Courses No: EEE 2217

Course Title: Electrical Drives and Instrumentation

Presentation on DC Machines

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Electric Machines

- **Device in which occurs electromagnetic phenomena is called machine.**
- **Converts electrical energy into mechanical energy or mechanical energy into electrical energy**
  - **–Generator**
  - **–Motor**
  - **–Transformer**

Faraday's Law of Electromagnetic Induction

- In 1831 Michael Faraday made an important discovery. He learned that "a voltage is induced in a conductor if the conductor cuts lines of magnetic flux."

- Moreover, The magnitude of the emf induced in a conductor is equal to the rate of change of magnetic flux i.e. The rate at which the magnetic flux changes with time.

DC Generator

- **An electrical Generator is a machine which converts mechanical energy (or power) into electrical energy (or power).**

Working Principle :

- If a conductor is placed in magnetic field and the conductor is rotated by any external means for which the conductor cuts rate of change of flux then there induced a voltage across the conductor according to Faraday's Laws of Electromagnetic Induction. This e.m.f. causes a current to flow if the conductor circuit is closed.

Essential parts of an electric generator:

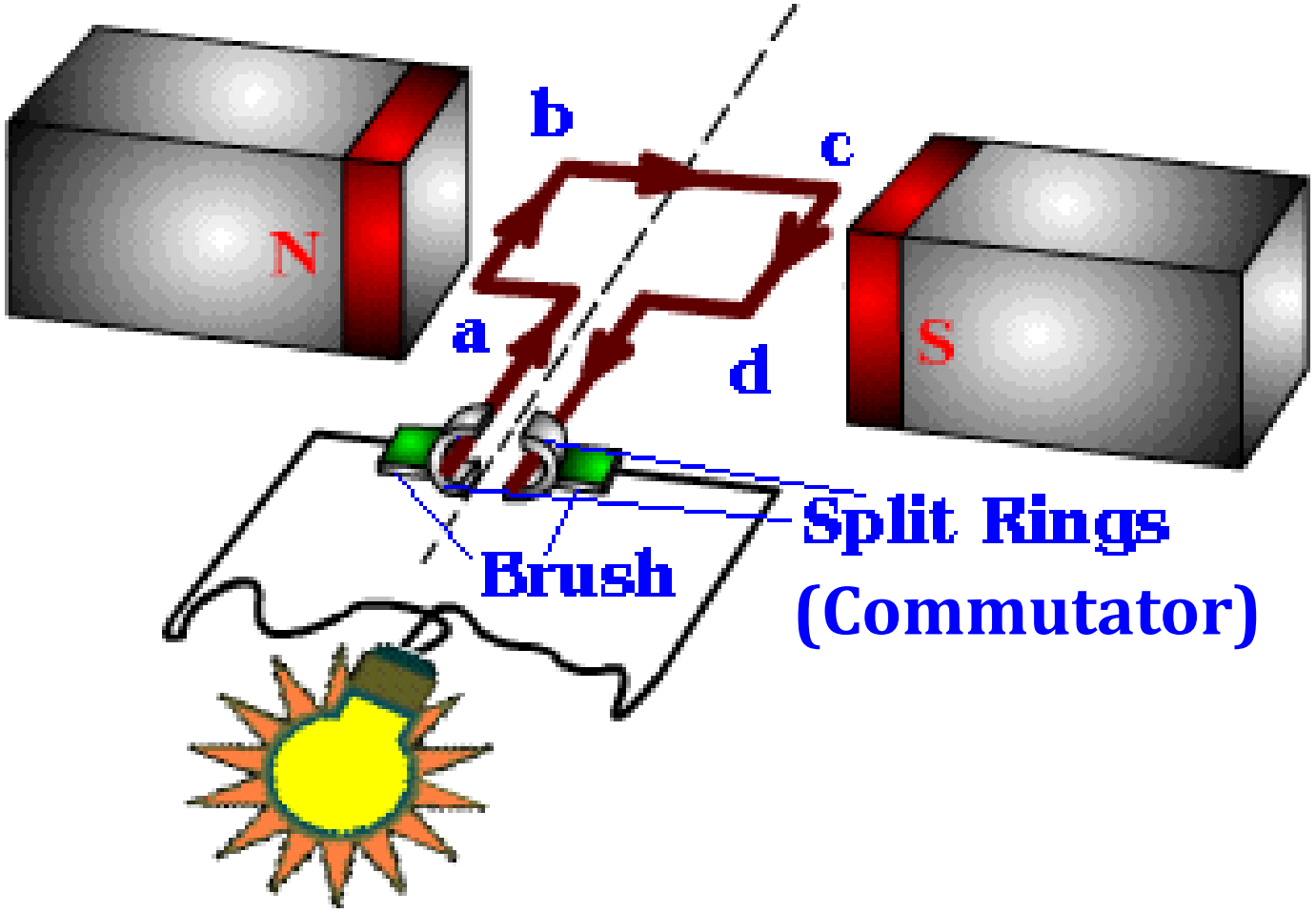
- ❖ Magnetic field and
- ❖ Armature in which conductors are housing.

