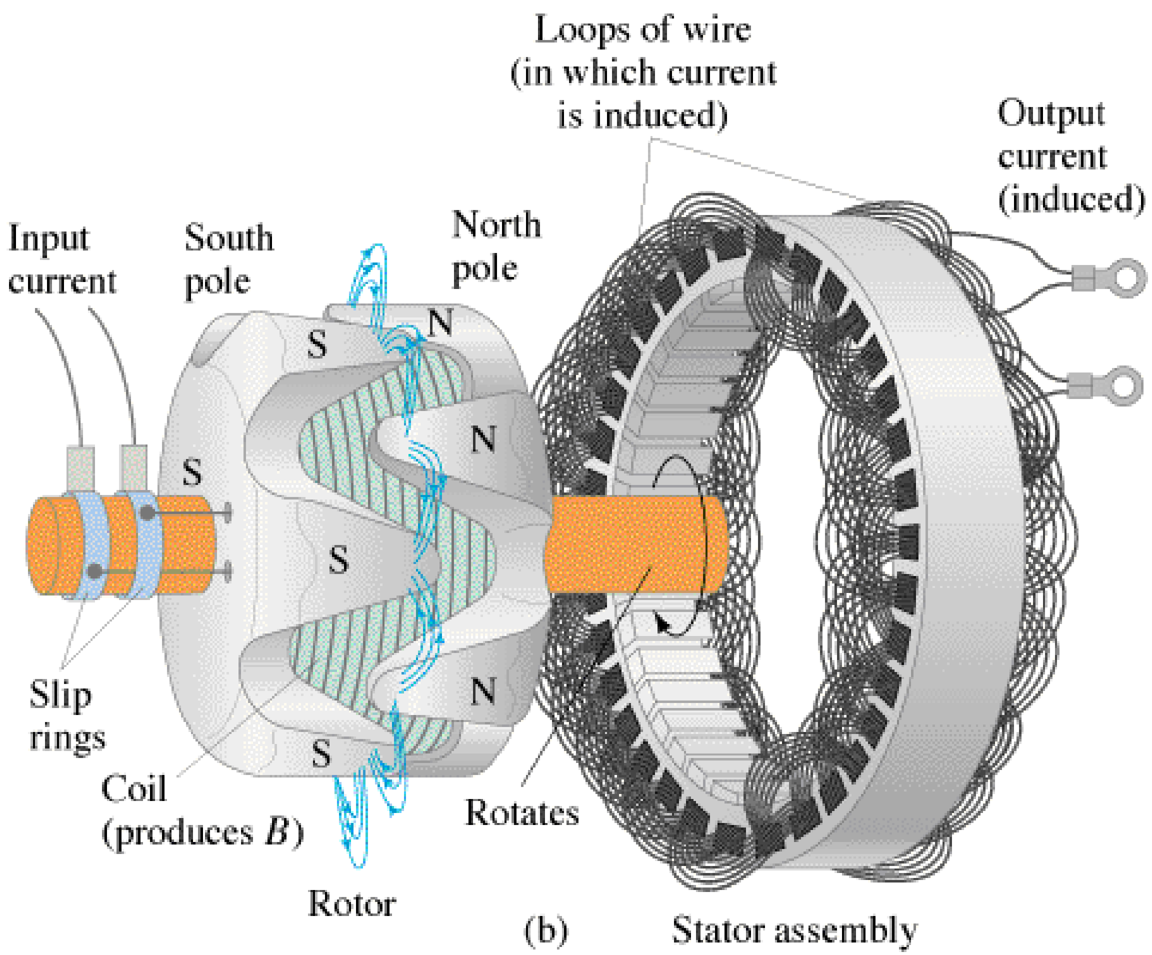
Alternators



An alternating voltage is produced in the stator coils. We then connect the stator coils to a diode (details later) which converts the AC to fluctuating DC.

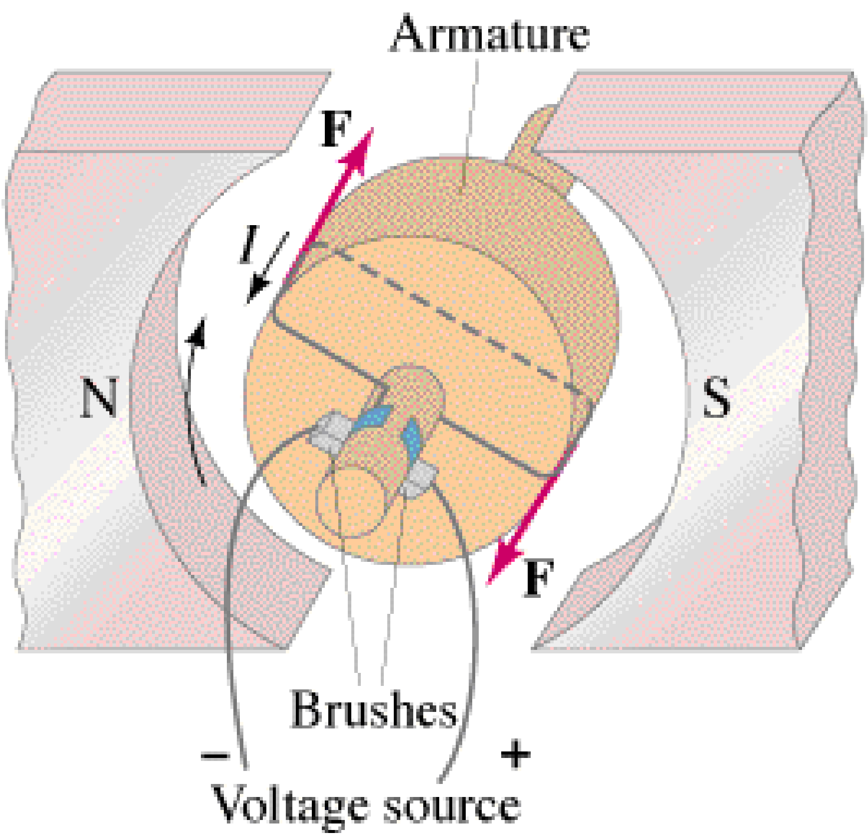
We can also add more stator coils carefully arranged.

Alternators



Now, the AC voltage is dramatically smoothed due to the arrangement of the stator coils.

Counter EMF



In this DC motor, the current produces a torque. If you keep applying a torque, the angular velocity continues to increase! However, as the coil turns, the magnetic flux changes and an EMF is produced. By Lenz's Law, this opposes the change. So an equilibrium speed is obtained. See examples in the textbook.

Counter EMF

- In a generator when current flows to an external load, the current in the coils experiences a torque (just like in a motor).

- This torque opposes the mechanical motion causing the induced current.