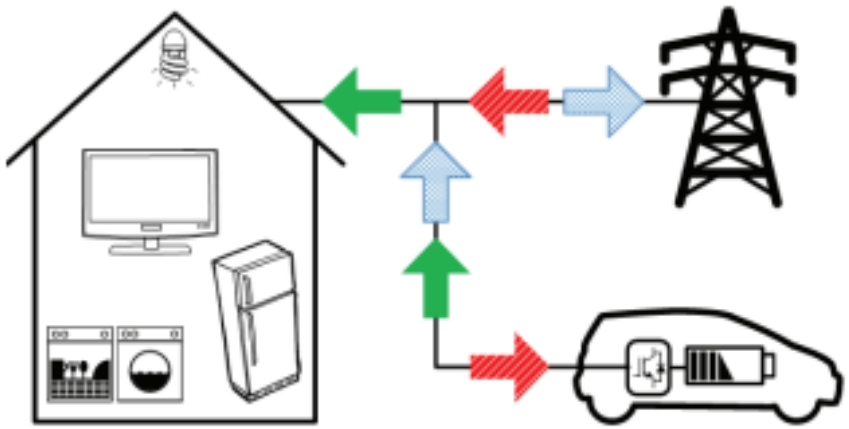
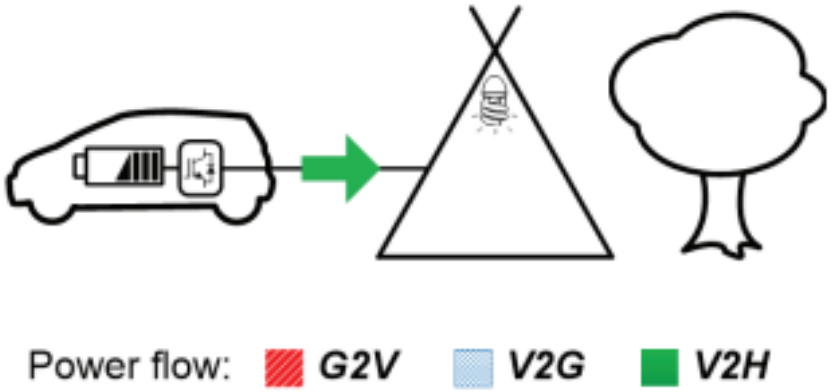
Unit - III
3.5 Elementary Generators

Dr.Santhosh.T.K.

G2V, V2G and V2H technologies





Syllabus

UNIT – III **10 Periods**

Principles of Electro Magnetics and Electro-mechanics: Electricity and Magnetism - magnetic field and faraday's law - self and mutual inductance - Ampere's law - Magnetic circuit - Magnetic material and B-H Curve – Single phase transformer - principle of operation - EMF equation - voltage ratio - current ratio – KVA rating - Electromechanical energy conversion – Elementary generator and motors.

Elementary Motor and Generator

- Motor
  - Electrical to mechanical energy conversion
- Generator
  - Mechanical to electrical energy conversion

Faraday's Laws

First Law :

Whenever the magnetic flux linked with a circuit changes, an e.m.f. is always induced in it.

or

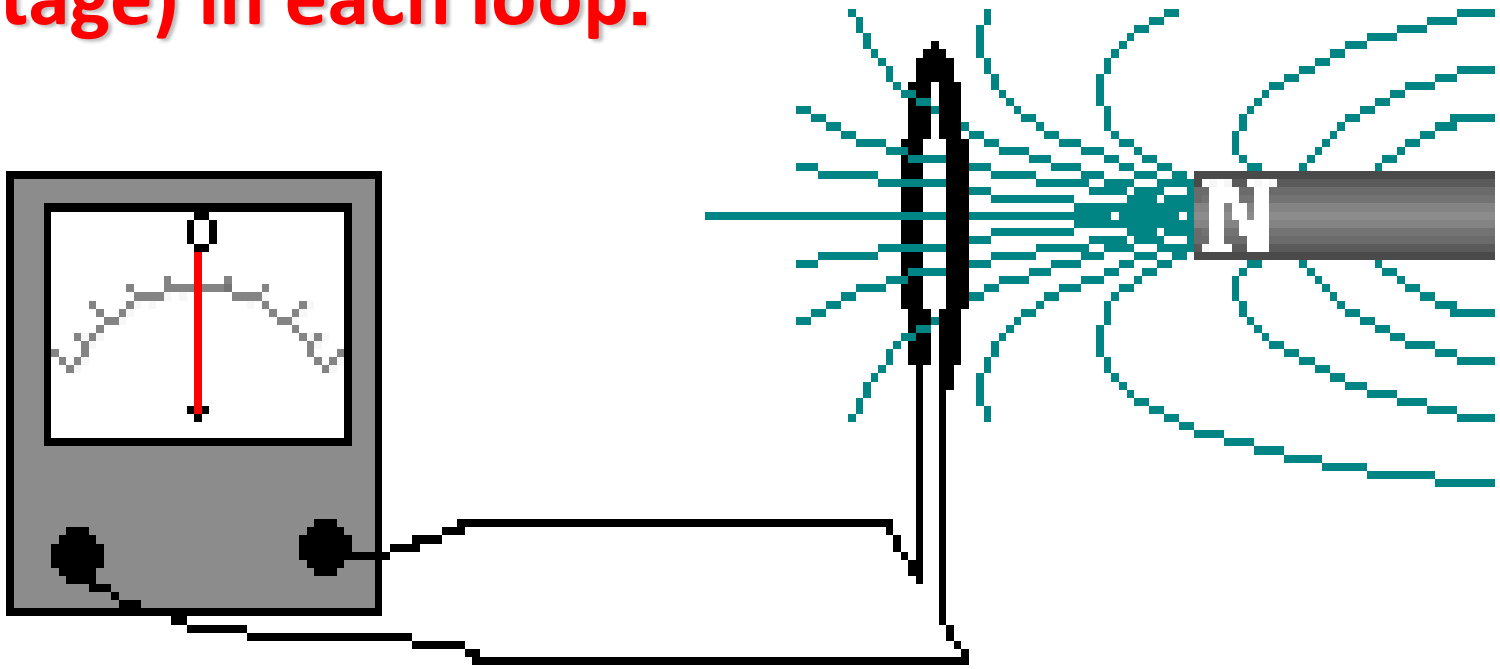
Whenever a conductor cuts magnetic flux, an e.m.f. is induced in that conductor.

Second Law :

The magnitude of the induced e.m.f. is equal to the rate of change of flux linkages.

Faradays Law of Electromagnetic Induction

A changing magnetic flux through a loop or loops of wire induces an electromotive force (voltage) in each loop.



Lenz's Law

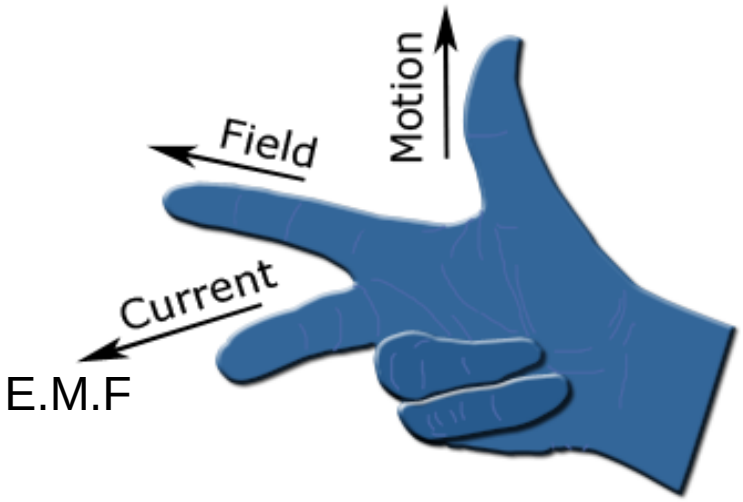
"The induced currents in a conductor are in such a direction as to oppose the change in magnetic field that produces them.."