Working Principle (Cont.)

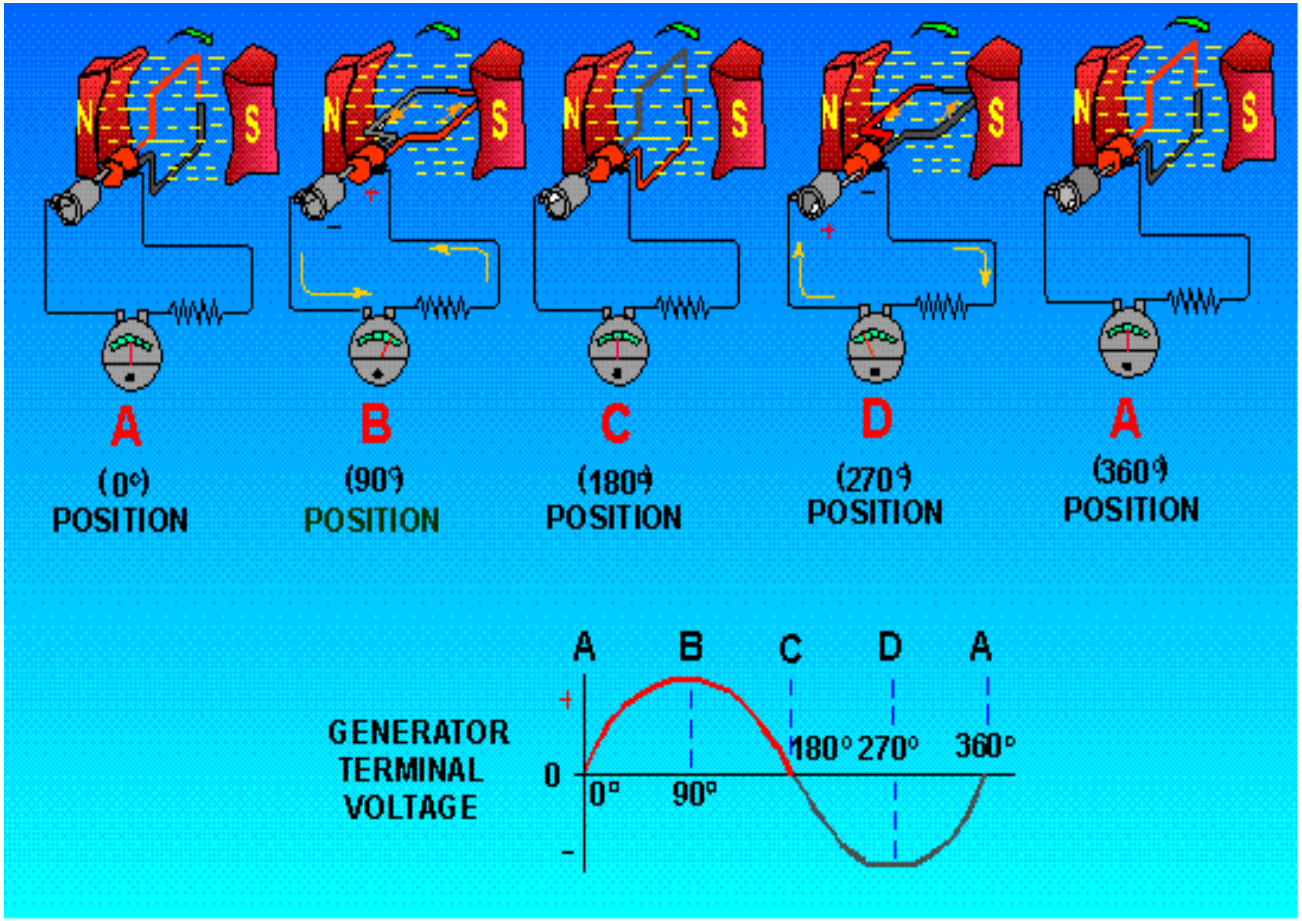
- The amount of voltage generated depends on:
  i. the flux density of magnetic field, B
  ii. the speed at which the conductor is moved, v
  iii. the length of the conductor within the magnetic field

