Topic 6 - Generators and Motors

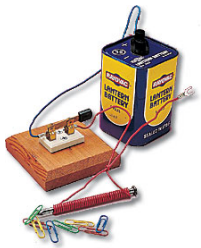
A device that converts mechanical energy (energy of motion – windmills, turbines, nuclear power, falling water, or tides) into electrical energy is called an *electric generator*. The operation of a generator depends on the relationship between electricity and magnetism.

Electricity to Magnetism

Deflection of a compass needle using electrical current showed that there is a relationship between electricity and magnetism. Hans Christian Oersted found that the current created a magnetic field around the wire. The amount of needle deflection depended on how much electric current was flowing in the wire. When the current was reversed, the needle moved in the opposite direction.

Electromagnets

When a soft iron core is inserted into a coil of wire and a current is passed through the wire, a very strong temporary magnet is produced, called an electromagnet.

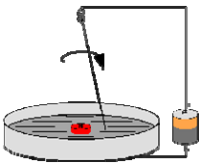


The strength of an electromagnet is affected by the …

- type and size of core
- strength of current
- number of coils

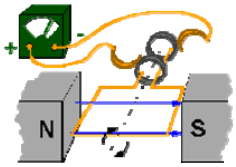
Magnetism to Electricity

Electric effects can also be created using a magnet. Michael Faraday (and Joseph Henry) discovered *electromagnetic induction* in 1831. They demonstrated that moving a conducting wire through a magnetic field by moving it back and forth through the field, Faraday created the first electricity-producing generator, which could generate electrical current. They also found that moving the magnet worked as well.



Faraday introduced terms such as ‘ion’, ‘electrode’, ‘cathode’, and ‘anode’ to science and invented the lines of magnetic force. The farad, a unit for measuring stored electric charge, was named after him.

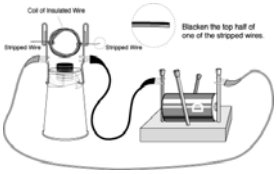
What’s in a Generator?



An AC generator – the most common type – has a coil of wire rotating inside a stationary field magnet. The central axle of an AC generator has a loop of wire attached to two slip rings. The current is switched as the loops move up and down alternatively through the magnetic field. The slip rings conduct the alternating current to the circuit through the brushes (the brush and ring assembly allows the whole loop to spin freely).

The electricity produced by this type of generator is called *alternating current* because it changes direction (in North America it changes direction 120 times per second – giving 60 Hertz or complete waves each second. In large AC generators many loops of wire are wrapped around an large iron core. Massive coils of wire rotating in huge generators can produce enough electricity to power an entire city.

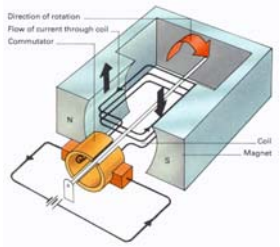
DC Generators



A DC generator is much the same as a DC motor, and is often called a dynamo. The spinning armature produces the electricity (if electricity is passed through a DC generator, it will spin like a motor). The armature is connected to a split ring commutator which enables this type of generator to send current through a circuit in only one direction. The DC generator's pulsating electricity is produced in one direction - referred to as *direct current* - and coincides with the spinning of the generator.

The St. Louis motor was designed to teach how a DC motor works

Electric Motors: Electric to Mechanical Energy



An electric motor is constructed in exactly the same way as a generator. Instead of producing electricity, it uses electrical energy to make a wire coil spins between the poles of a magnet. Current flowing through the coils makes it an electromagnet, which is then affected by the laws of magnetic forces when it is in proximity to the field magnet. *Opposite poles attract and like poles repel*. All electric motors operate on this principle.

Some motors run on direct current (*DC*). It is 'direct', because the electricity flows in only one direction. Alternating current (*AC*) flows back and forth 60 times per second

DC Motors

Faraday constructed the first motor. By coiling (copper) wire around a (iron) metal core a strong electromagnet can be made. When attached to an electrical source it will produce a strong magnetic field. To keep this electromagnet spinning in a magnetic field, the direction that the current is traveling through the coil must be switched. This is accomplished by with a gap, which allows the polarity of the electromagnet change just before it aligns with the permanent magnet.

DC motors use a commutator (a split ring that breaks the flow of electricity for a moment and then reverses the flow in the coil, when the contact is broken, so is the magnetic field) and brushes (contact points with the commutator) to reverse the flow of electricity through the magnetic field. The armature (the rotating shaft with the coil wrapped around it) continues to spin because of momentum, allowing the brushes to come into contact once again with the commutator.

AC Motors

AC motors have a rotating core, or rotor, made up of a ring of non-magnetic conducting wires connected at the ends and held in a laminated steel cylinder. Surrounding the rotor is a stationary component called a stator. The stator is a two-pole electromagnet. When the motor is turned on, the attraction and repulsion between the poles of the stator and the rotor cause the rotor to spin.