OR

"The direction of induced E.M.F in a coil (conductor) is such that it opposes the cause of producing it.."

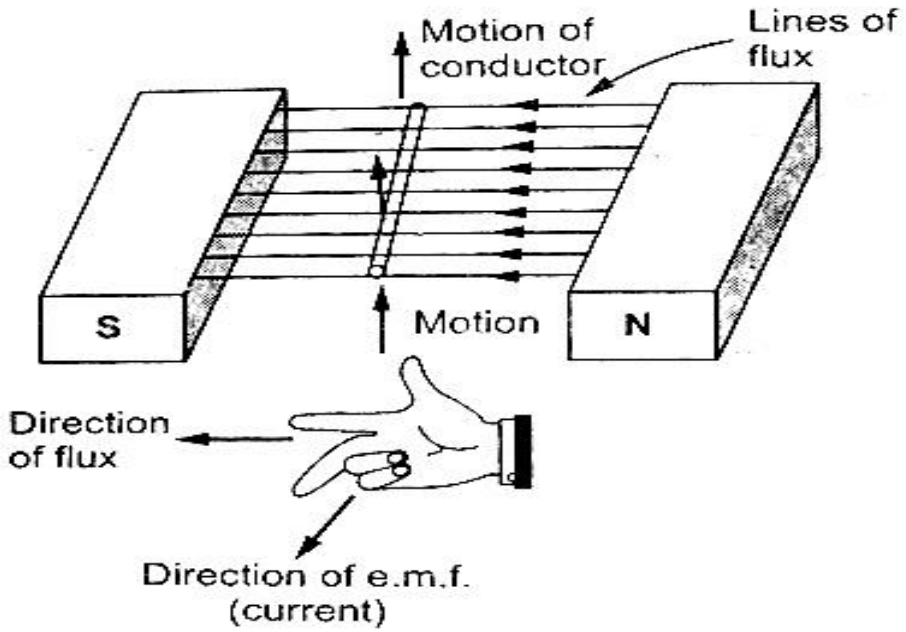
Fleming's Right Hand Rule

For generators



- **The Thumb represents the direction of Motion of the conductor.**
- **The First finger (four finger) represents Field.**
- **The Second finger (Middle finger) represents Current**

Fleming's Right Hand Rule



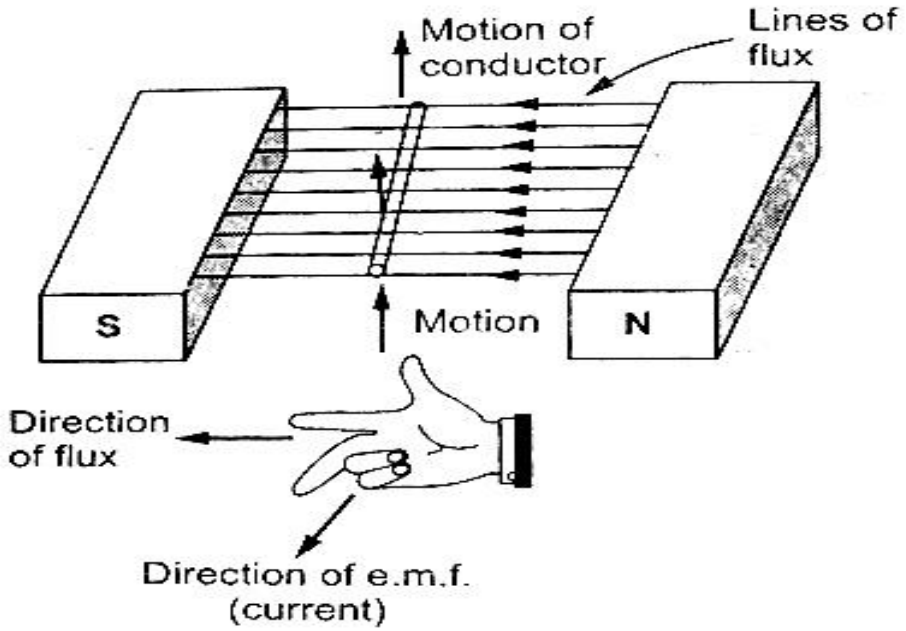
Basic requirements for E.M.F. generation