$$E = Blv \text{ volts}$$

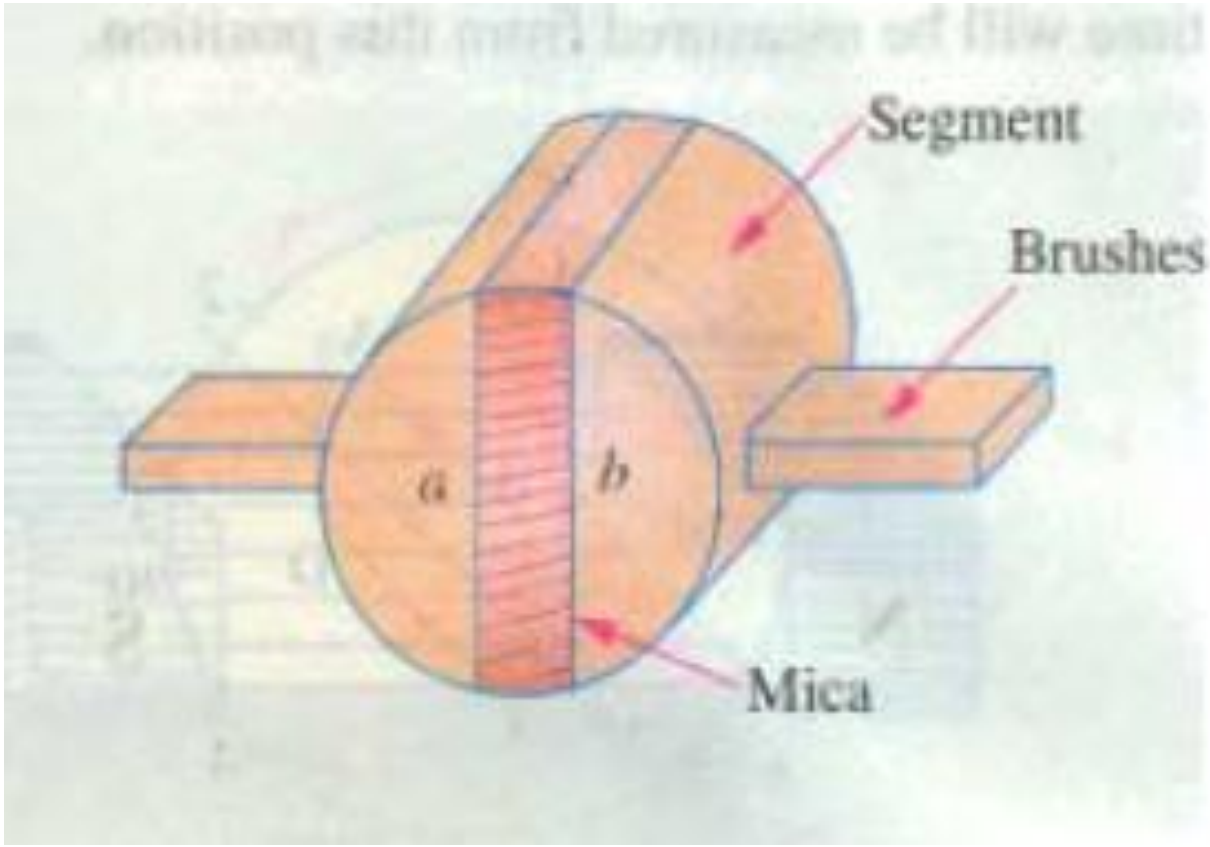
Working Principle (cont.)



Working Principle (cont.)



