Fractional-kW Motors and DC Machines

Lecture No. 46
DC Machines – Principle and Construction

Lecture delivered by:

Objectives

At the end of this lecture, student will be able to:

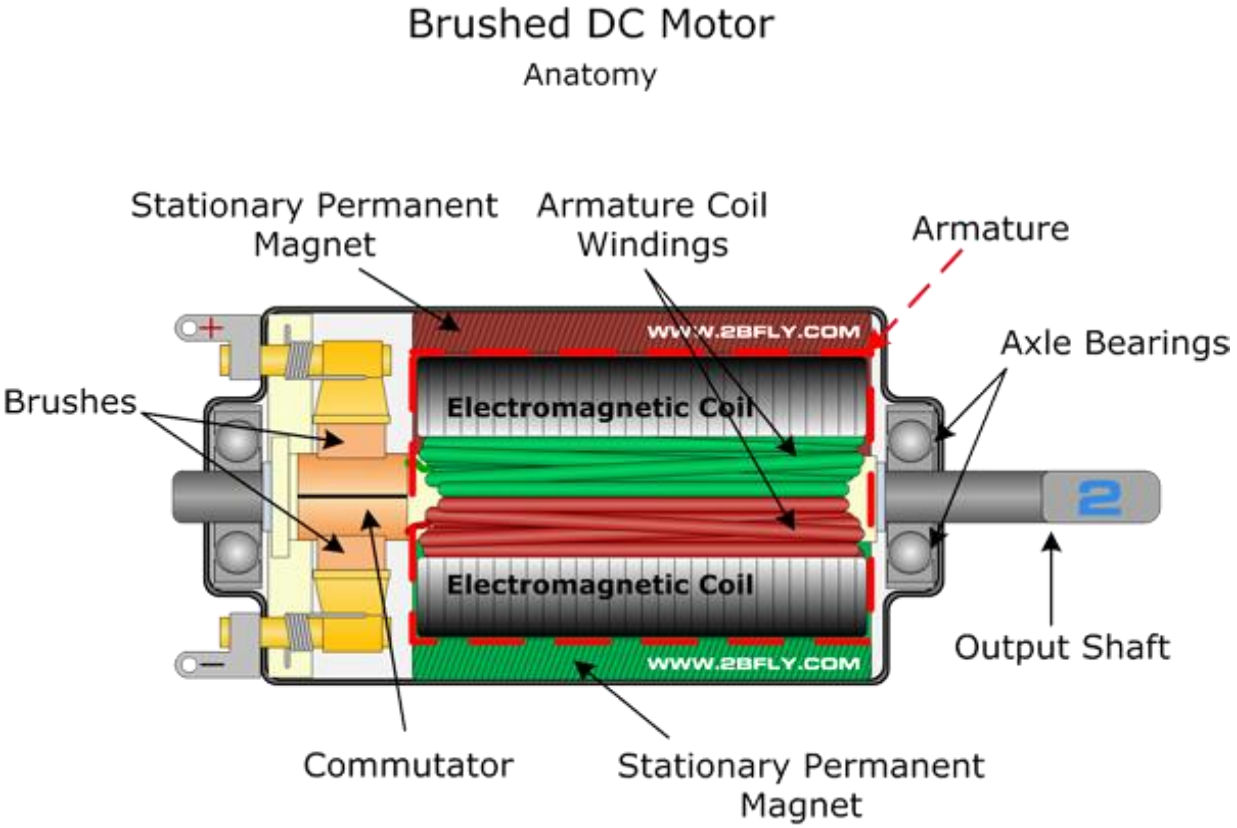
- Explain the basic principle of induced E.M.F. and electromagnetic torque
- Discuss the need for commutator
- Identify different parts of a DC machine and understand their function