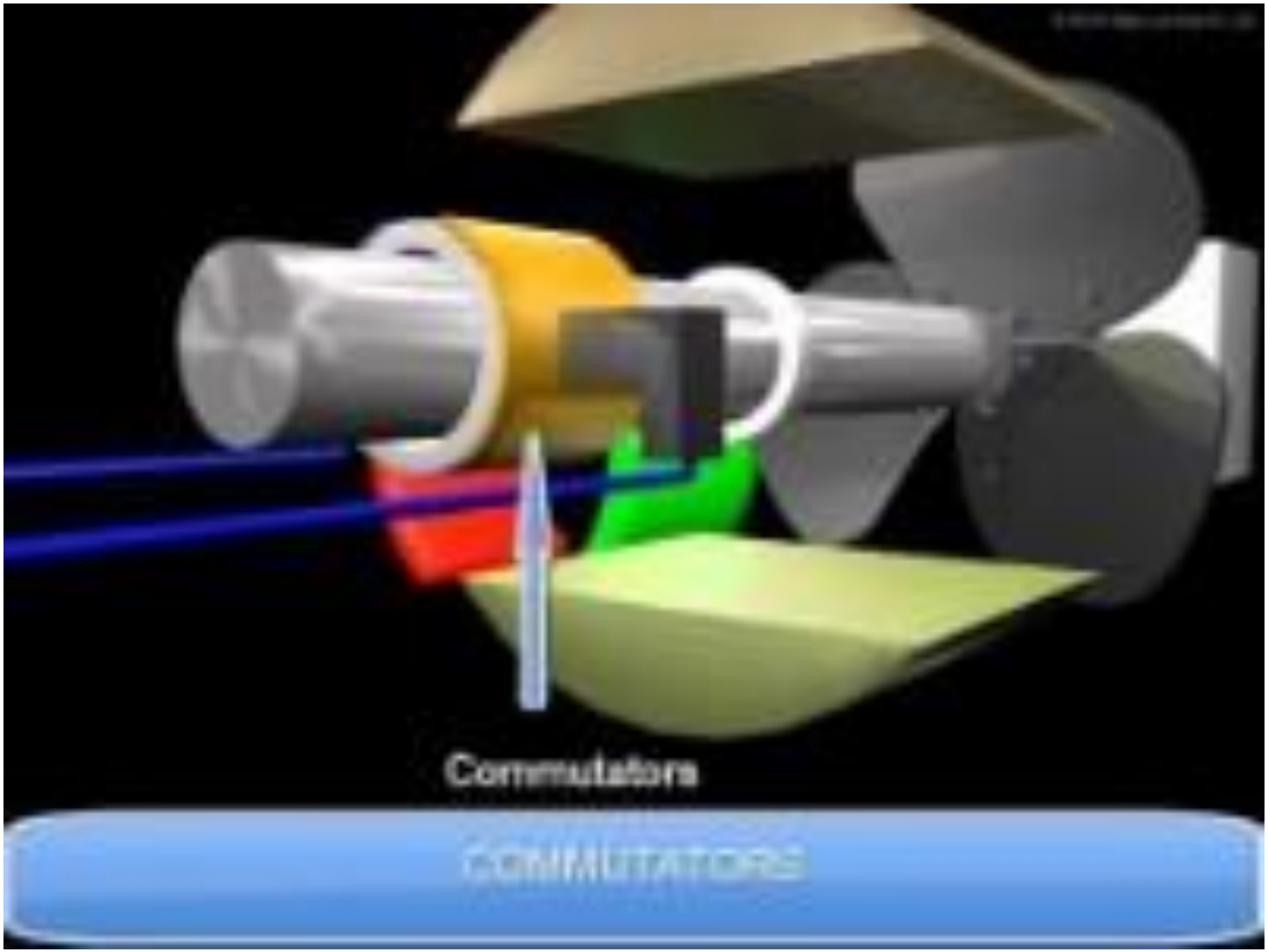
1.A uniform Magnetic field

2.A System of conductors

3.Relative motion between the magnetic field and conductors

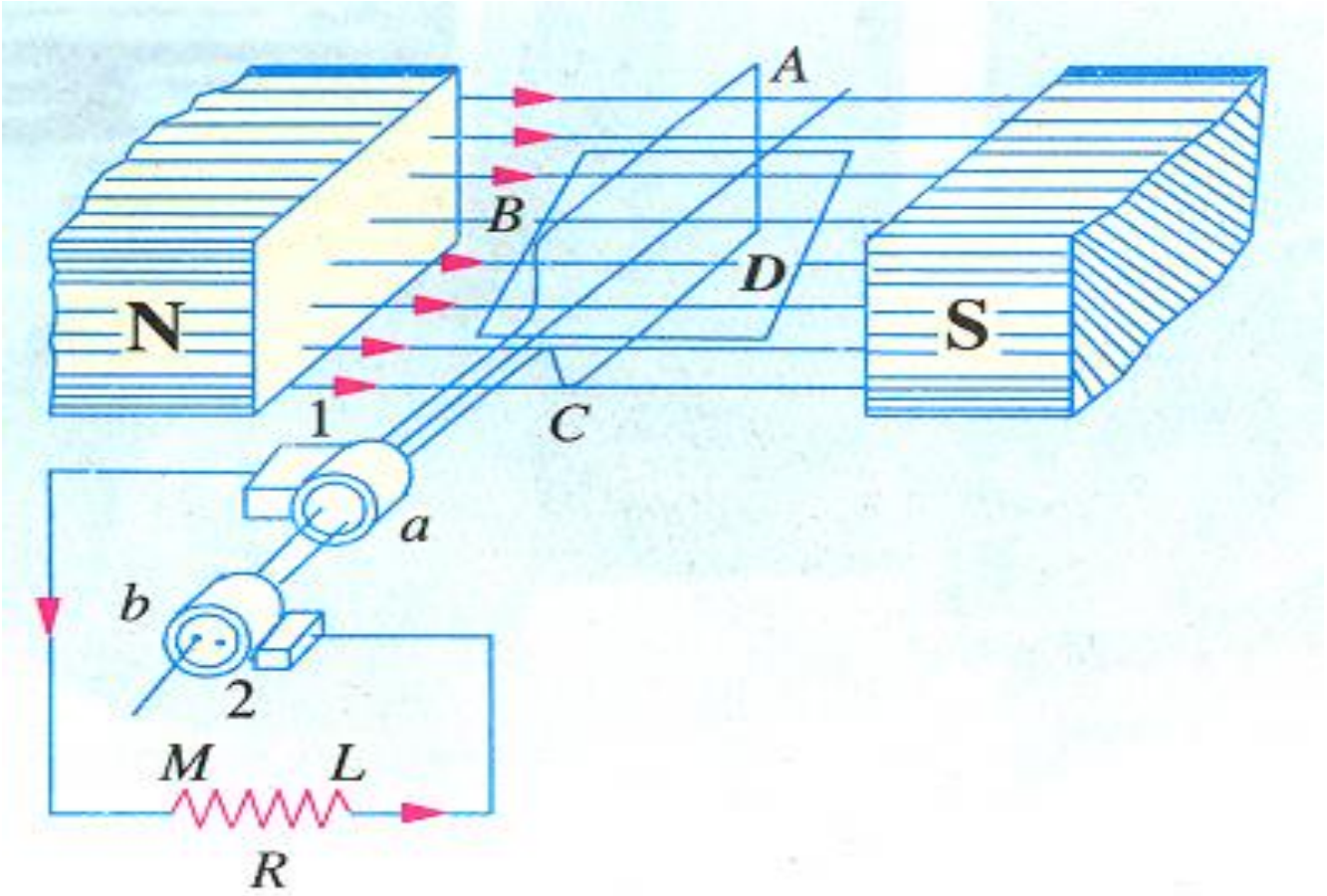
Elementary Generator



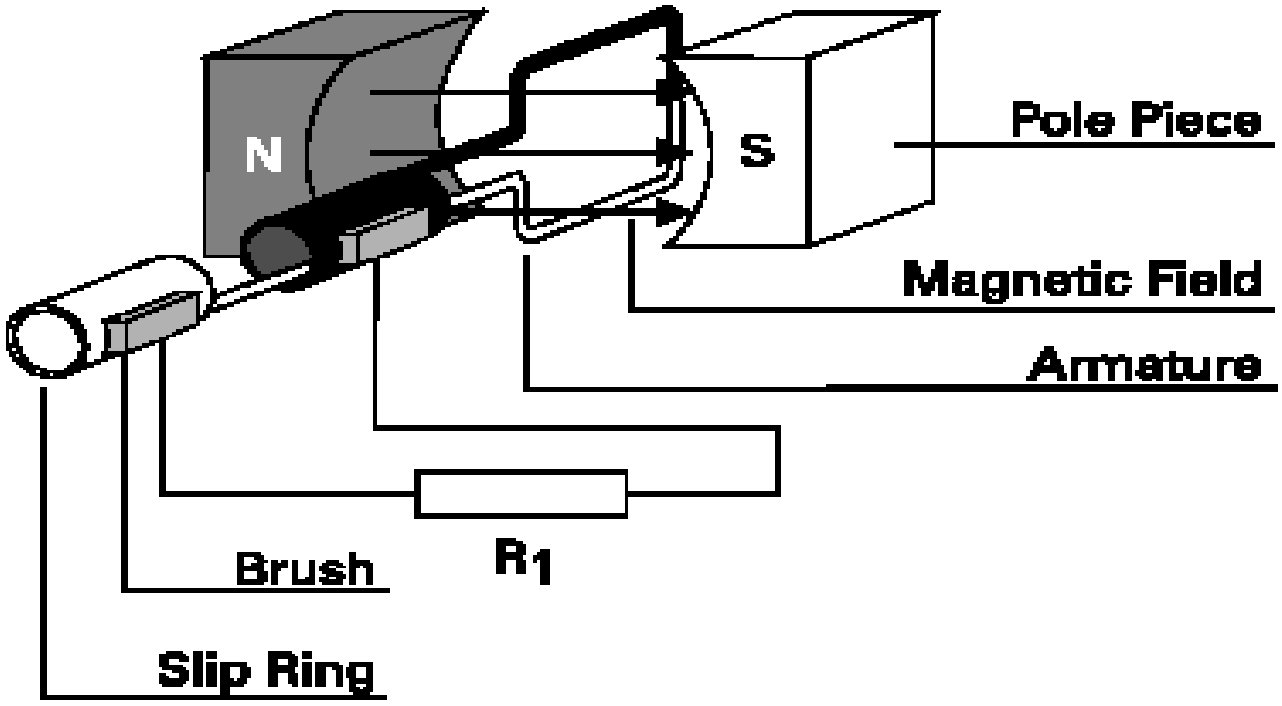


Video 1

Simple loop generator

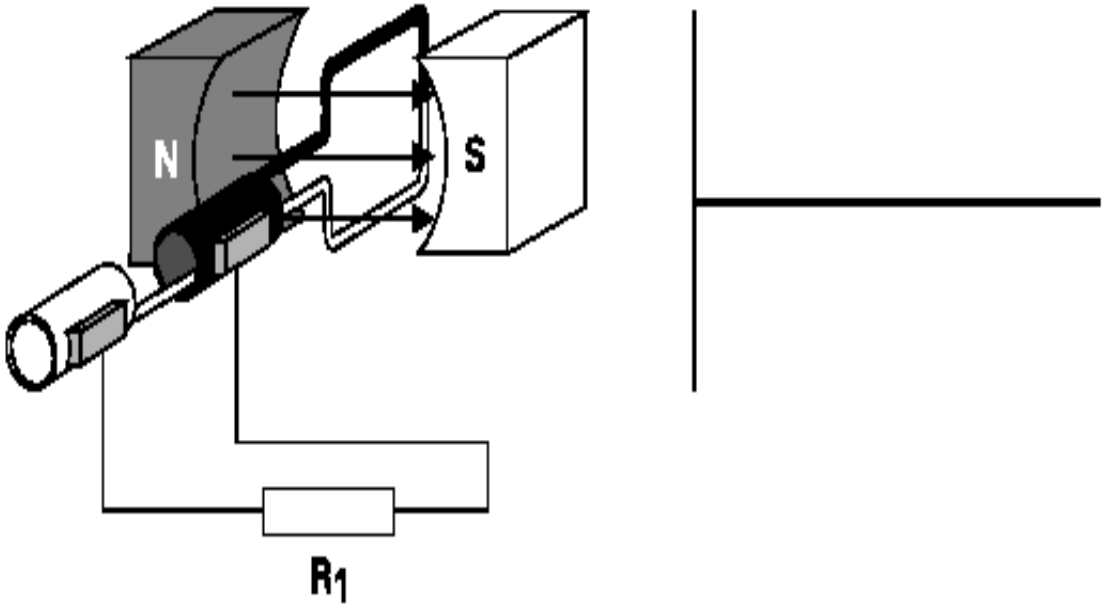


Basic Generator



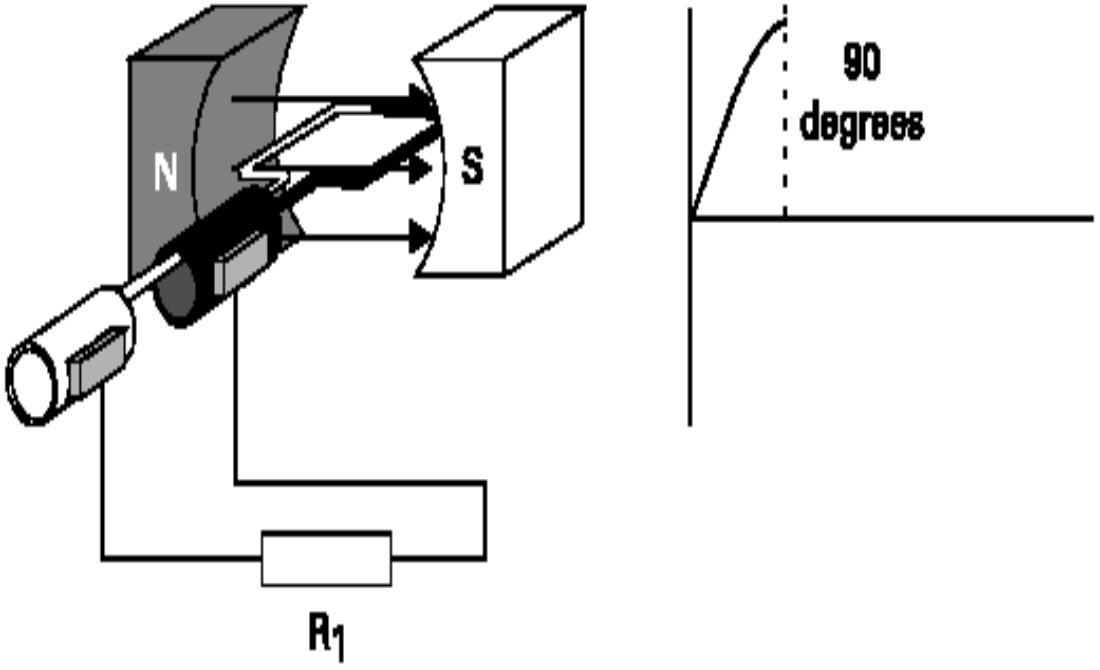
Basic generator operation

