Actuators

By Kamlesh Bachkar

Electric Motors

DC motors converts electrical energy into mechanical energy.

Electromagnetic direct current (DC) motors

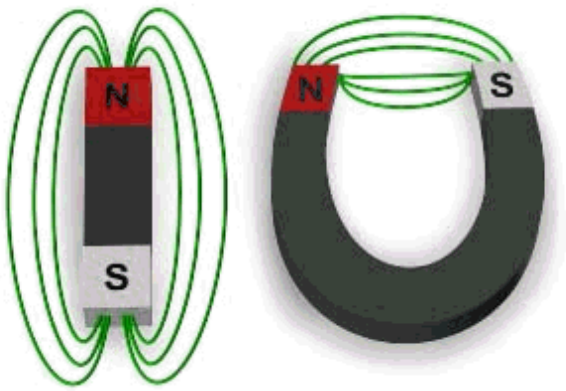
Electromagnetic alternating current (AC) motors

Type of motor to choose for an application depends on the

- How fast you want the object to move,
- The weight, size of the object to be moved,
- The cost and size of the motor,
- The accuracy of position or speed control needed.

Basic Idea

- A motor uses **magnets** to create motion.
- The fundamental law of all magnets: Opposites attract and likes repel.



- Inside an electric motor, these attracting and repelling forces create **rotational motion**.
- Two Sources: Magnetic material or Electromagnet

Electromagnets

When a current flows through a conductor, a magnetic field surrounds the conductor. As current flow increases, so does the number of lines of force in the magnetic field

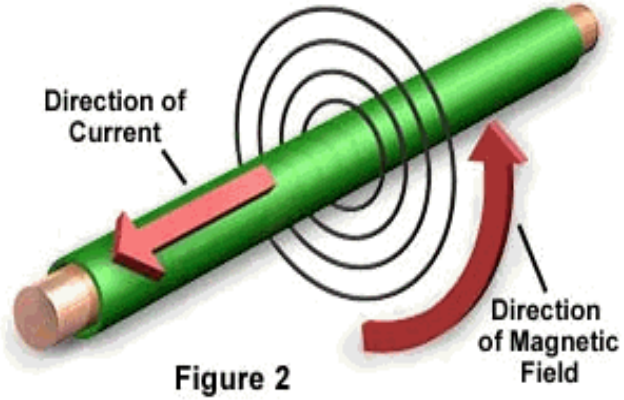
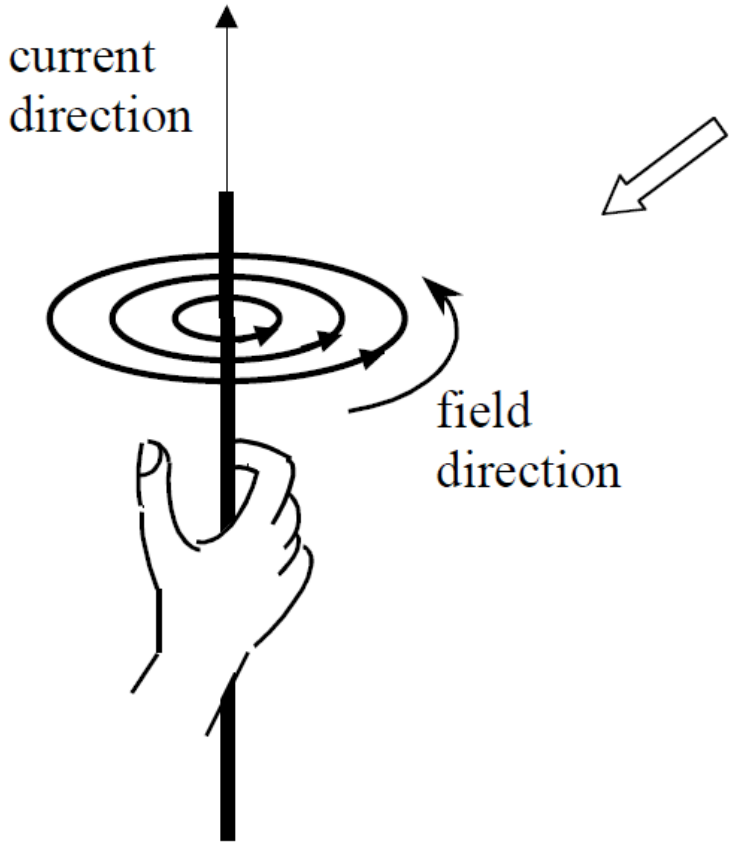


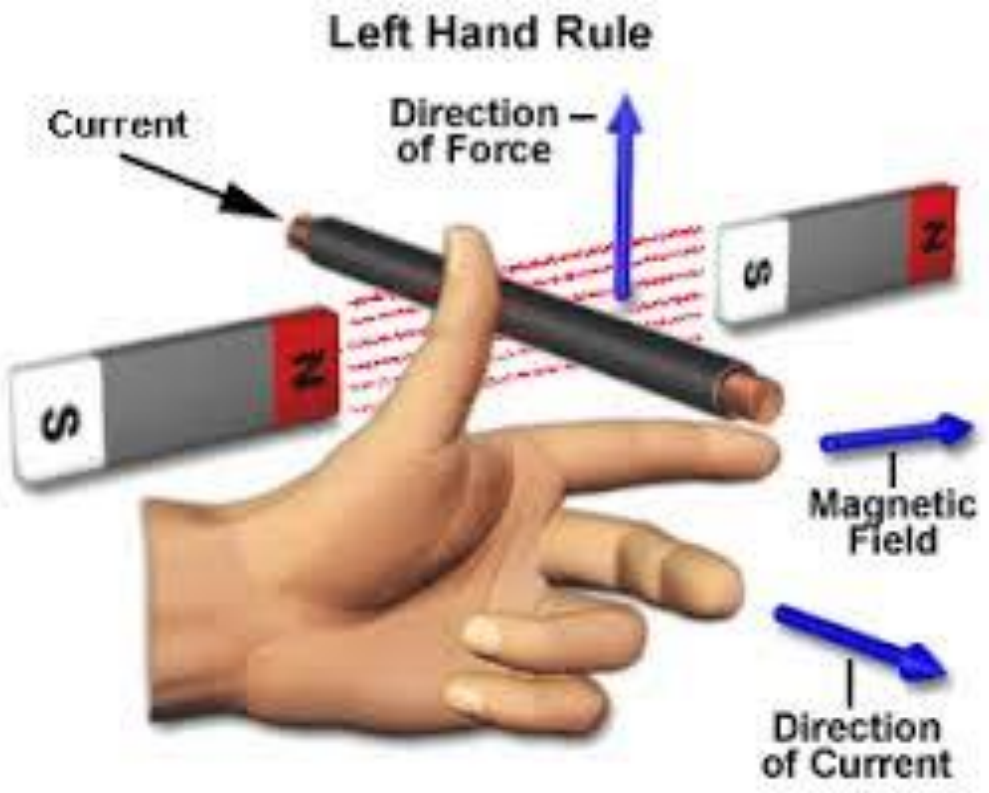
Figure 2

You can see that the field is perpendicular to the wire and that the field's direction depends on which direction the current is flowing in the wire