Commutator



Typical view of Commutator

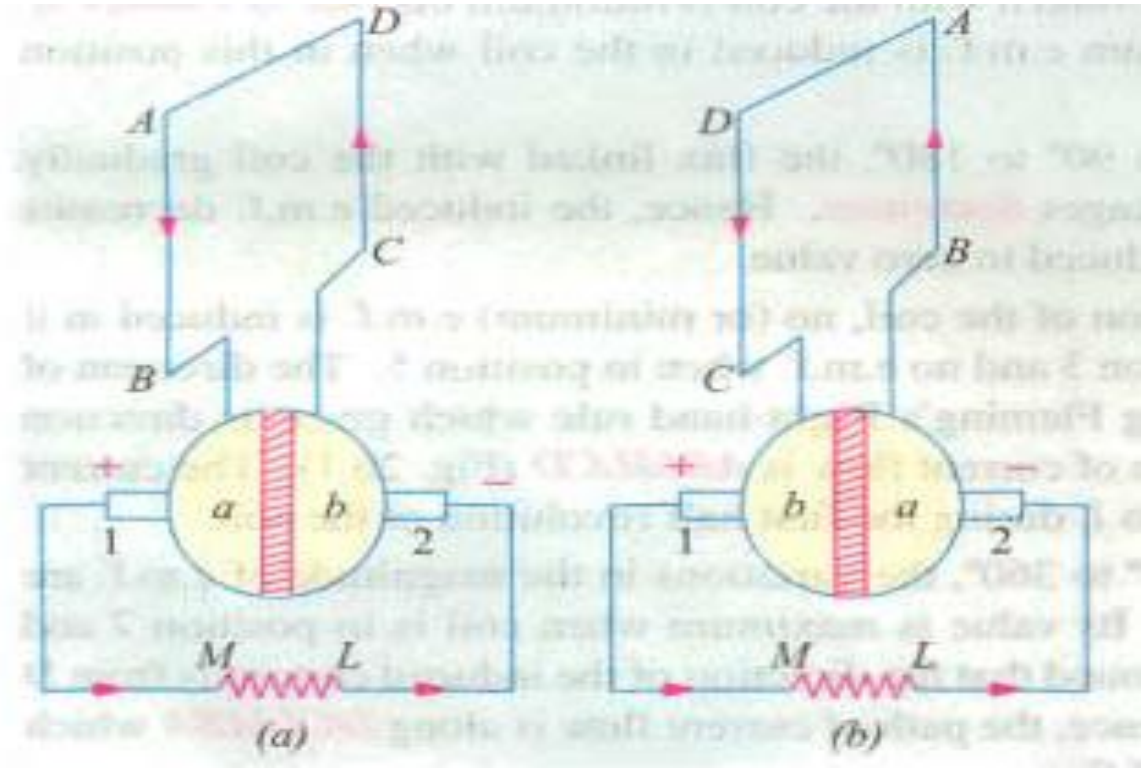
Unidirectional Current From Alternating Current

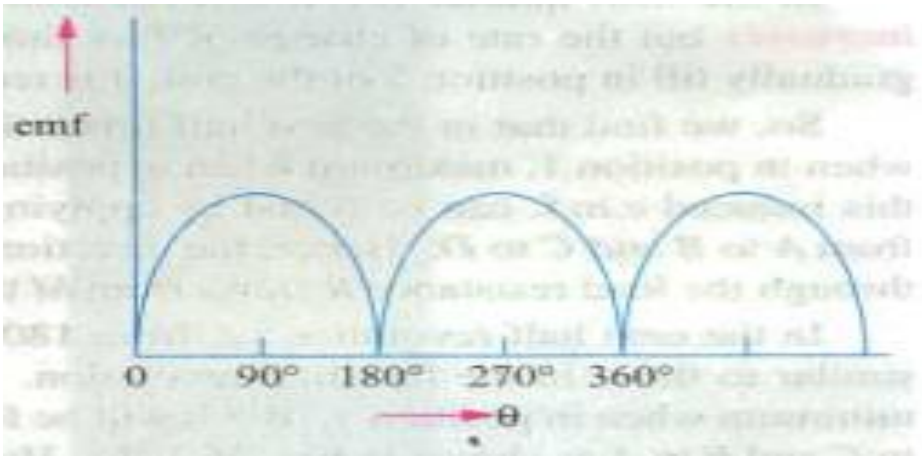
Commutator: Converts alternating currents into unidirectional currents.

Fig(a). Currents flows along ABMLCD i.e. Brush no.1 in contact with segment a acts as the positive end of supply and 'b' as negative end .

In **fig(b),** direction of induced current is reversed and position of segments 'a' and 'b' have also reversed.

Current through load resistance again flows from M to L





PARTS OF DC MACHINE

Major parts of the machine are:

- Magnetic frame or Yoke
- Pole coils or poles
- pole core and pole shoes
- Armature
- Commutator
- Brushes, Bearings and shaft.