An armature rotates through the magnetic field. At an initial position of zero degrees, the armature conductors are moving parallel to the magnetic field and not cutting through any magnetic lines of flux. No voltage is induced.



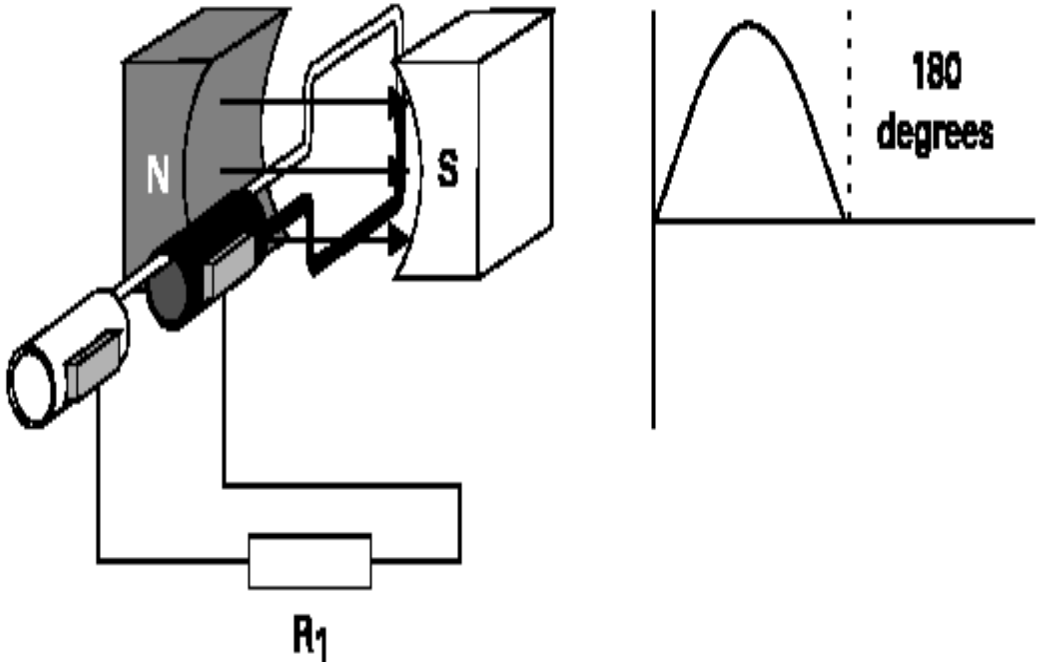
Generator operation from zero to 90 degrees

The armature rotates from zero to 90 degrees. The conductors cut through more and more lines of flux, building up to a maximum induced voltage in the positive direction.



