L 29 Electricity and Magnetism [6]

- Review- magnetism
- Faraday's Law of Electromagnetic Induction
  - – induced currents
  - – electric generator
  - – eddy currents

Laws of Magnetism

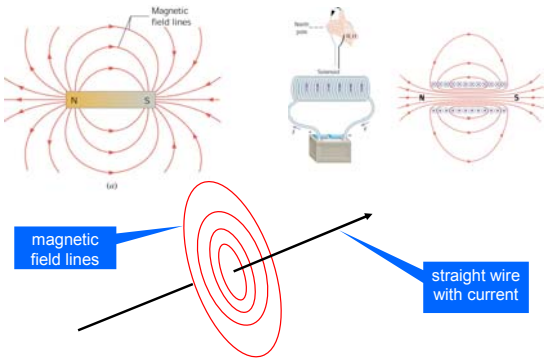
- If you pass current through a loop of wire. you get a magnet ➔ Oersted's discovery
- Basic laws of magnetism

➔electric currents produce magnetic fields (Ampere)

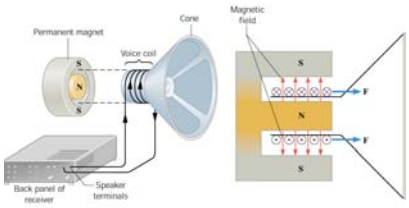
➔magnetic field lines are always closed loops

- permanent magnets: the currents are *atomic currents* – due to electrons spinning in atoms- these currents are always there
- electromagnets: the currents flow through wires and require a power source, e.g. a battery

Bar Magnet Electromagnet

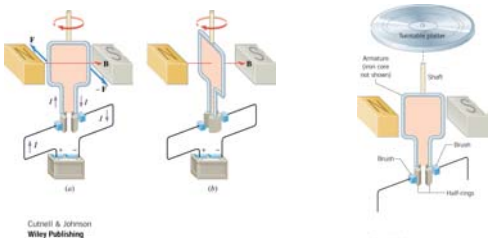


Speakers use magnets to make sound



The force between the permanent magnet and the voice coil moves the speaker cone

The electric motor

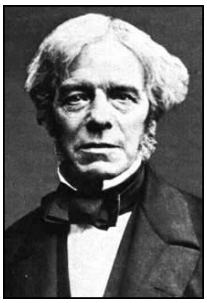


When a current is present in a coil, it experiences a torque and rotates.

Faraday's Law of Electromagnetic induction

- Faraday thought that if currents could produce magnetic fields, magnetic fields should be able to produce currents
- He was correct with one important requirement ➔ *the magnetic field must be changing in some way to induce a current*
- the phenomenon that a changing magnetic field can induce a current is called **electromagnetic induction**

Michael Faraday (1791-1867)

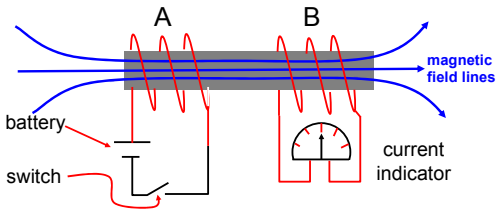


- discovered **electromagnetic induction**
- led to the discovery of the generation of electricity
- son of a blacksmith
- had very little formal education – trained to be a bookbinder
- considered one of the greatest scientists of all time
- declined to accept knighthood.
- gave Christmas lectures for kids

The laws of electricity and magnetism

- law of electricity.— electric charges produce *electric "fields"*
- laws of magnetism.—
  - – currents produce magnetic fields
  - – magnetic field lines are closed loops
- Faraday's law of electromagnetic induction.— a changing magnetic field can produce a current (*induced currents*)

Induced currents (a)



→ When a current is turned on or off in coil A, a current **briefly** appears in coil B

→The current in coil B is called an **induced current.** The current in B is only present when the current in A is changing.

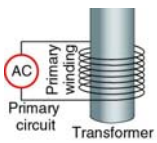
Induced currents (b)

a) No current is induced if the magnet is stationary.

b) When the magnet is pushed toward the coil or pulled away from it an induced current appears in the coil.

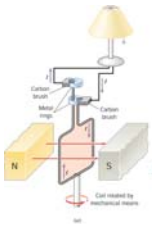
c) The induced current only appears when the magnet is being moved

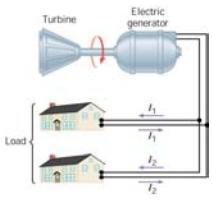
Induced currents (c)



- If an AC (time varying) current is used in the primary circuit, a current is induced in the secondary windings.
- If the current in the primary windings were DC, there would be NO induced current in the secondary circuit.

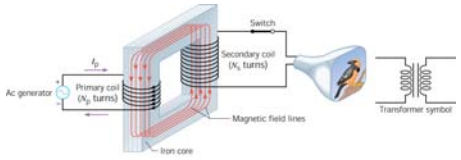
electric generators





When a coil is rotated in a magnetic field, an induced current appears in it. This is how electricity is generated. Some external source of energy is needed to rotate the turbine which turns the coil.

The transformer



The voltage on the secondary depends on the number of turns on the primary and secondary.

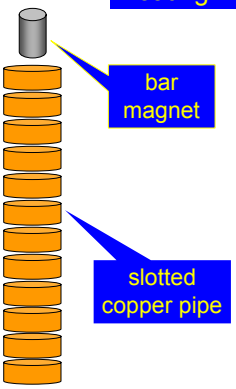
Step-up→ the secondary has more turns than the primary
Step-down→ the secondary has less turns than the primary

Eddy currents

- When time varying magnetic fields are around, currents can appear in nearby conductors --- these are eddy currents
- an induction stove uses eddy currents to cook food

Only the metal pot gets hot, not the glass pot or the stove.

Floating magnet – induced currents



As the magnet falls, it induces currents in the copper pipe known as eddy currents. These currents produce a magnetic field that opposes that of the falling magnet, so the magnet does not accelerate but descends slowly