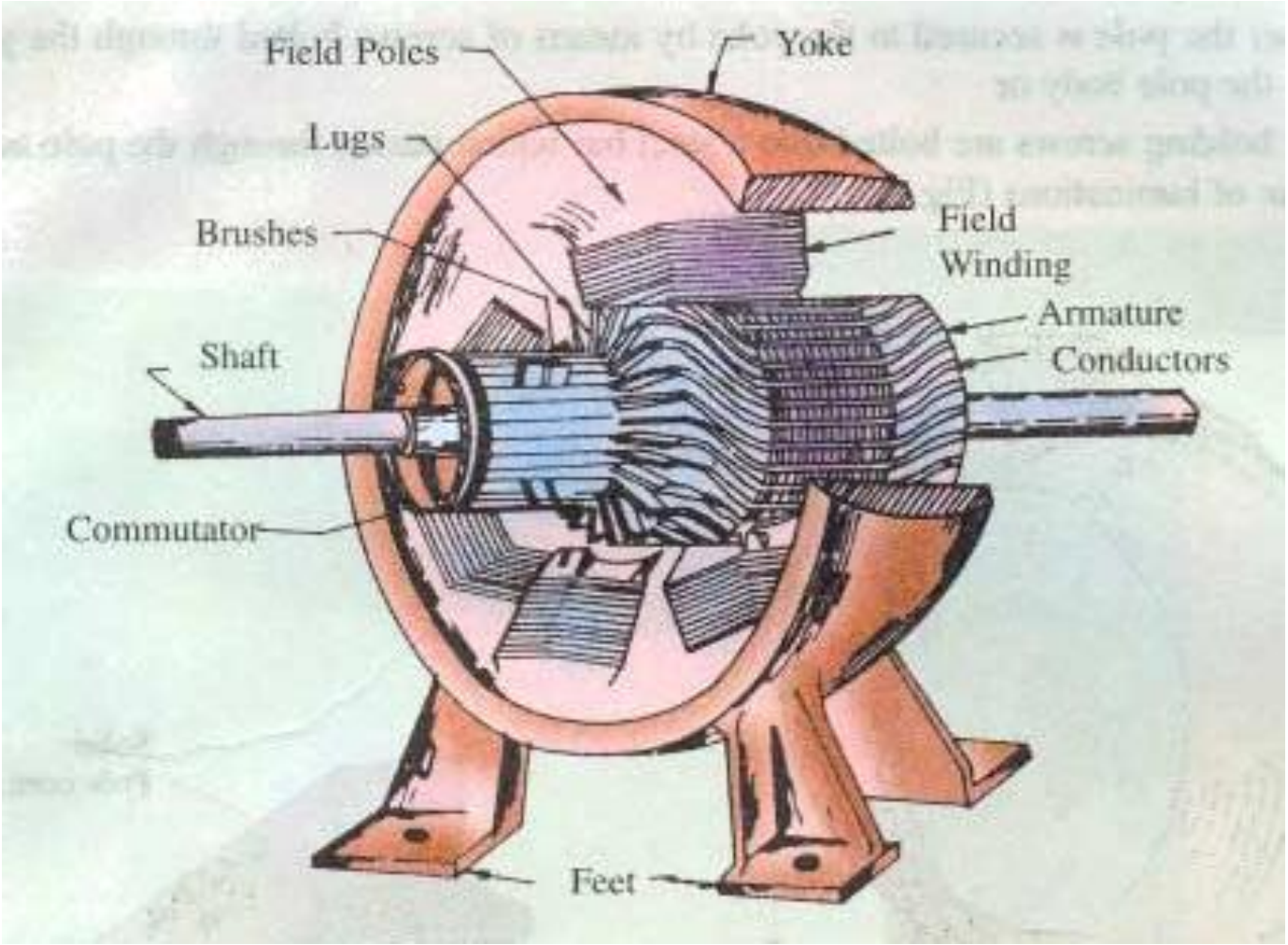
Yoke

- It serves two major purposes
    i. It provides mechanical support for the poles and acts as a protecting cover for the whole machine
    ii. It carries the magnetic flux produced by the poles.

Materials used

- For small machine – cast iron
- For large machine – cast steel

Sectional View of an D.C. Generator



Pole Coils

- Consists of copper wire or strip

- When current passes through these coils, they electromagnetize the poles which produce the necessary flux that is cut by revolving armature conductors.