Right hand Rule

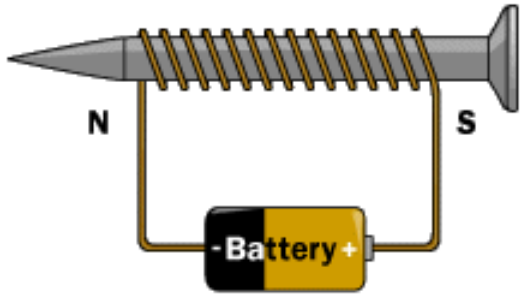


Fleming's Left hand rule

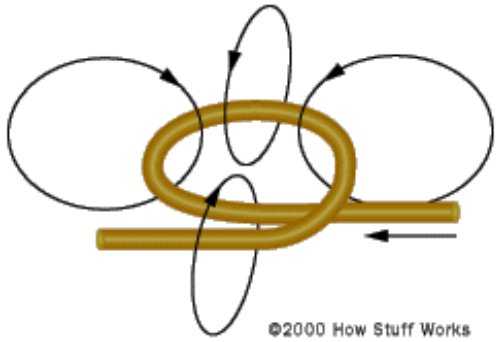


Coil the Wire

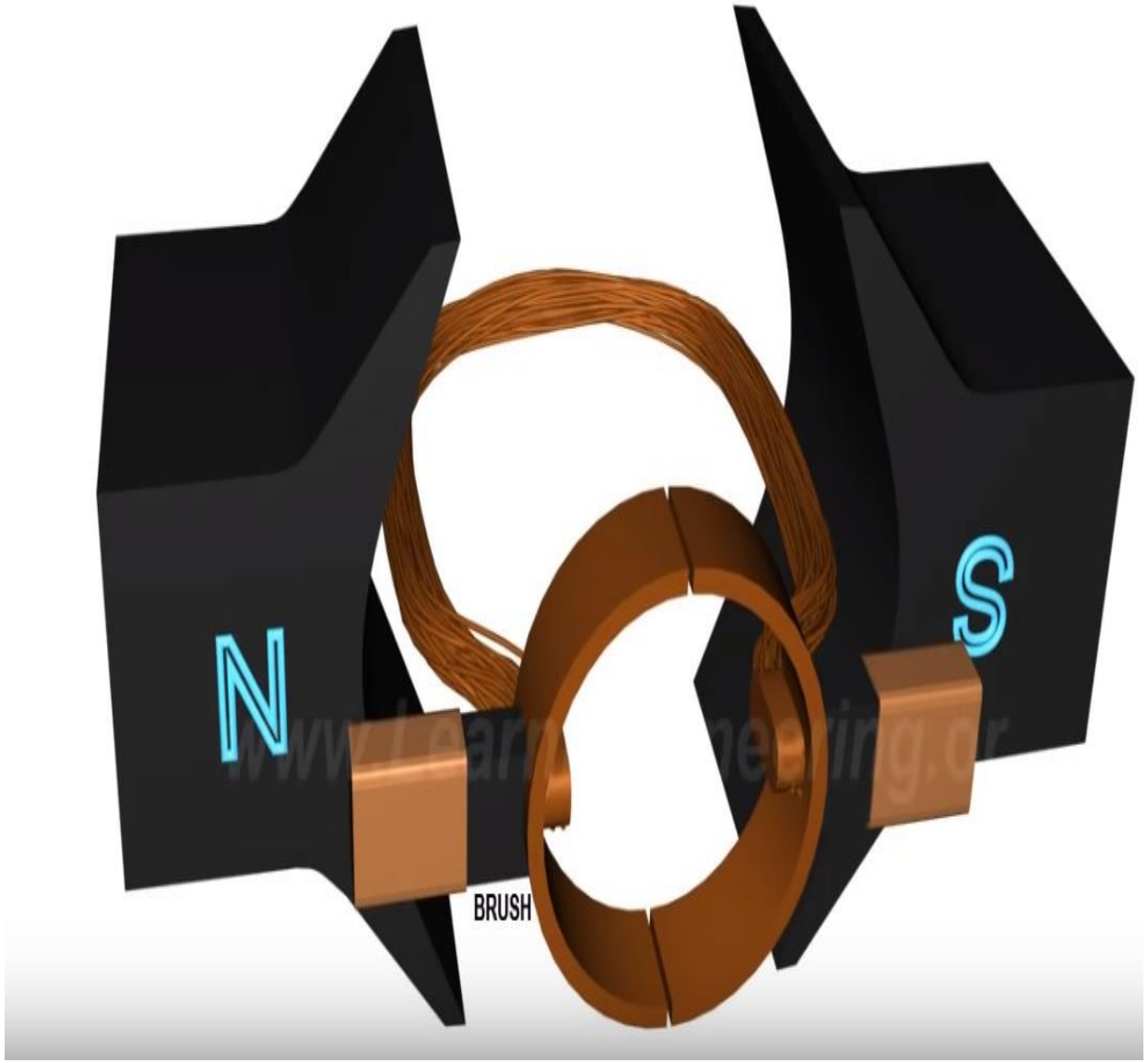
- Because the magnetic field around a wire is circular and perpendicular to the wire, an easy way to amplify the wire's magnetic field is to **coil** the wire.
- If you wrap wire around a nail 10 times, connect the wire to a battery, the nail behaves just like a bar magnet.