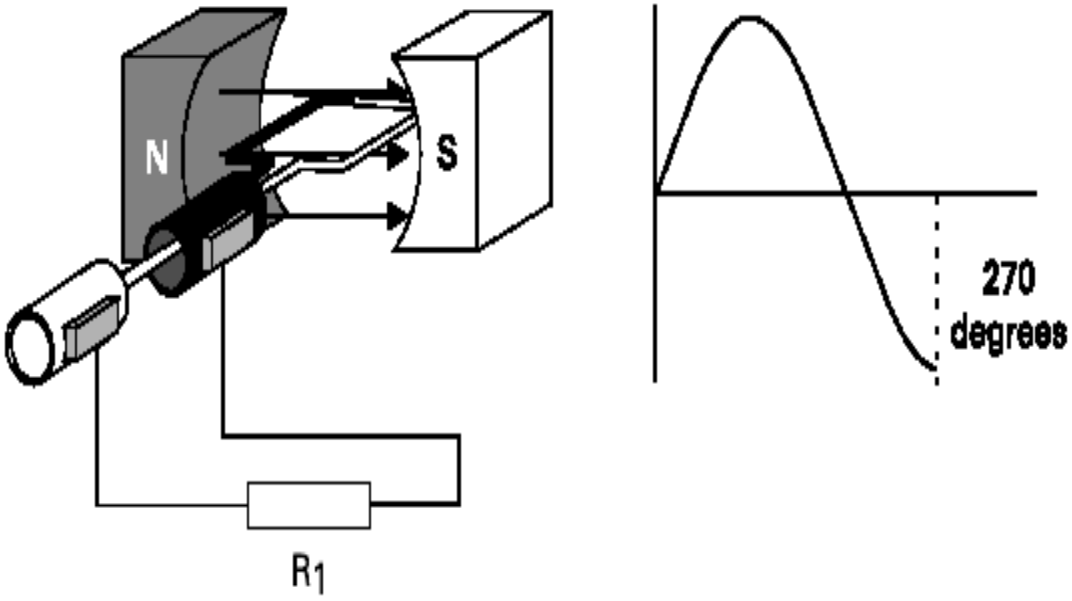
Generator operation from 90 to 180 degrees

The armature continues to rotate from 90 to 180 degrees, cutting less lines of flux. The induced voltage decreases from a maximum positive value to zero.



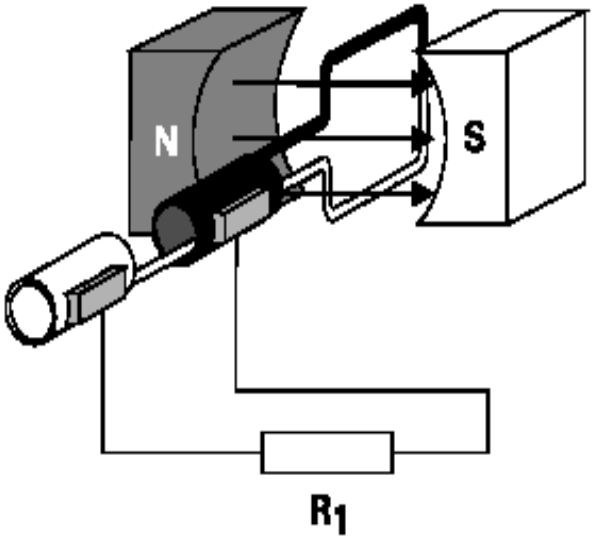
Generator operation from 180 to 270 degrees

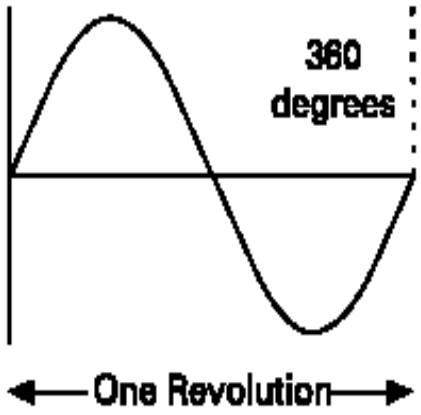
The armature continues to rotate from 180 degrees to 270 degrees. The conductors cut more and more lines of flux, but in the opposite direction. Voltage is induced in the negative direction building up to a maximum at 270 degrees.



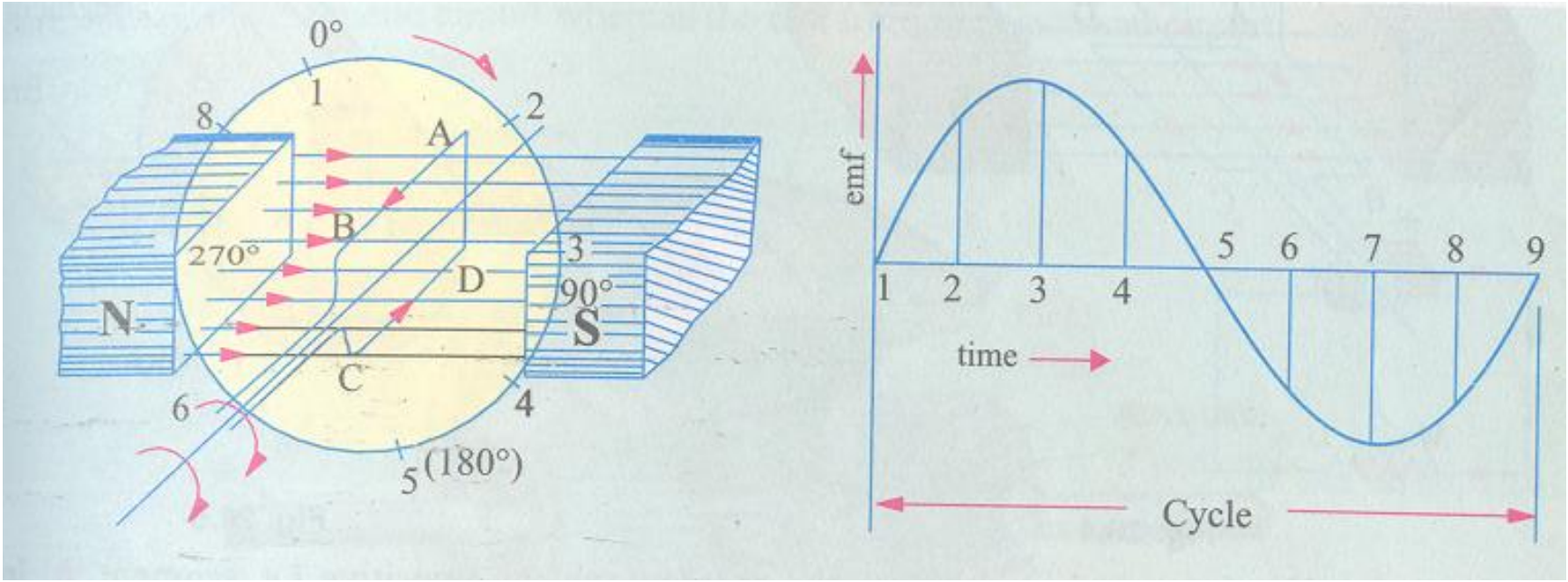
Generator operation from 270 to 360 degrees

The armature continues to rotate from 270 to 360 degrees. Induced voltage decreases from a maximum negative value to zero. This completes one cycle. The armature will continue to rotate at a constant speed. The cycle will continuously repeat as long as the armature rotates.