Field Winding/Pole Coil

Pole core and Pole shoes

- The field magnets consists of pole cores and pole shoes.
- **Purposes:**

1. Spread out the flux in the air gap and reduce the reluctance due to being of larger cross section.
2. Supports the field coils or exciting coils.

Armature

Armature core:

- cylindrical shaped

- Houses the armature conductor or coils- causes them to rotate and cut flux

Armature winding:

- Insulated from each other

- Conductor are placed in the armature slots .

Typical View of Armature

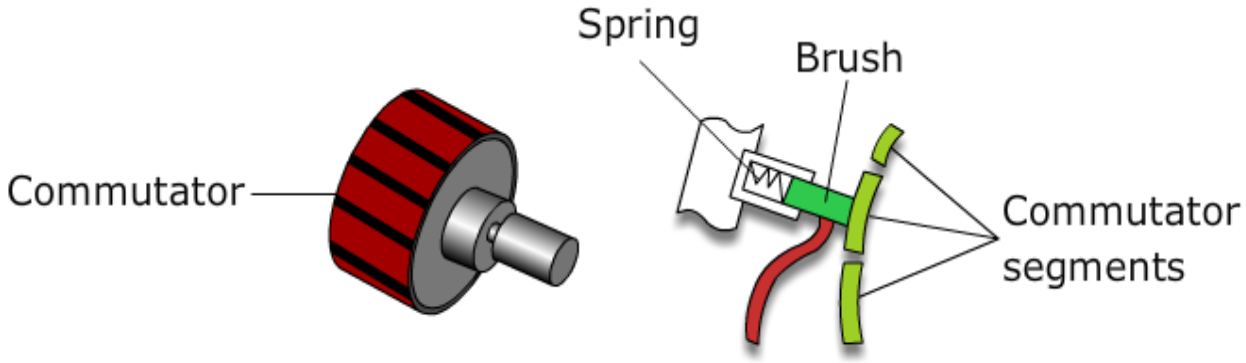
(a)

(b)

Commutator

The commutator converts the alternating emf into unidirectional or direct emf.

Cylindrical structure

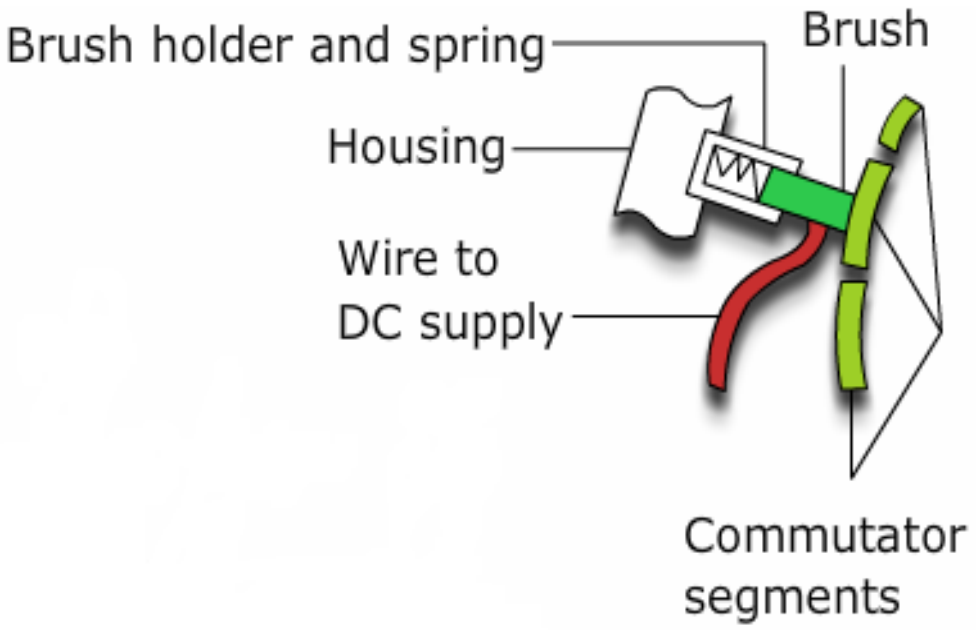


Brushes and Commutator

To produce a magnetic field, direct current passes through the armature's loops of wire.

Brushes

- Made up of **carbon or graphite**, collects the current from the commutator and convey it to the external load resistance.



Terminology

Coil: Two conductors connected in series is called coil of one turn.

Coil side: any side of coil that cuts lines of flux.

Coil span or coil pitch: distance between two coil sides of a coil.