A simple electromagnet



One loop's magnetic field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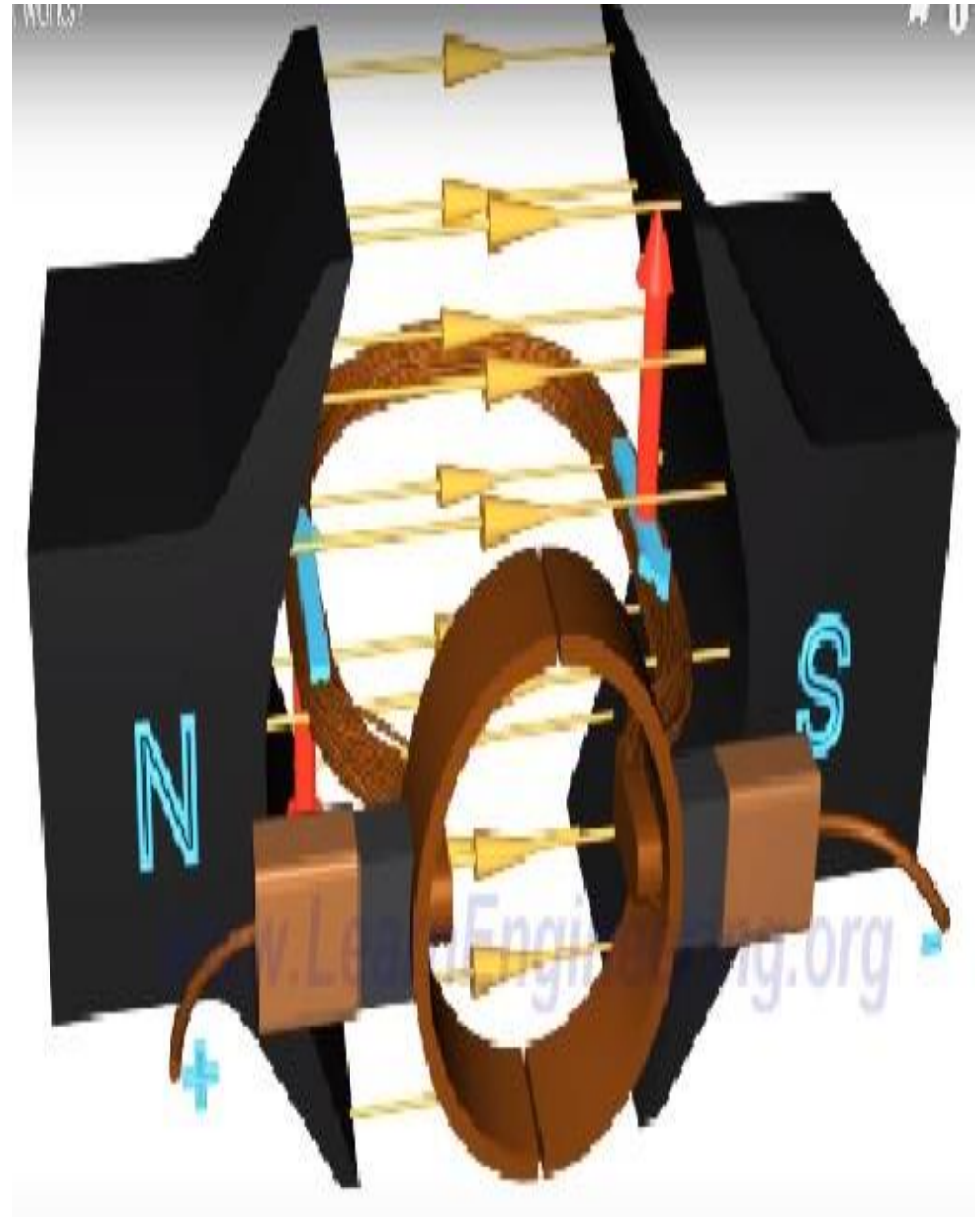
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