Topics

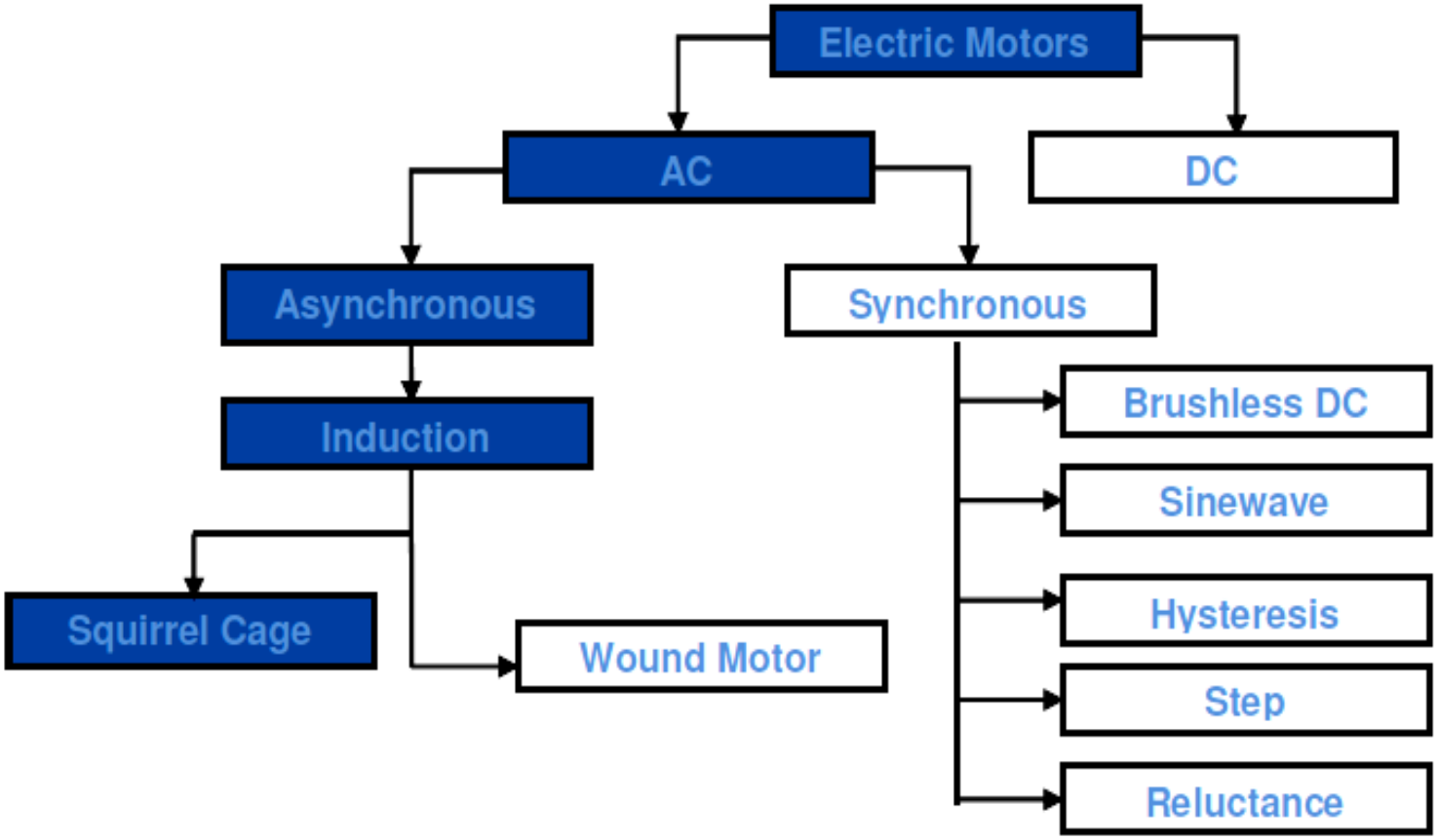
- Fleming's left-hand rule
- The Action of a Commutator
- D.C. Machine Construction
- Principle of operation of a simple DC Motor
- Back e.m.f

