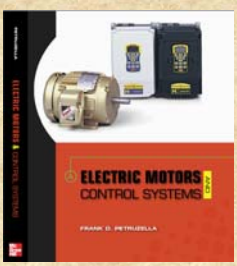


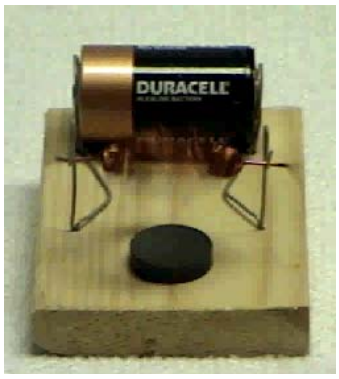
Chapter 5

Electric Motors

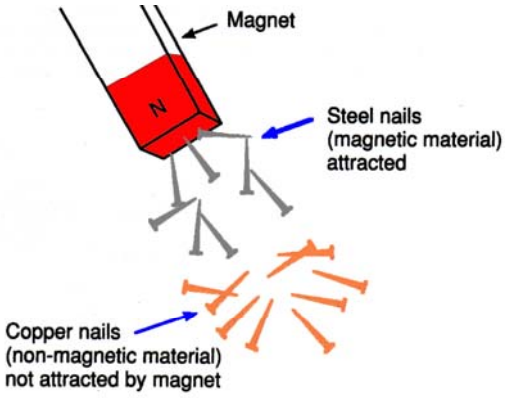
PART 1 Motor Principle

MAGNETISM

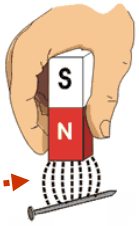
Electric motors are used to convert electric energy into mechanical energy. They use *magnetism* and electric currents to operate.

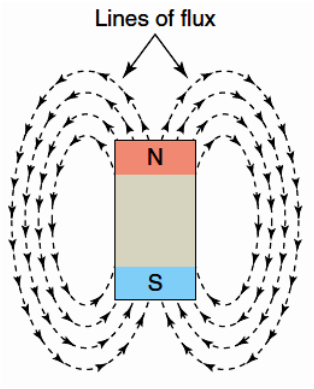


A permanent magnet will attract and hold *magnetic materials* such as iron and steel when such objects are near or in contact with the magnet.



The permanent magnet is able to attract magnetic materials because of its inherent magnetic force, which is referred to as a *magnetic field*



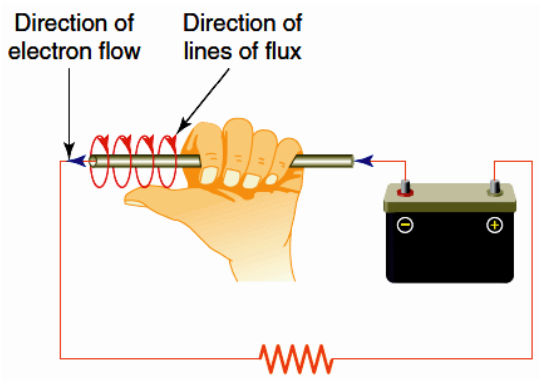


The magnetic field of a permanent bar magnet is represented by *lines of flux.*

- **The stronger the magnetic field, the greater the number of lines of flux.**
- **Lines of flux are assumed to have a direction of movement from a N-pole to a S-pole of a magnet as shown in the diagram.**

ELECTROMAGNETISM

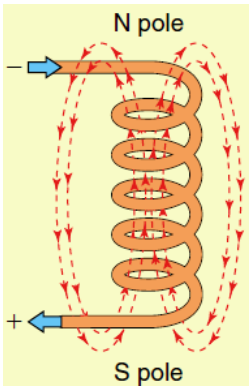
A magnetic field is also produced around a *current-carrying conductor*.



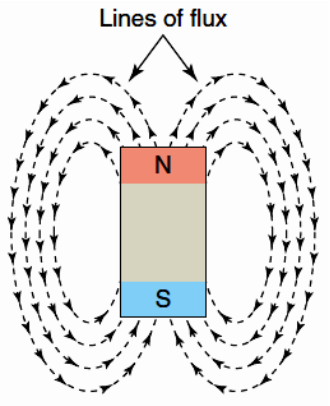
- The strength of the magnetic field is directly proportional to the amount of current flowing through the conductor.
- The shape of the magnetic takes the form of concentric circles around the wire.