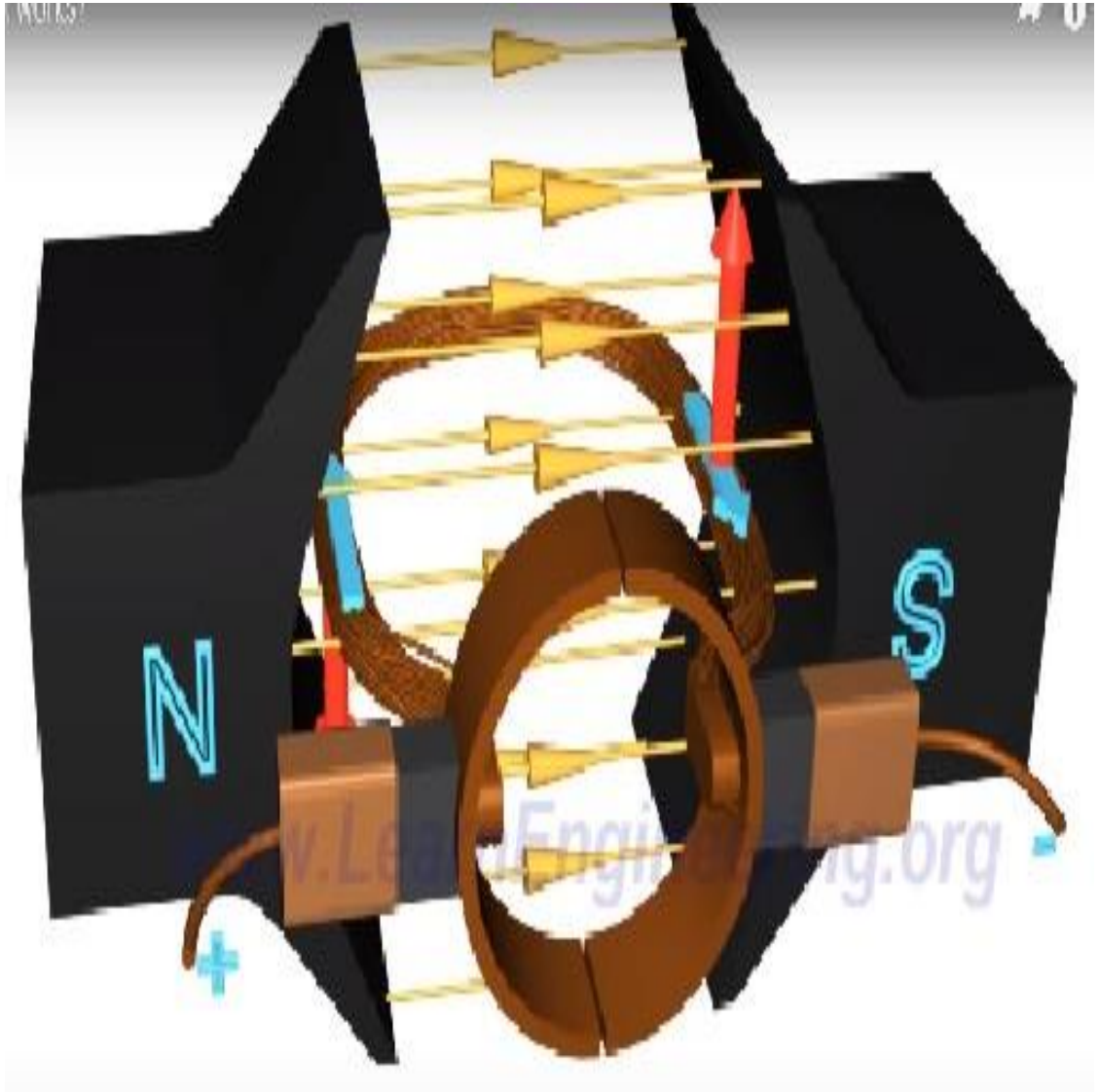
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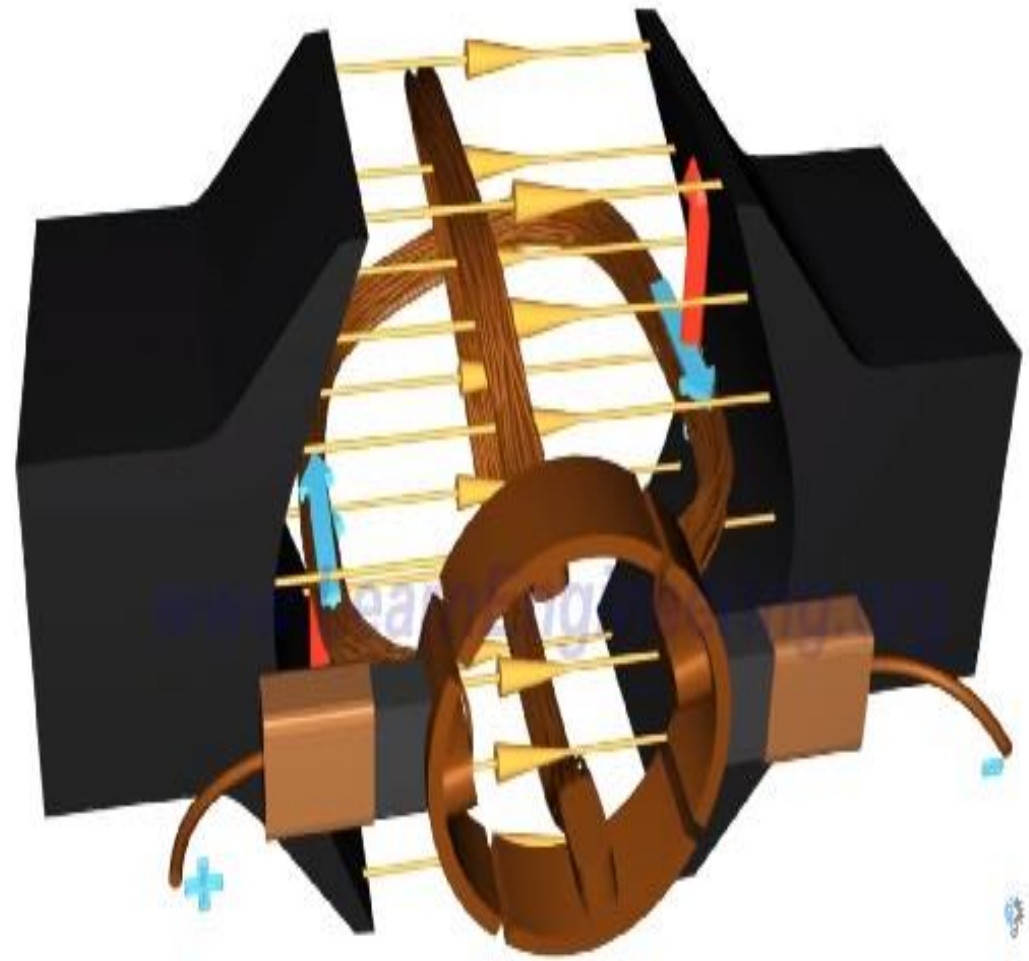
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