Introduction

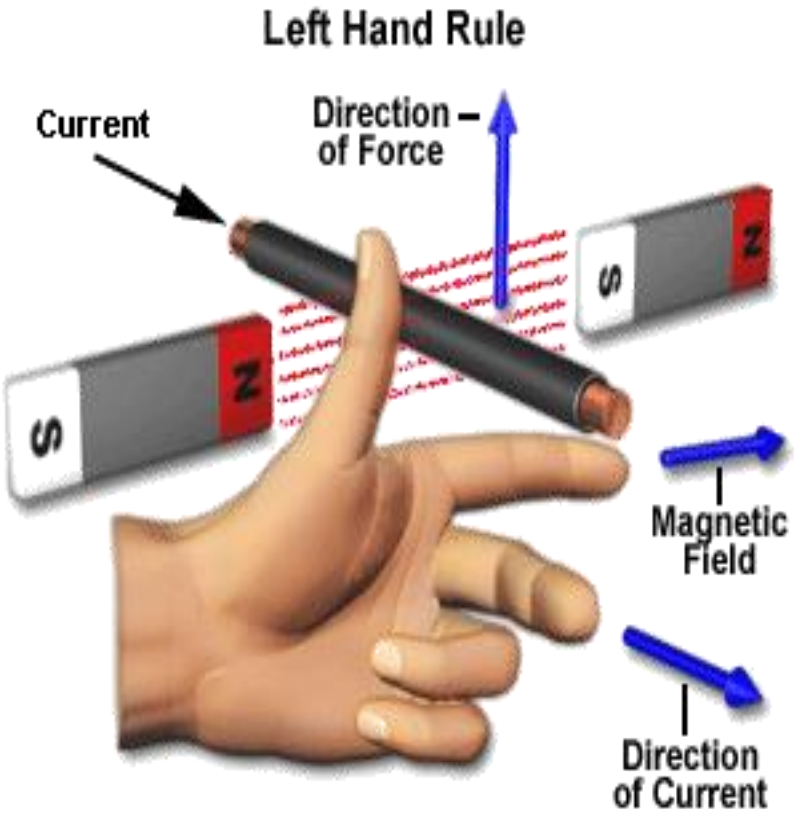
- Motor converts electrical energy into mechanical energy
- Generator converts mechanical energy to electrical energy