The relationship between the direction of current flow through a conductor and the direction of the magnetic field created can be shown using the ***left-hand conductor rule.***

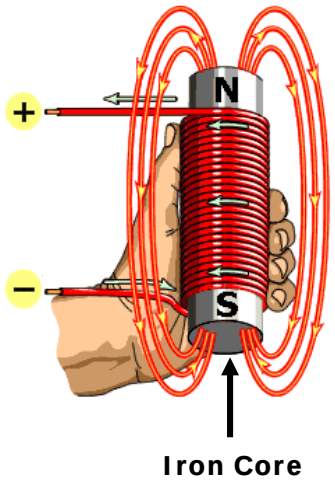
When current-carrying conductor is shaped into a *coil* all the individual flux lines produced by each section of wire join together to form one large magnetic field around the coil.



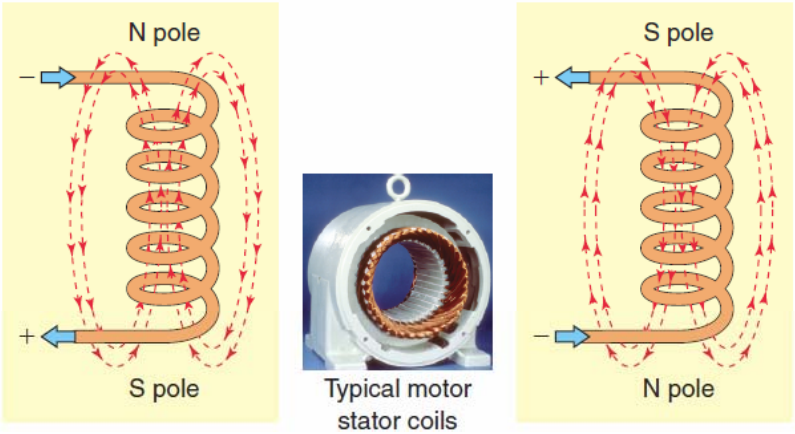
The magnetic field produced by a current-carrying coil resembles that of a permanent magnet



The magnetic field of a wire coil is much greater than the magnetic field around the wire before being formed into a coil and can be further strengthened by placing a *core of iron* in the center of the coil.



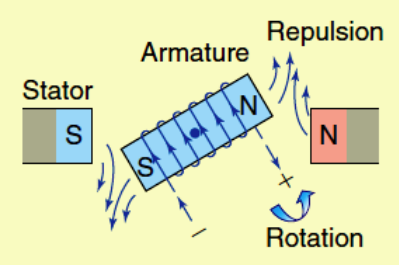
A *motor stator* is constructed using windings or coils of wire wound on a iron core.



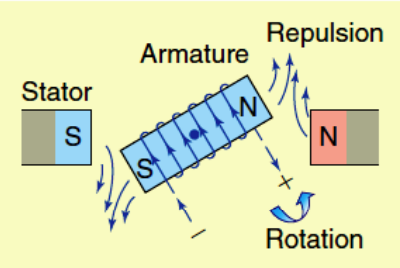
The polarity of the poles reverses whenever the current flow through the coil reverses.

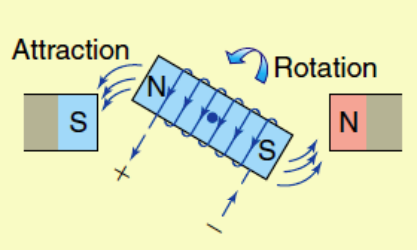
MOTOR ROTATION

An electric motor rotates as the result of the interaction of two magnetic fields.



- The electromagnet is the moving armature part and the permanent magnet the fixed stator part.
- Like magnetic poles repel each other, causing the armature to begin to turn.
- After it turns part way around, the force of attraction between the unlike poles becomes strong enough to keep the permanent magnet rotating.