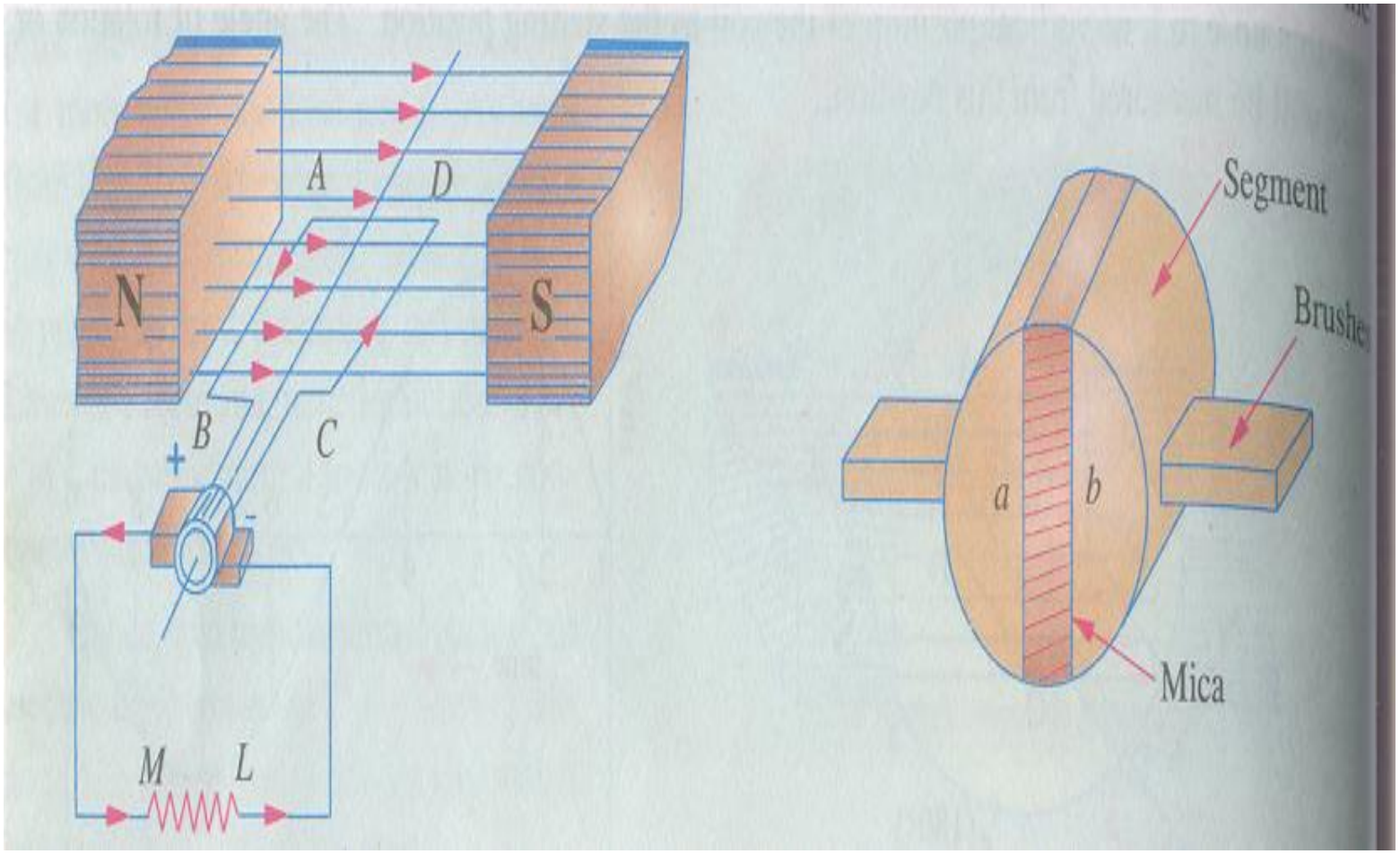




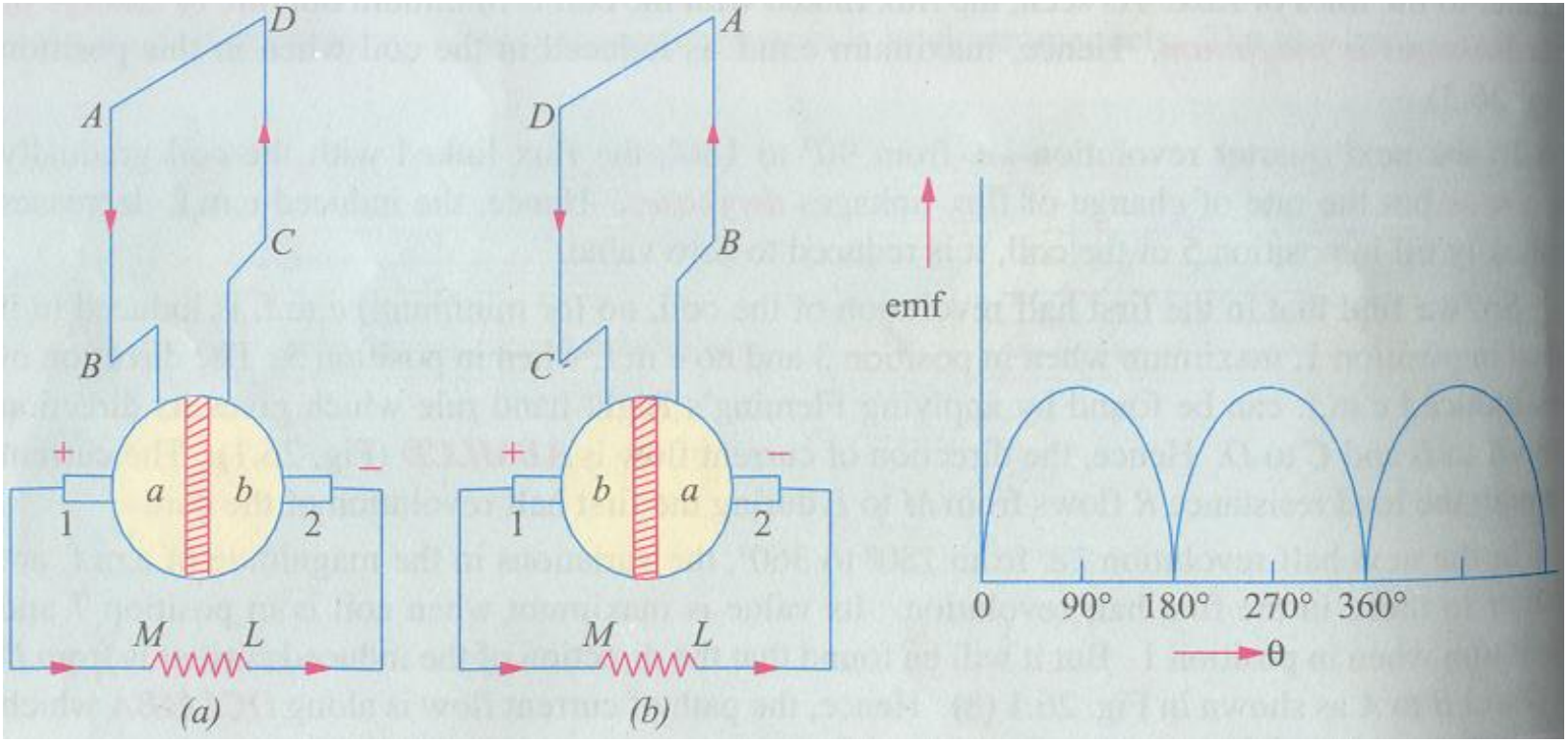
Simple loop generator with slip ring



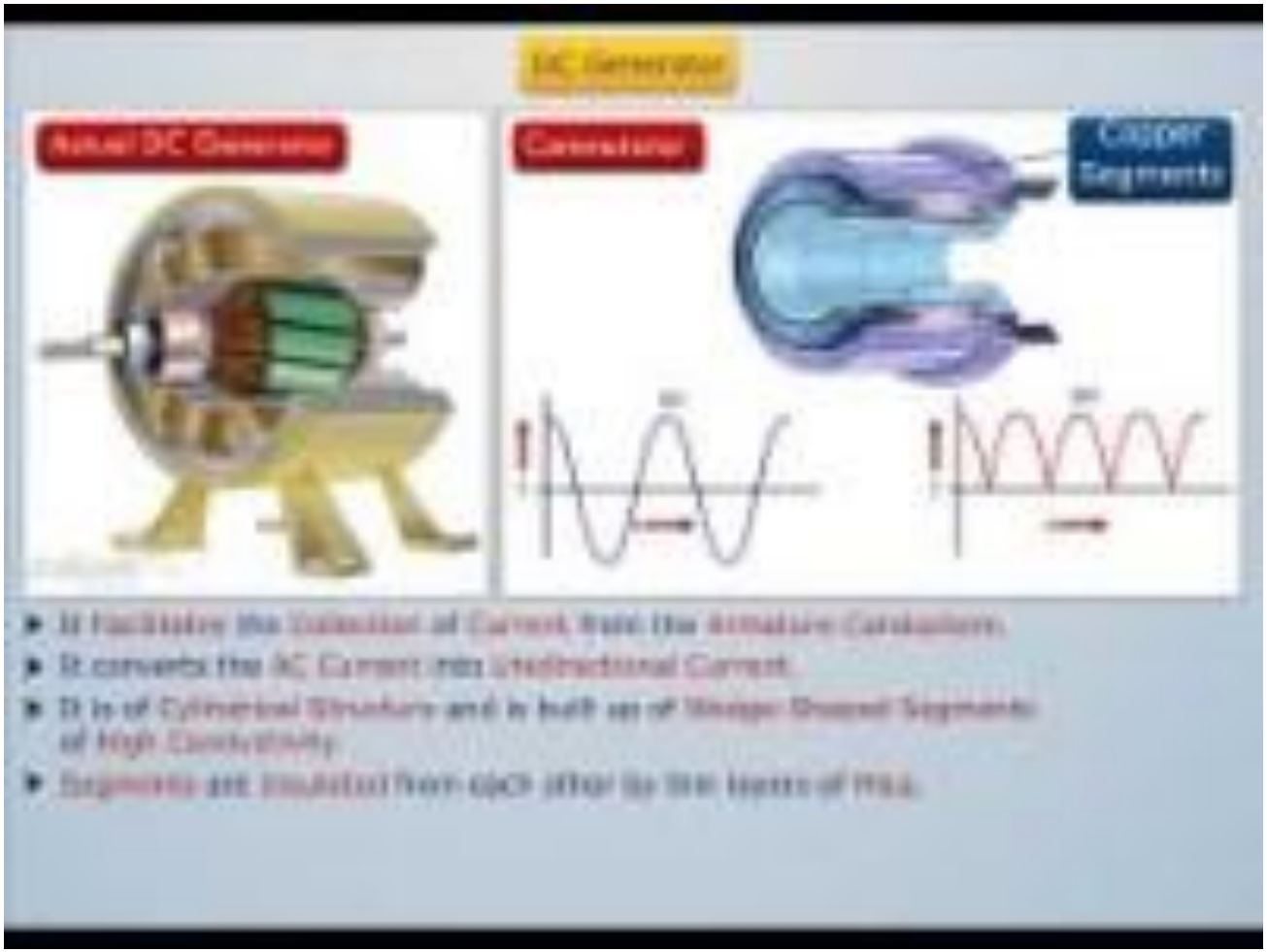
Simple loop generator with split ring



Simple loop generator with split ring



DC Machine Construction

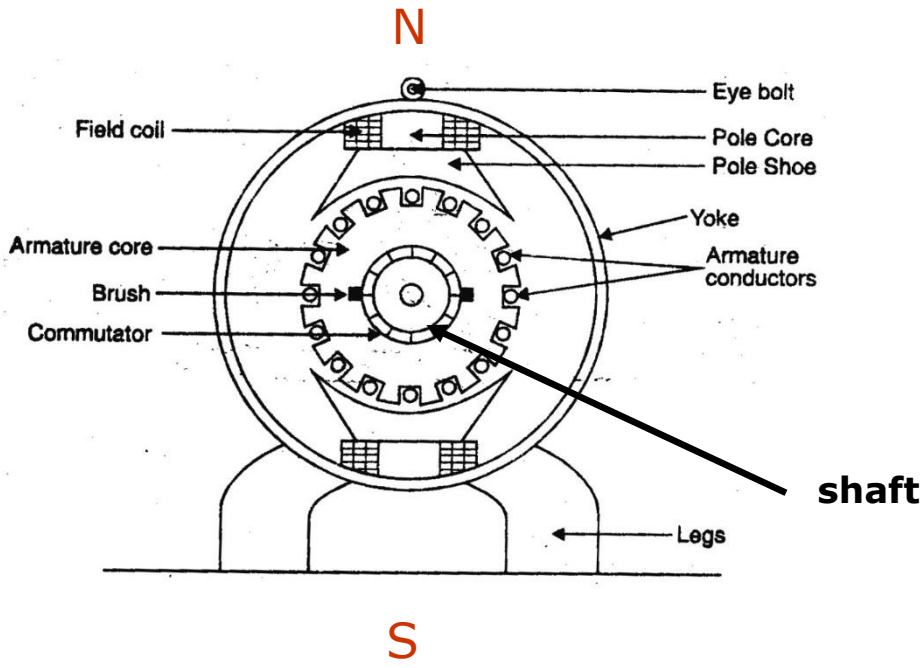