Introduction



Fleming's left-hand rule

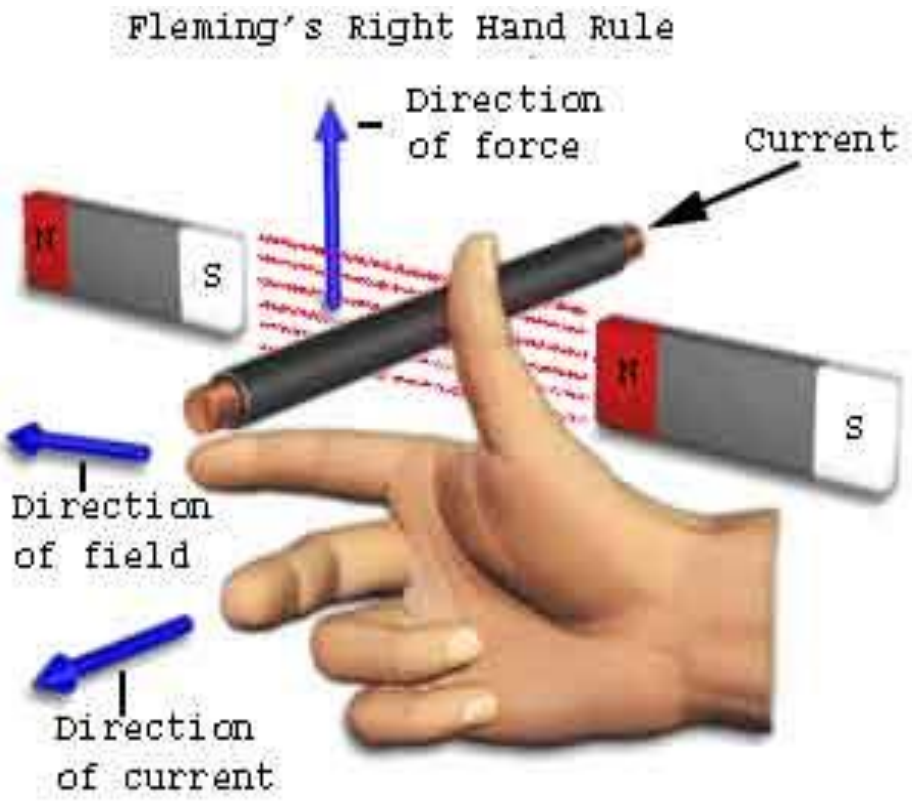


First finger - Field

Second finger - Current

Thumb - Motion

Fleming's Right-hand rule

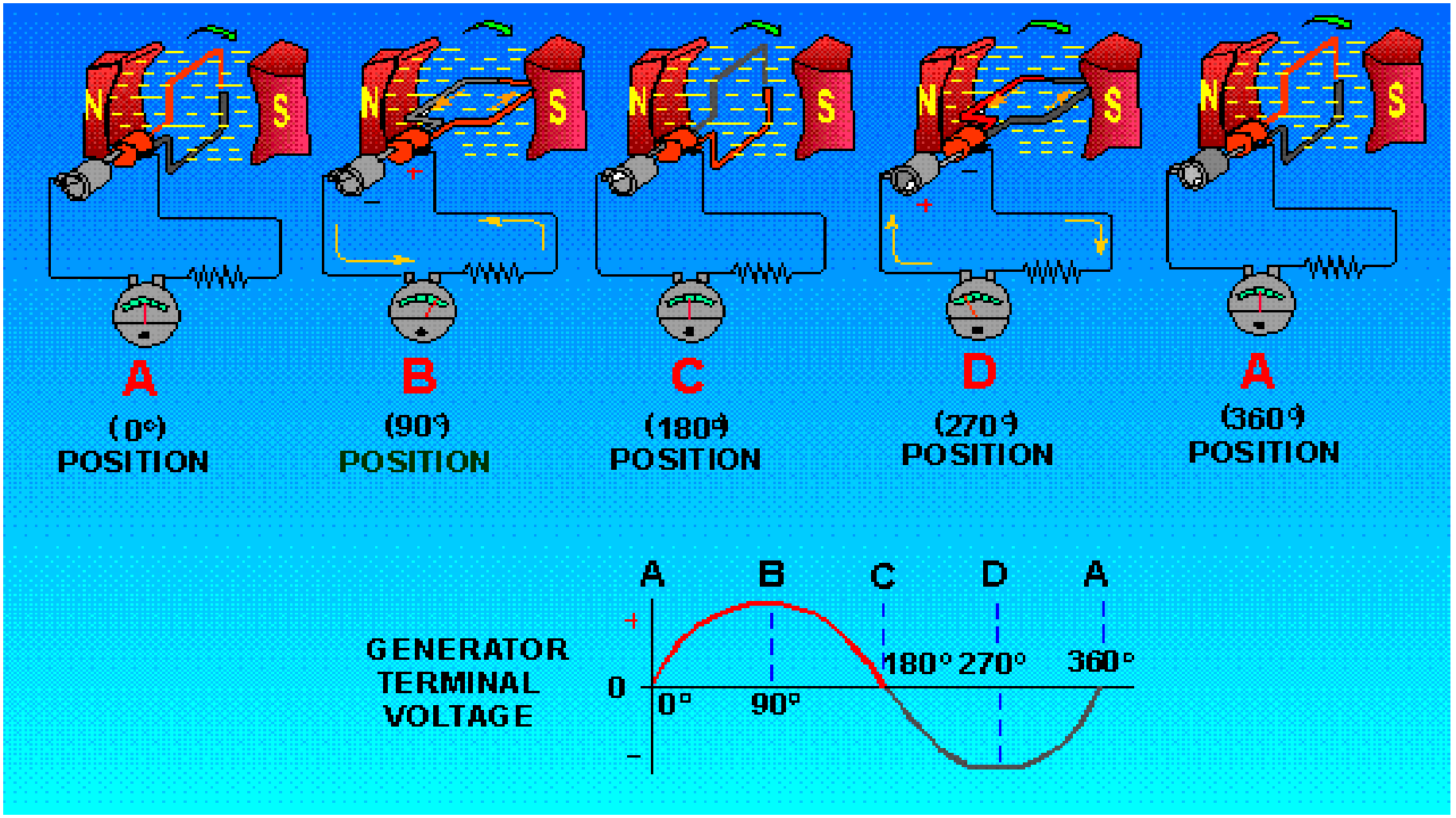


First finger—Field