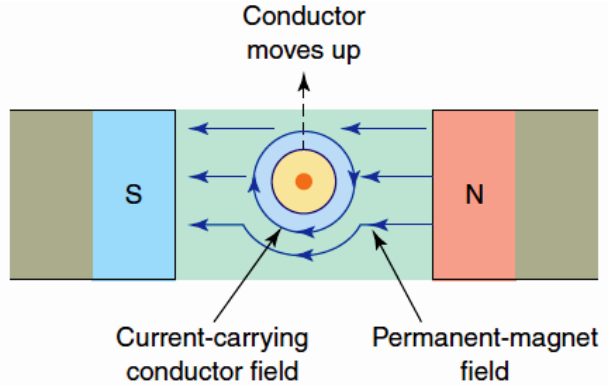




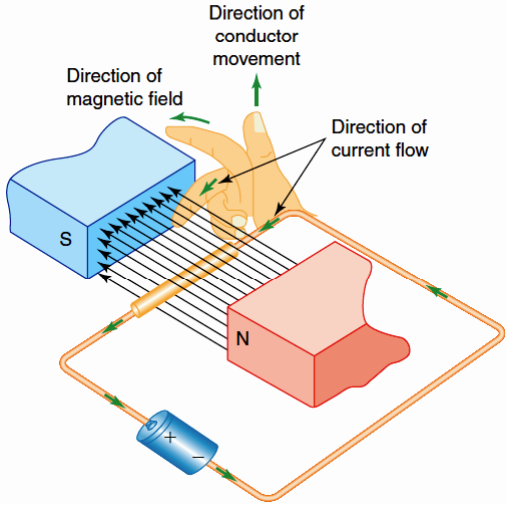
- **The rotating electromagnet continues to turn until the unlike poles are lined up. At this point the rotor would normally stop because of the attraction between the unlike poles.**
- ***Commutation*** **is the process of reversing armature current at the moment when unlike poles of the armature and field are facing each other, thereby reversing the polarity of the armature field.**
- **Like poles of the armature and field then repel each other, causing armature rotation to continue.**

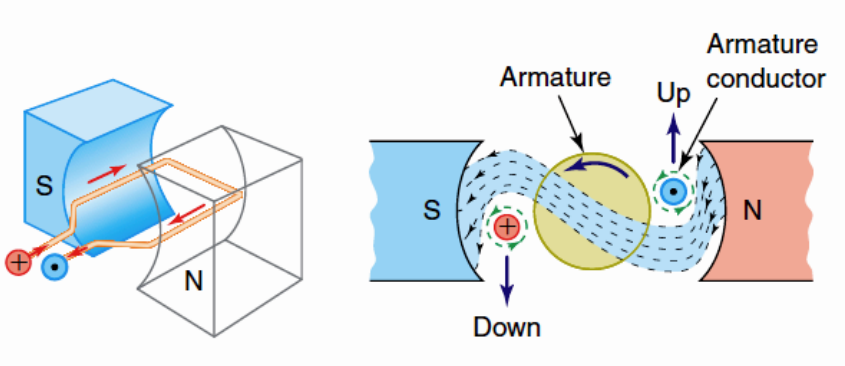
When a current-carrying conductor is placed in a magnetic field, there is an interaction between the magnetic field produced by the current and the permanent field, which leads to a force being experienced by the conductor.

The current-carrying conductor when placed in and at right angles to a magnetic field tends to move up at right angles to the field.



One method used to determine the direction of movement of a conductor carrying current in a magnetic field is the *right-hand motor rule*.

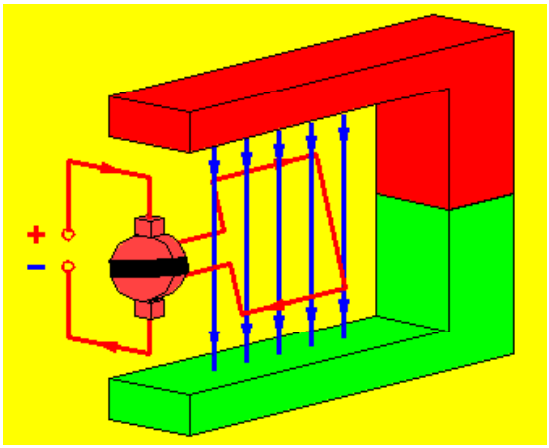


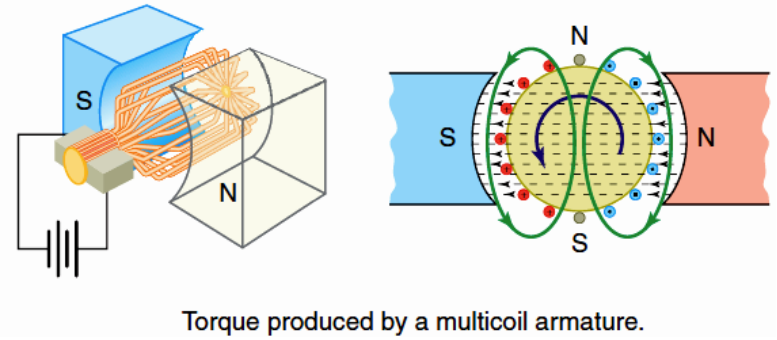


Torque produced by a single-coil armature.

- **The interaction of the two magnetic fields causes a bending of the lines of force**
- **When the lines tend to straighten out, they cause the loop to undergo a rotating motion. The left conductor is forced downward, and the right conductor is forced upward, causing a counterclockwise rotation of the armature.**

Simulated Motor Rotation





Torque produced by a multicoil armature.

- **A practical motor armature is made up of many coils of conductors**

- **The magnetic fields of these conductors combine to form a resultant armature field with north and south poles that are interact with those of the main stator field to exert a continuous torque on the armature.**

Motor Classifications

In general, motors are classified according to the type of power used (AC or DC) and the motor's principle of operation.