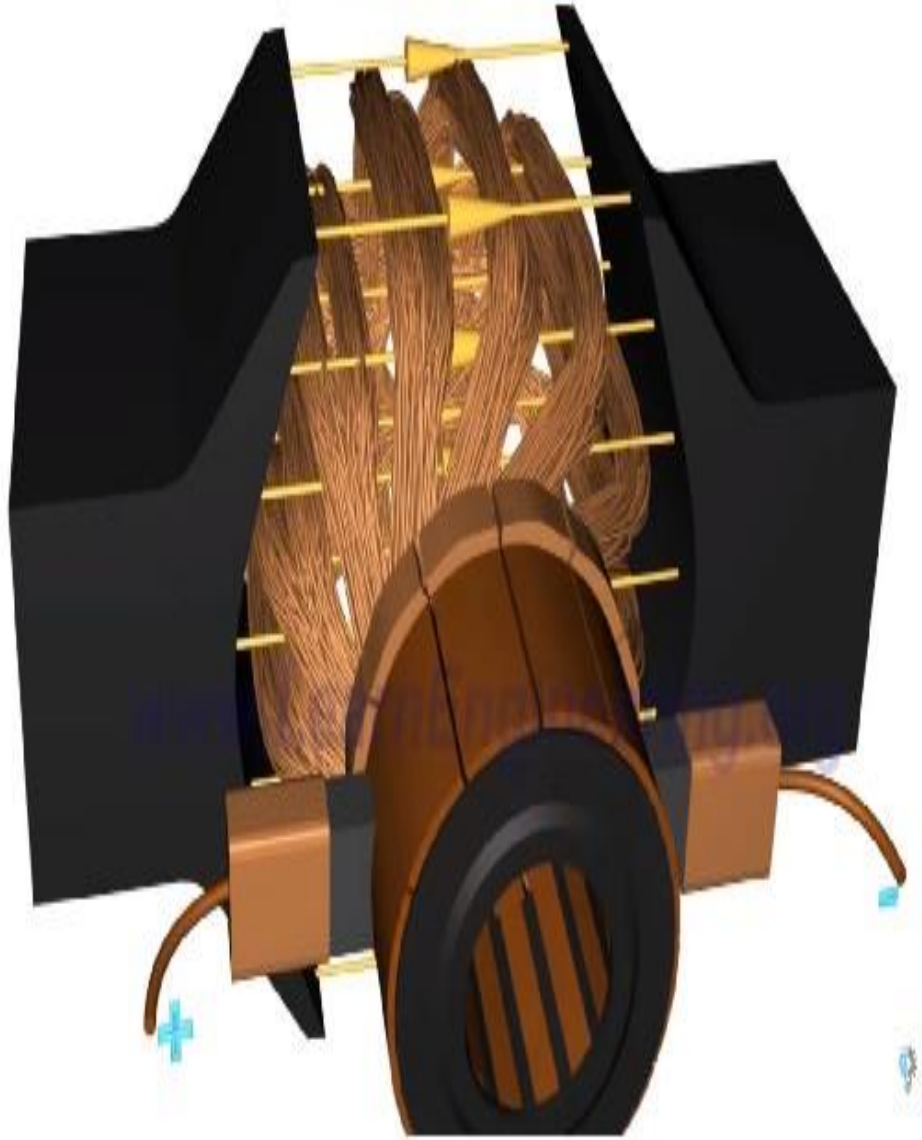
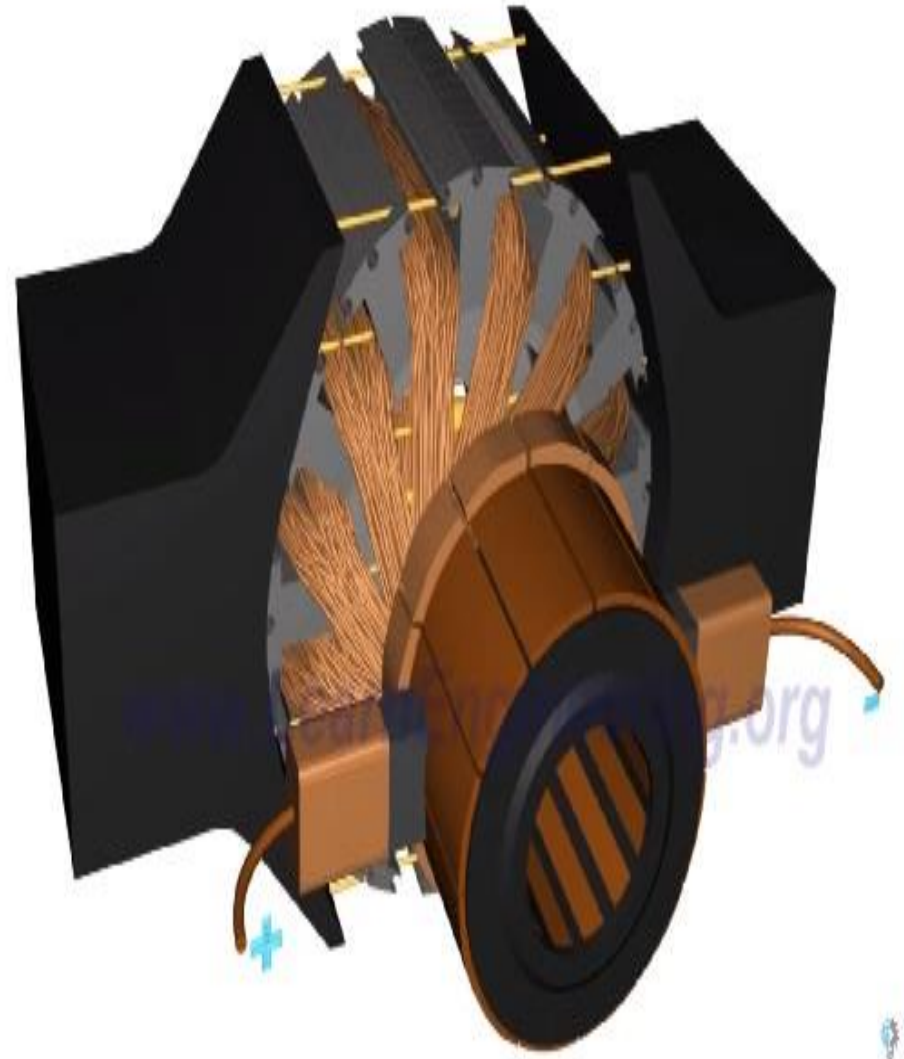
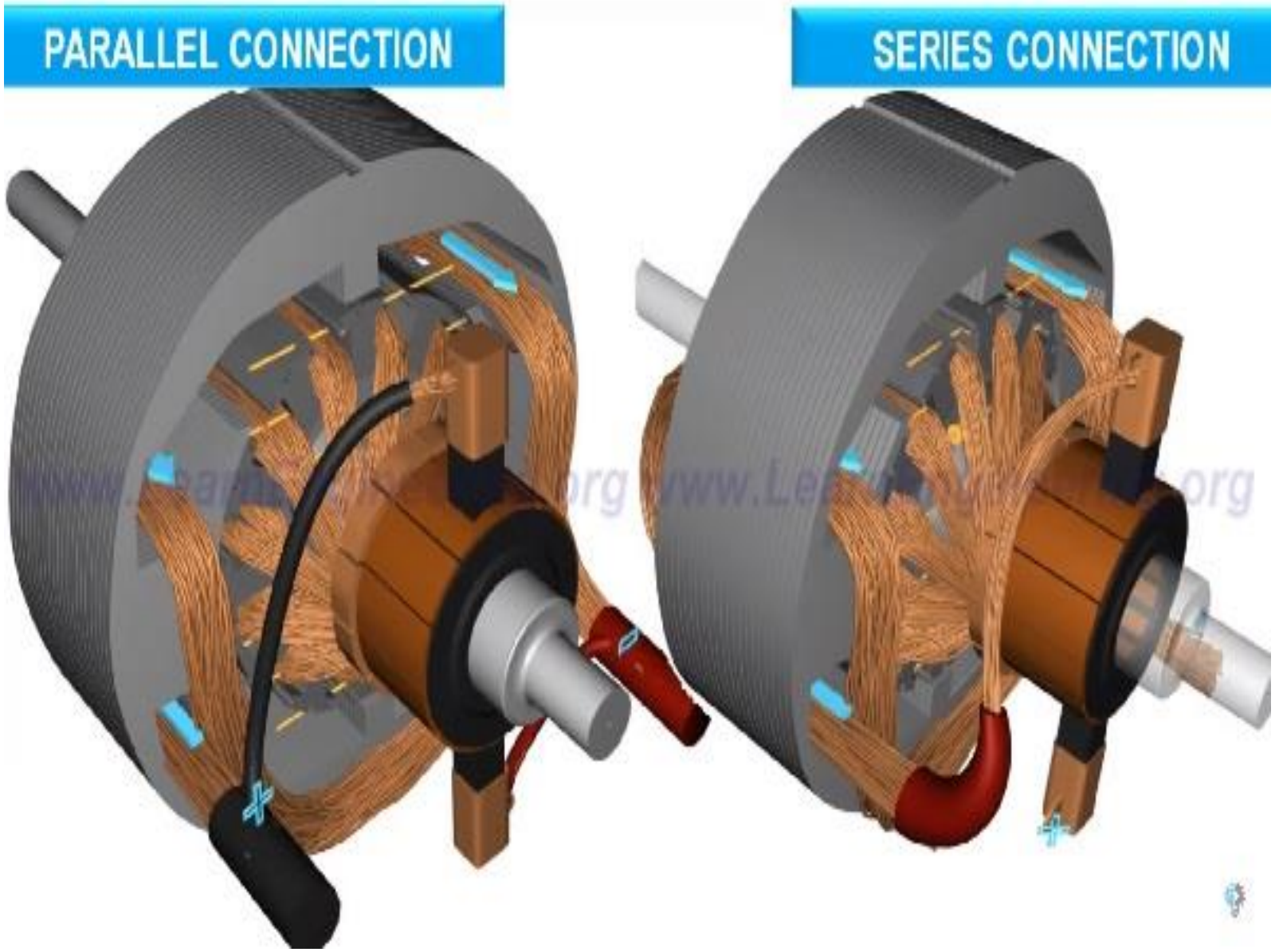
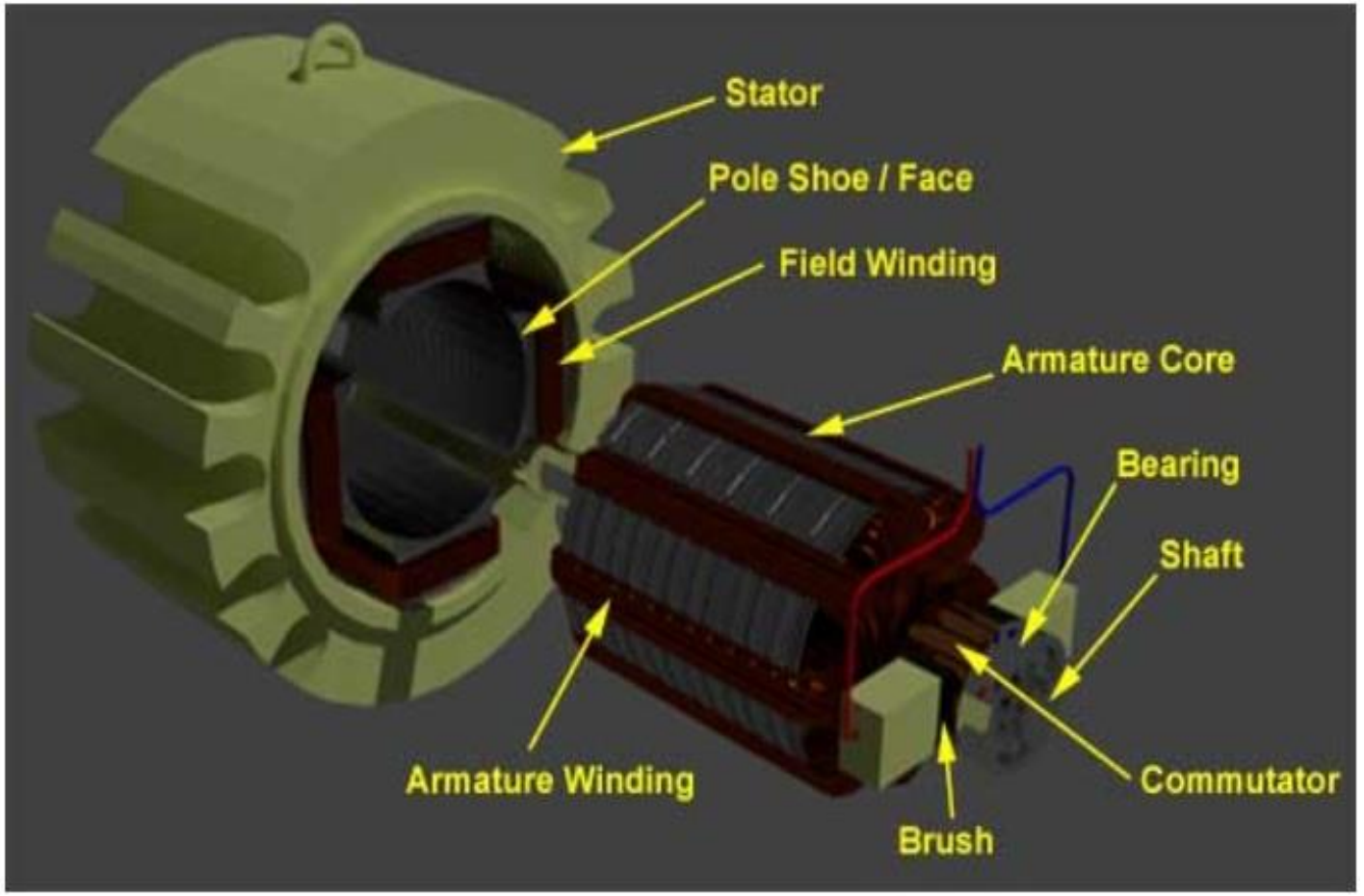