Thumb—Motion

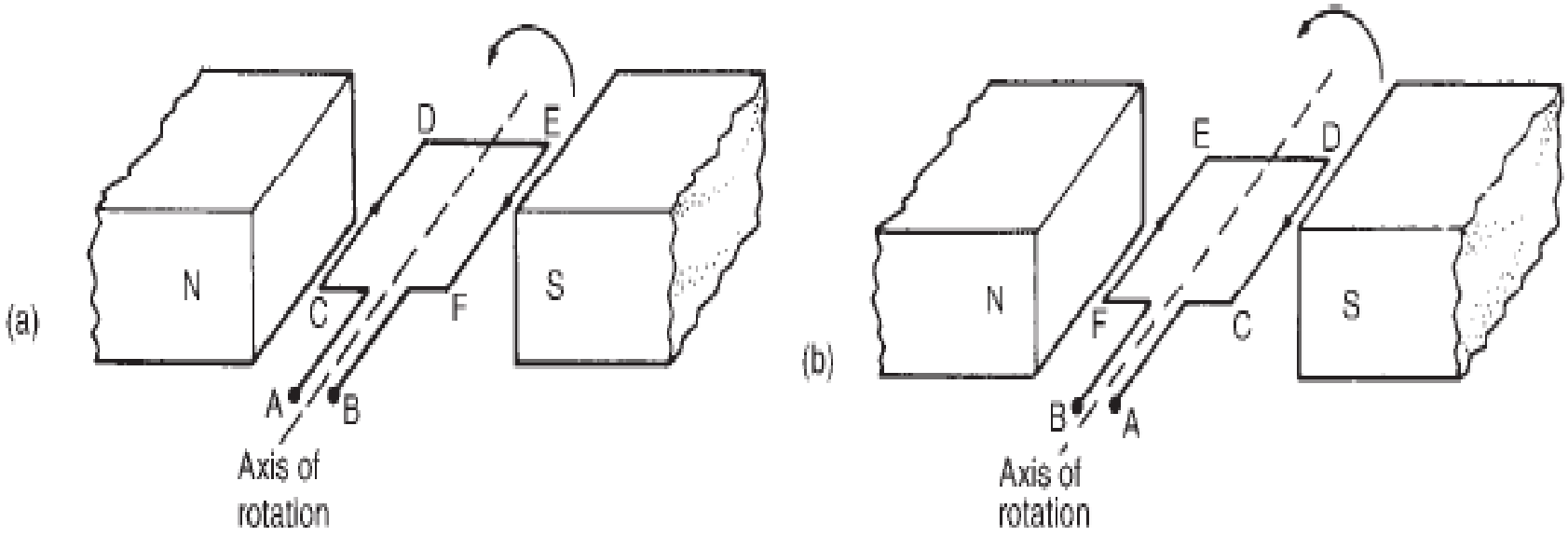
Second finger—E.m.f.

Generation Principle



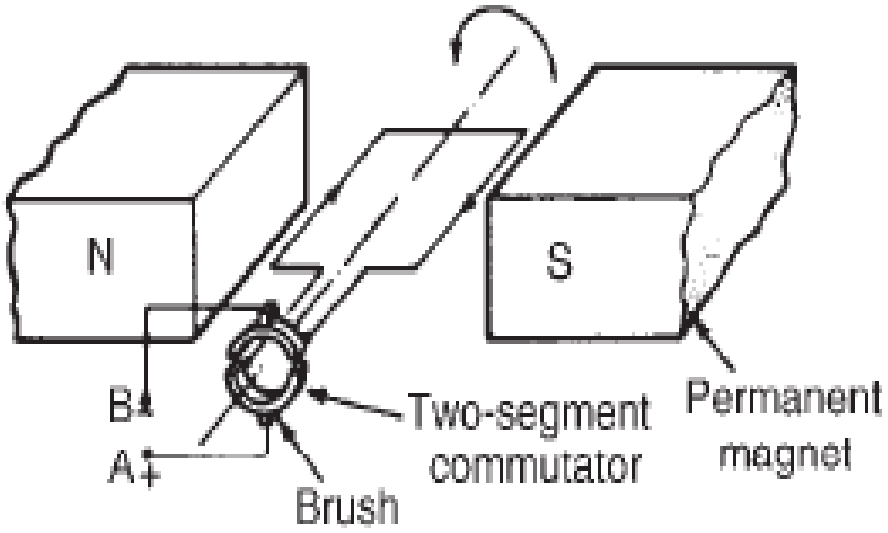
The Action of a Commutator

- In an electric motor, conductors rotate in a uniform magnetic field.