Pole pitch: distance between identical points on adjacent poles.

Pole pitch=No. of conductor/pole

If there are 48 conductors and 4 pole then

Pole pitch=48/4=12.

If coil pitch=pole pitch, called full pitch.

Front pitch(Y_F): distance between the second coilside of one coil and the first coilside of the next coil which are connected at the front i.e. commutator end of the armature.

Back pitch (Y_B):the Distance , measured in terms of the armature conductors, which a coil advances on the back of the armature is called back pitch.

Commutator pitch: distance between the segments to which the two ends of a coil are connected.

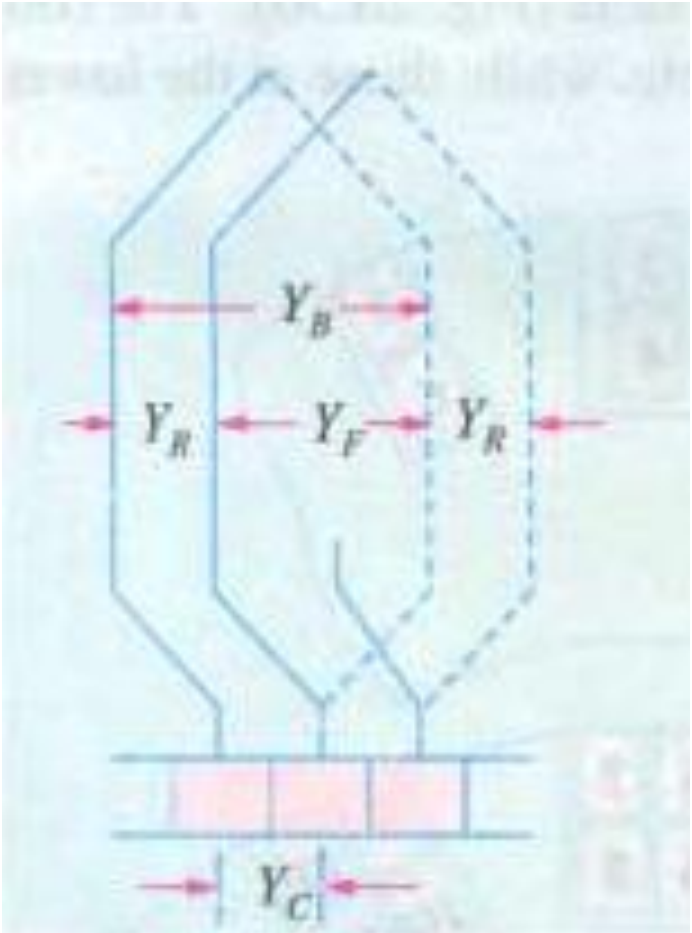


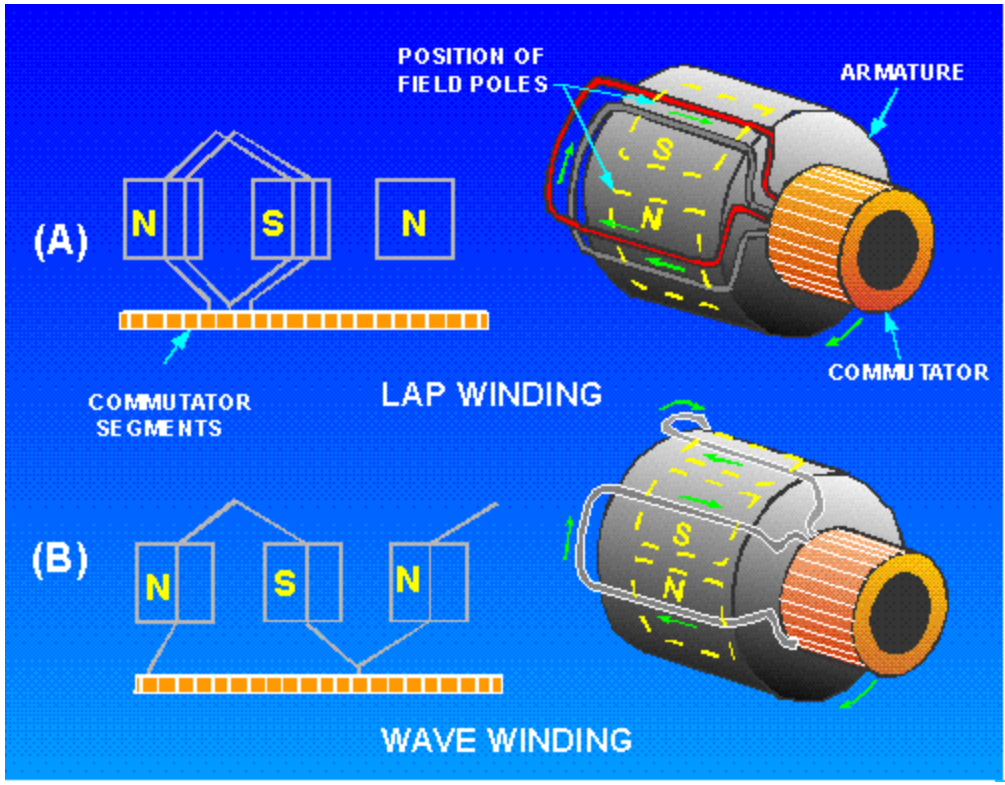
Fig. 26.25

Lap Winding

One coil side must be under the north pole and the other coil side under the south pole.

The coil is placed on the armature and spans the distance from the north pole to the same point on the south pole , or one pole pitch.