[Video 2]

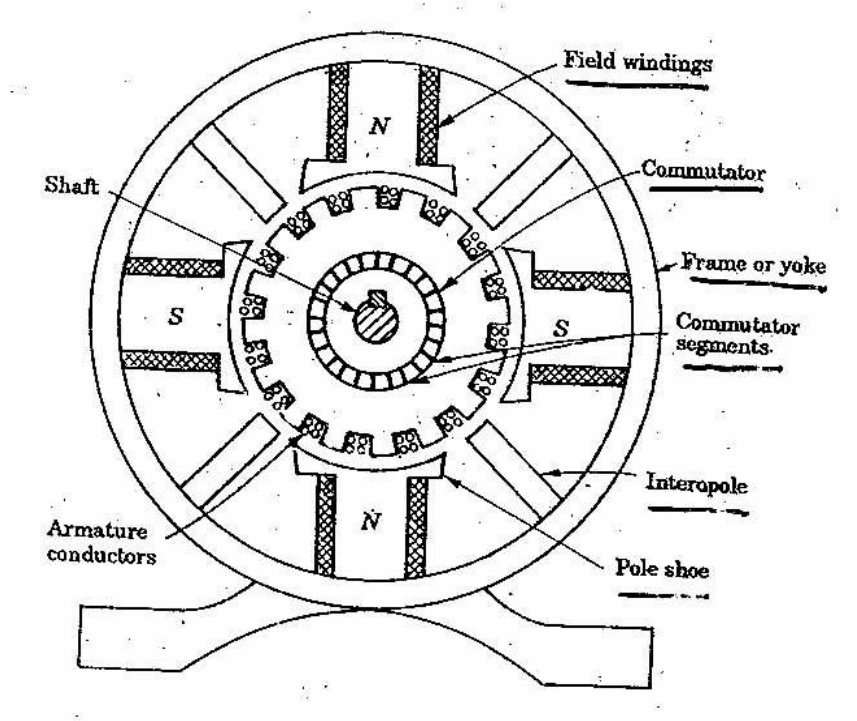
Constructional Details Of DC Machine

- **Yoke:**
- **Rotor:**
- **Stator:**
- **Field electromagnets:**
- **Pole core and pole shoe:**
- **Brushes:**
- **Shaft:**
- **Armature:**
- **Coil:**
- **Commutators:**
- **Bearings:**