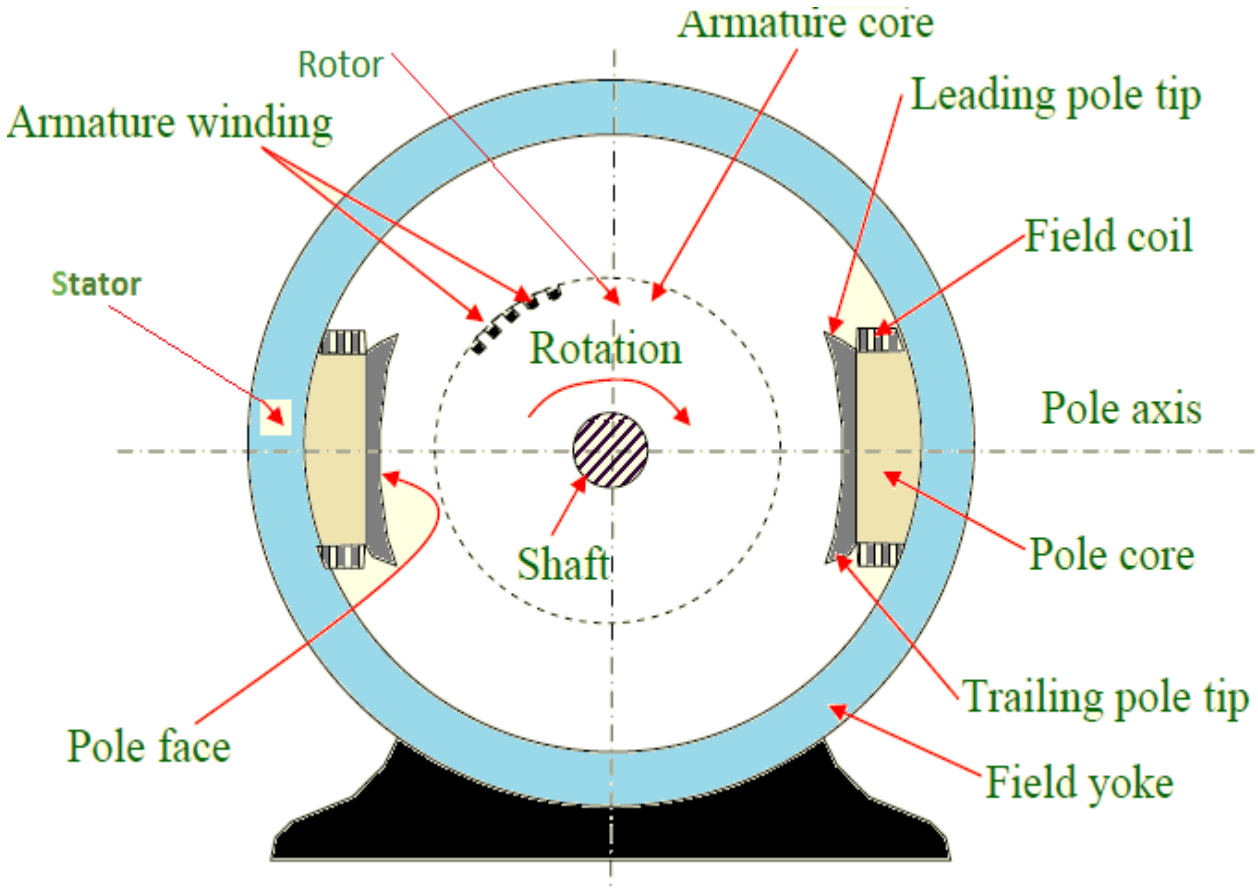
The Action of a Commutator

- For rotation to continue in the same direction, it is necessary for the current flow to be as shown in Figure , i.e. from D to C and from F to E. This apparent reversal in the direction of current flow is achieved by a process called **commutation**