In Lap winding, the **finishing end of one coil** is connected to a **commutator segment** and to the starting end of adjacent coil situated under same pole and so on .



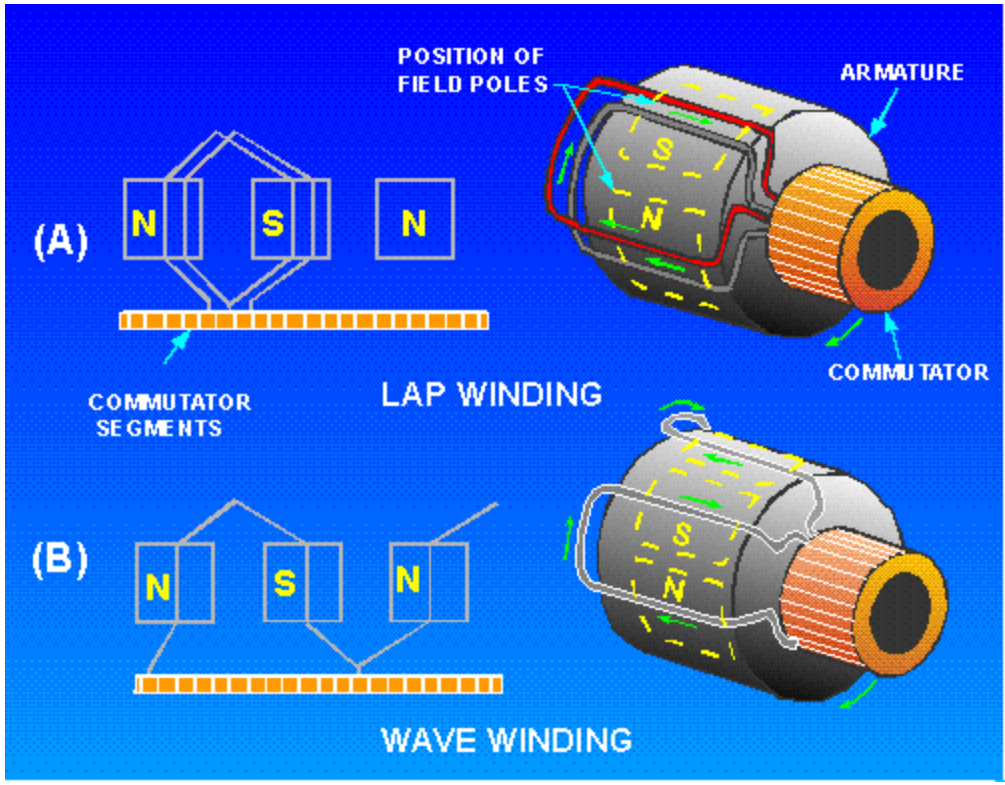
Used in machines designed for low voltage and high current.

Wave Winding

Two coil side does not lie under the same pole pair.

Coil A has one side under the north pole and the other side under the south pole.

Coil B is not located under the same poles as coil A.



Used in machines designed for high voltage and low current

Difference between Lap and Wave winding

- In lap winding, has many parallel paths in the armature.
- No.of parallel paths in armature=mP;

  P=No. of pole

  m=multiplicity of Lap winding
- So it is more suited for high current low voltage application.
- In wave winding the no of parallel path is only two. So it is suitable for high voltage low current application.