PARALLEL CONNECTION
SERIES CONNECTION

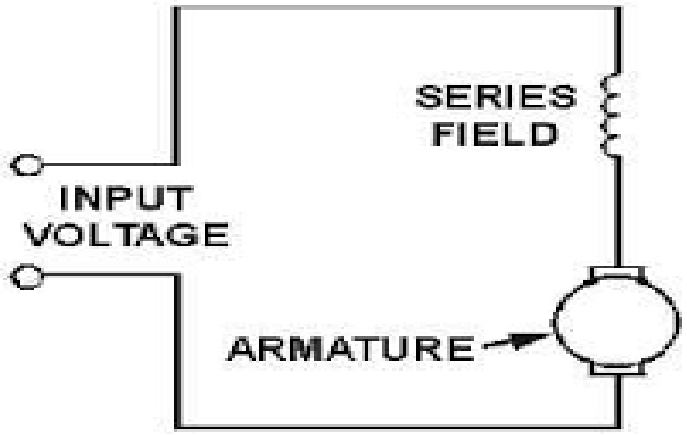
Construction of dc motor

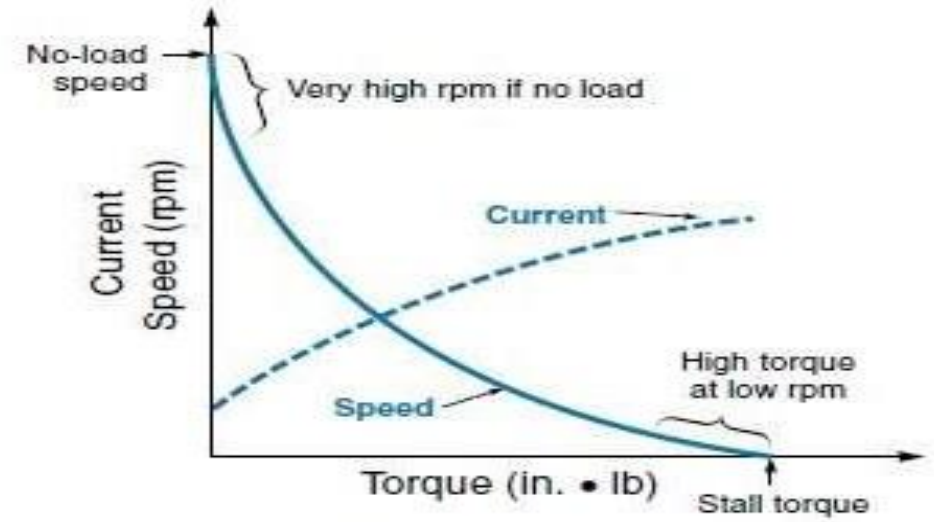
- Stator
- Rotor
- Yoke
- Poles
- Field windings
- Armature windings
- Commutator
- Brushes



D.C Series Motors

- In these armature and field windings are connected in series.
- Armature and field currents are equal



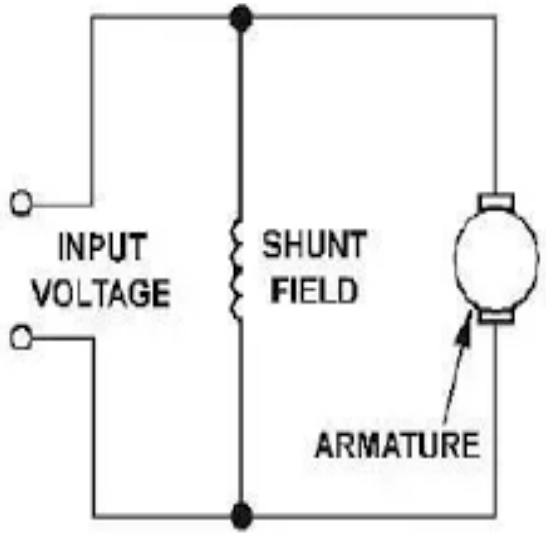


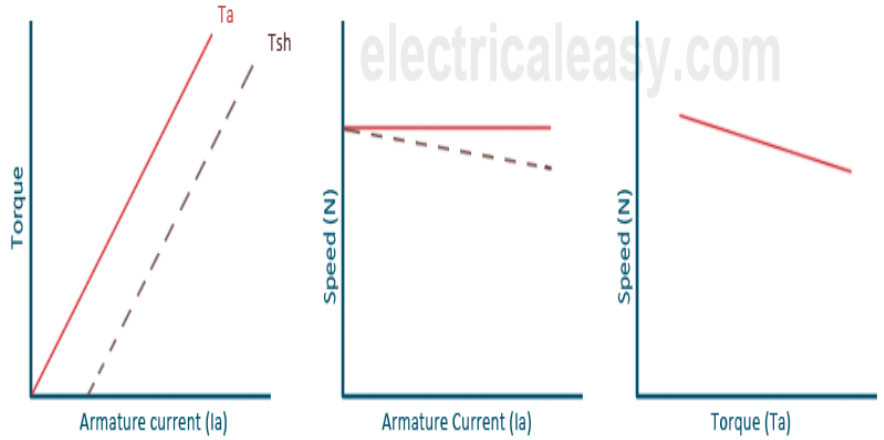
(c) Torque–speed curve for series motor

- They exhibit very high starting torques
- Torque-speed curve is hyperbolic
- With increase in current torque increases