D.C. Machine Construction

- The basic parts of any d.c. machine are shown in Figure



Construction of DC Motor

D.C. Machine Construction

a) a stationary part called the **stator having,**

I. a steel ring called the **yoke, to which are attached**

II. the magnetic **poles, around which are the**

III. field windings, i.e. many turns of a conductor wound round the pole core; current passing through this conductor creates an electromagnet

D.C. Machine Construction

- A rotating part called the **armature mounted in bearings housed in** the stator and having,

  I. Yoke

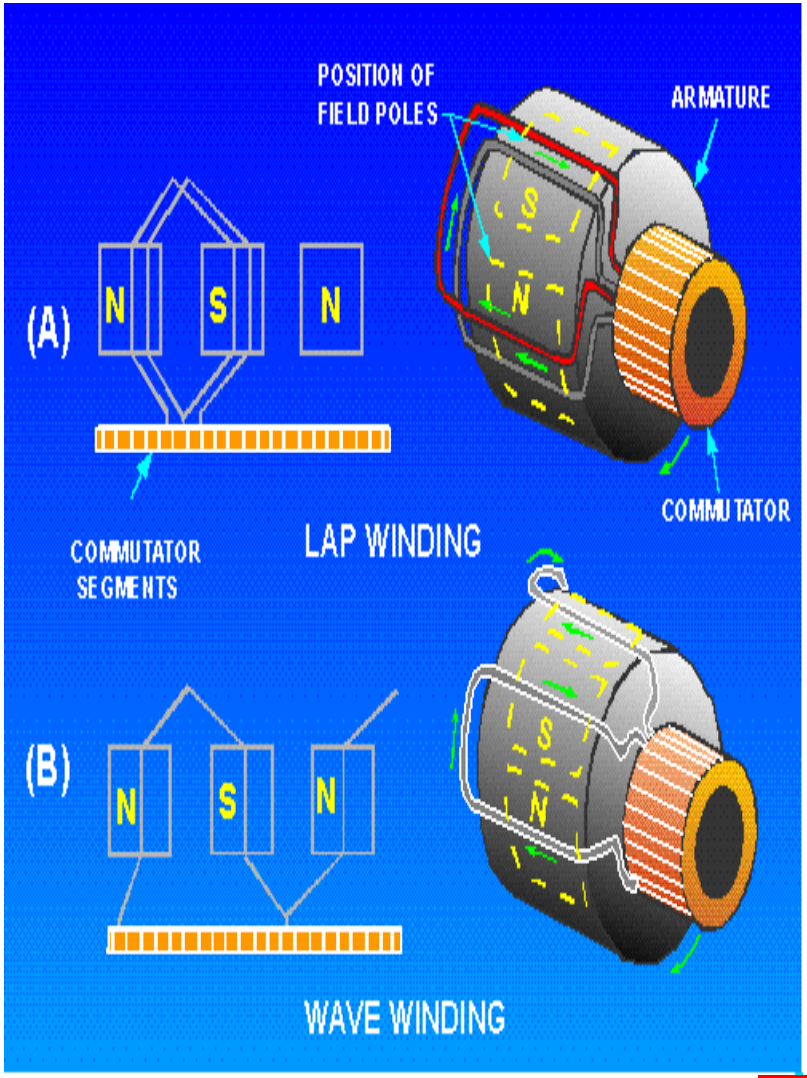
  II. armature winding

  III. Commutator

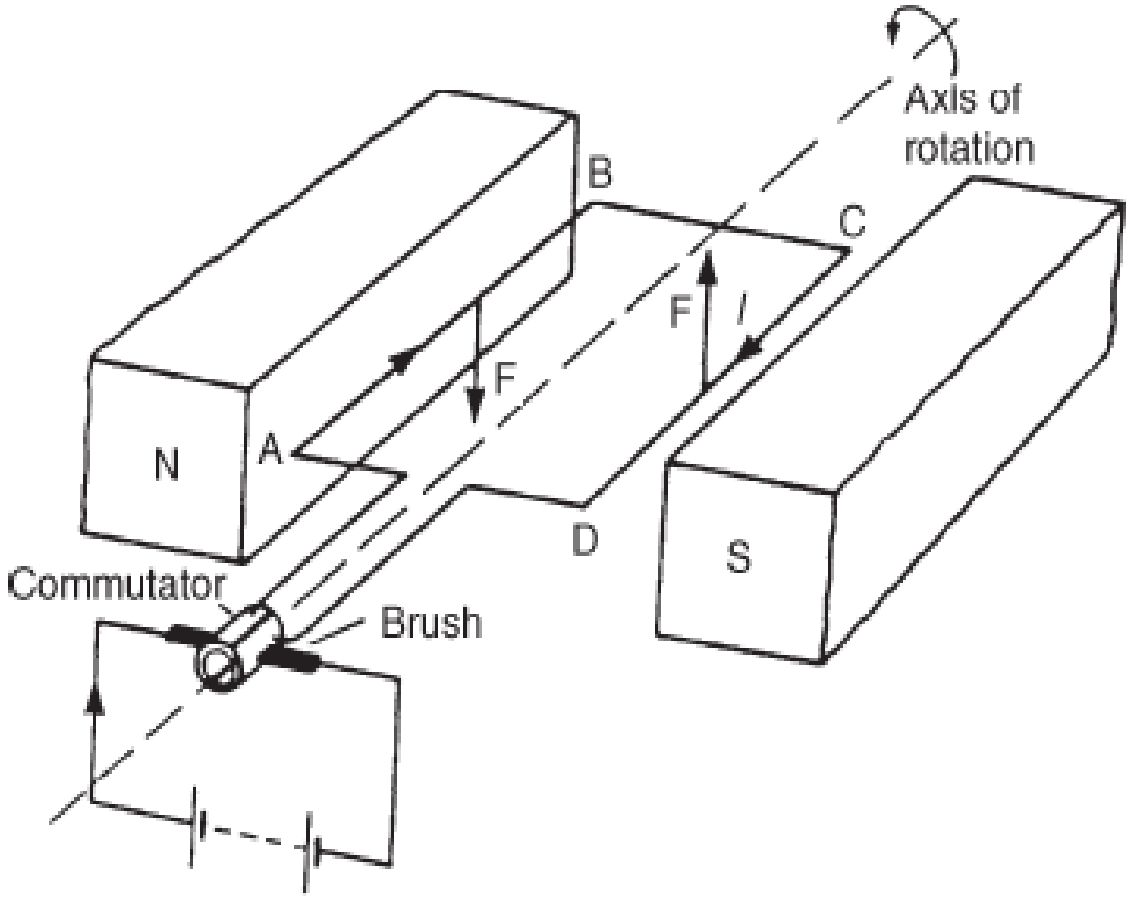
- Armature windings can be divided into two groups, These are called **wave windings** and **lap windings**

Wave and Lap Windings

- In **wave windings** there are two paths in parallel irrespective of the number of poles. Wave wound generators produce high voltage, low current outputs
- In **lap windings** there are as many paths in parallel as the machine has poles. Lap wound generators produce high current, low voltage output.



Principle of operation of a simple DC Motor



Principle of operation of a simple DC Motor

- Force F to be exerted on the current-carrying conductor which, by Fleming's left-hand rule, is downwards between points A and B and upward between C and D for the current direction shown
- The current direction is reversed every time the coil swings through the vertical position and thus the coil rotates anti-clockwise for as long as the current flows

Back e.m.f.

- When a DC motor rotates, an e.m.f. is induced in the armature conductors. By Lenz's law this induced e.m.f. E opposes the supply voltage V and is called a back e.m.f., and the supply voltage, V is given by

$$V = E + I_a R_a \quad or \quad E = V - I_a R_a$$

Summary

- DC Machines work on the principle of Faraday's law, Flemings Left Hand and Flemings Right Hand rule
- DC Motor and Generator have same construction
- Commutator is essential for Motor to have unidirectional rotation
- Commutator is essential for Generator to have unidirectional emf at the terminal