D.C Shunt Motors

- In these armature and field windings are connected in parallel.
- Armature and field currents are equal



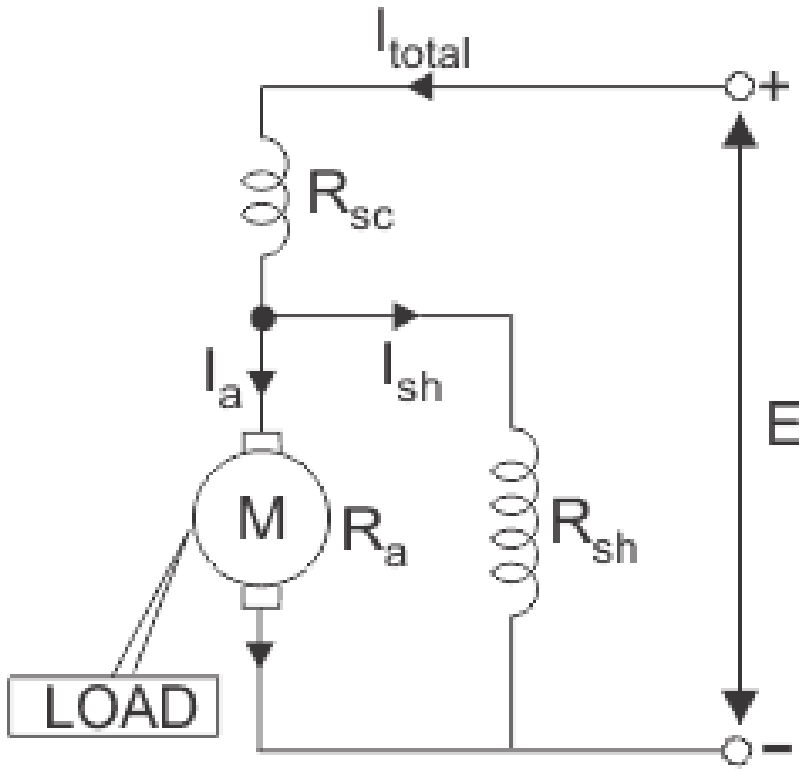


Characteristics of DC shunt motor

- They maintain torque with increase in laod
- Torque-speed curve is hyperbolic
- With increase in current torque increases

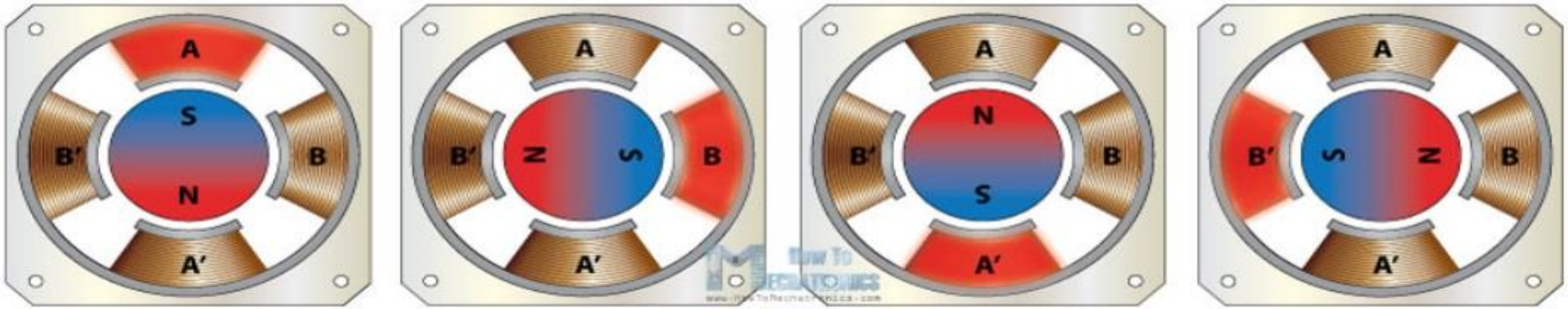
Compound Motor:

- In these compound motor has a shunt field winding in addition to the series winding.
- Here number of magnetic lines of force produced by each of its poles is the resultant of flux produced by the shunt coil & series coil.



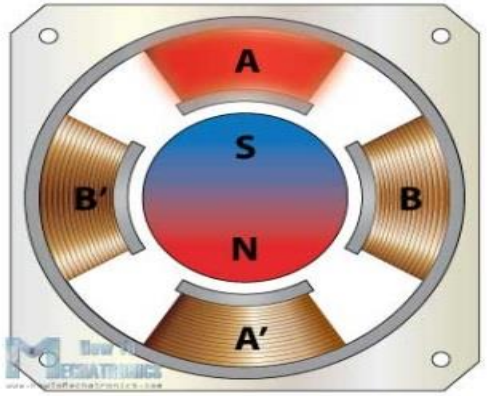
Stepper motors

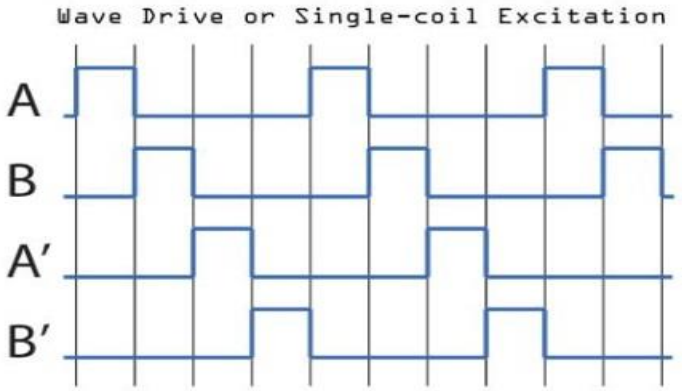
- Stepper motor is a brushless DC motor that rotates in steps.
- The stepper motor consists of a rotor that is generally a permanent magnet and it is surrounded by the windings of the stator.
- As we activate the windings step by step in a particular order and let a current flow through them they will magnetize the stator and make electromagnetic poles respectively that will cause propulsion to the motor.



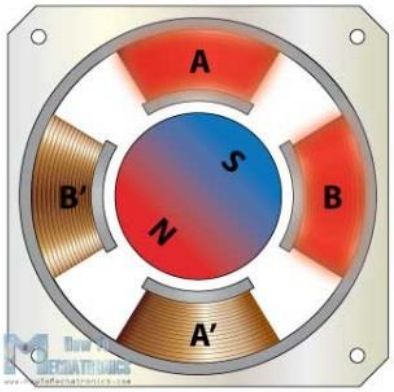
Driving Modes

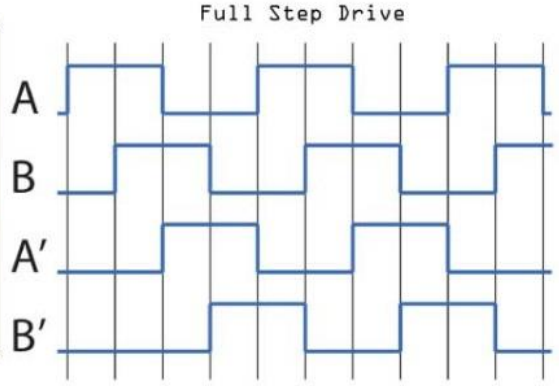
Single Coil Excitation



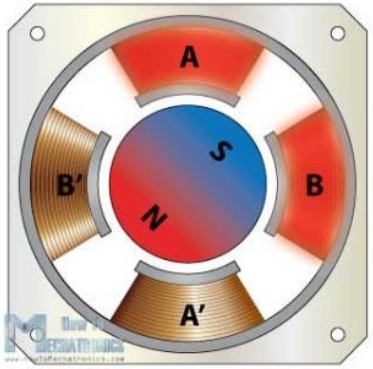


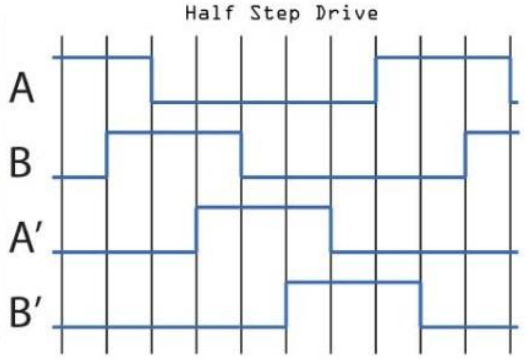
Full step drive mode



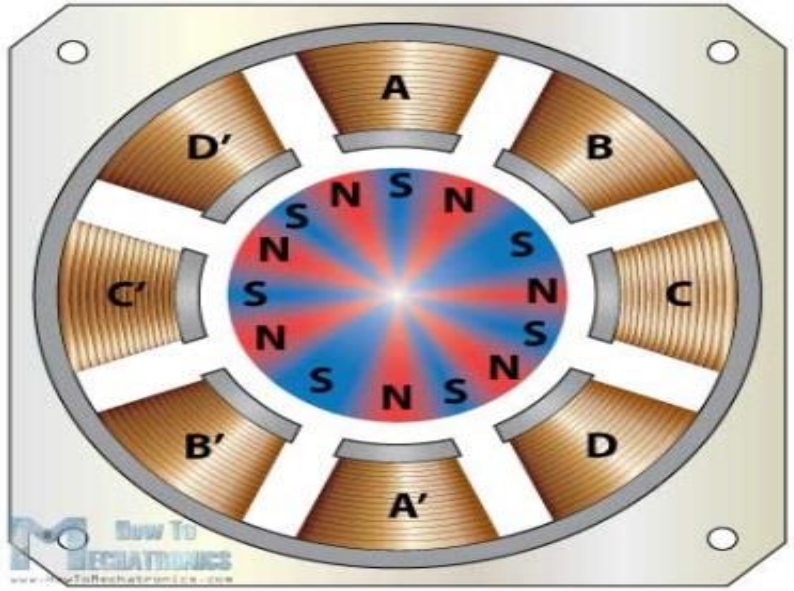


(Half step drive)one active coil followed by 2 active coils



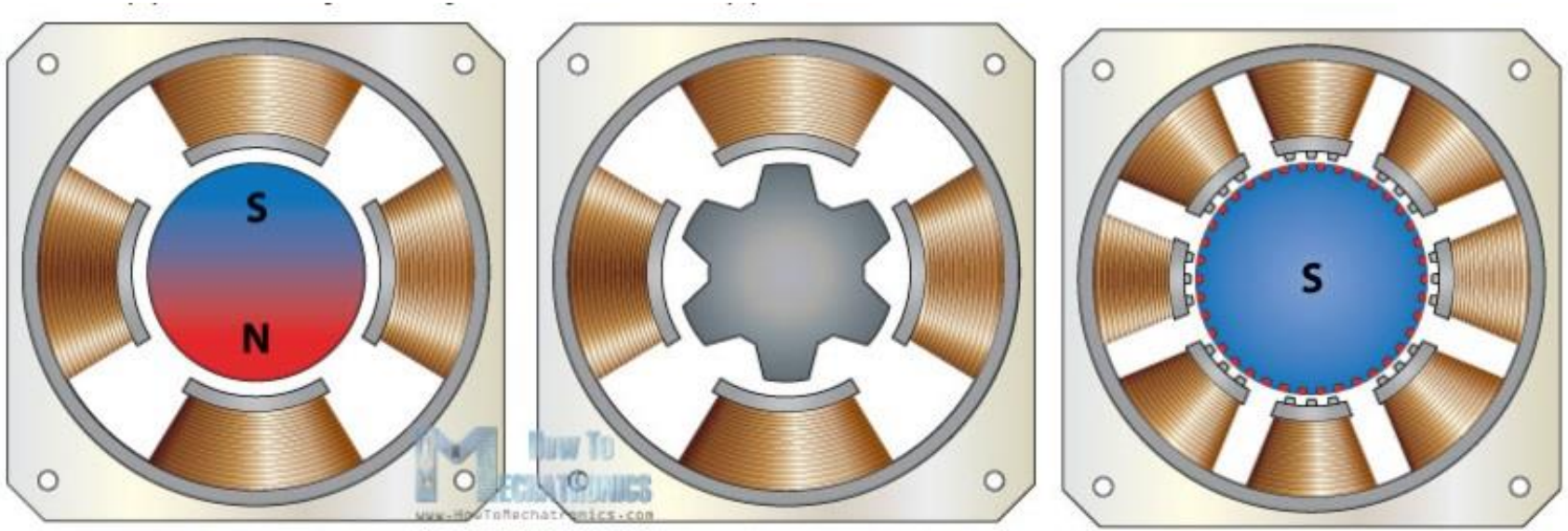


Normally used stepper motor



By construction there are 3 types of stepper motor :

Permanent magnet stepper, variable reluctance stepper and hybrid synchronous stepper motor



Brushless D.C Motors (BLDC):

Brushless DC motor may be described as an electronically commuted motor which does not have brushes

In brushless motors, permanent magnets are around rotor & electromagnets are in stator.