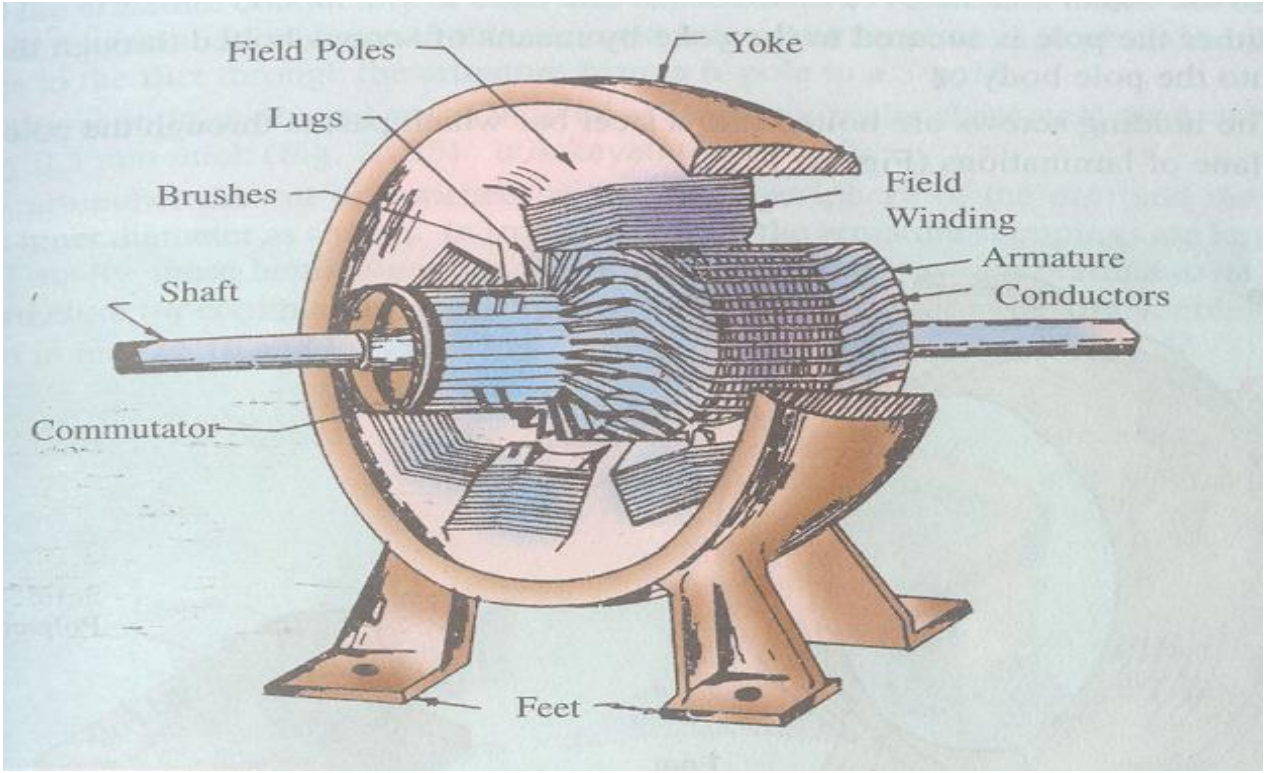
Cross section view of a DC machine



Main parts of a 4-pole DC machine



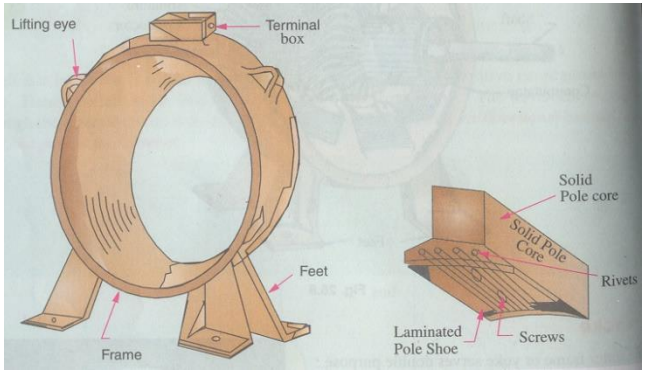
Practical DC Machine



1)Yoke

1)Yoke:-

- Acts as frame of the machine
- Mechanical support
- low reluctance for magnetic flux
- High Permeability
  - -- For Small machines -- Cast iron—low cost
  - -- For Large Machines -- Cast Steel (Rolled steel)



Large DC machine

Small DC machine

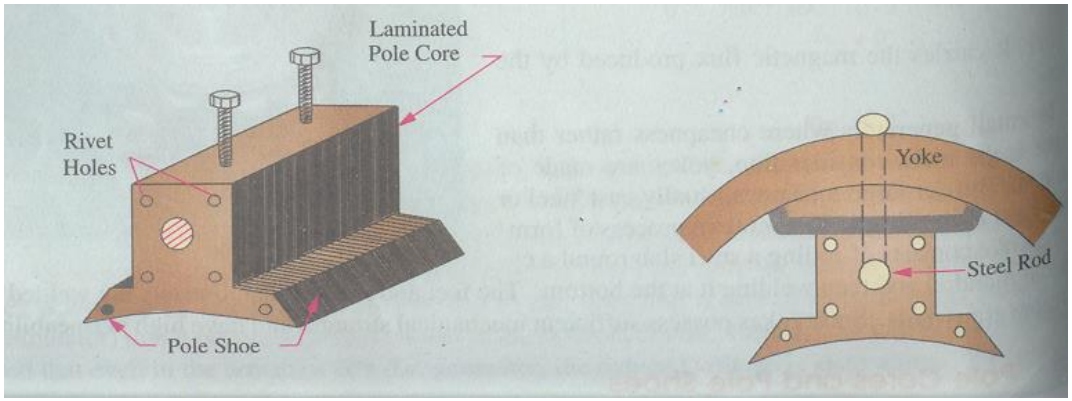
2)pole cores and pole shoes

2)Field Magnets:-

a) Pole core (Pole body) :- --Carry the field coils
--Rectangle Cross sections
-- Laminated to reduce heat losses
--Fitted to yoke through bolts

b) Pole shoe:- Acts as support to field poles
and spreads out flux

Pole core & Pole shoe are laminated of annealed steel
(Of thickness of 1mm to 0.25 mm)



2)pole cores and pole shoes

2)Field Magnets:-

c) Field coils (Magnetizing coils):- -- Provide excitation
(exciting coils) I . e field flux

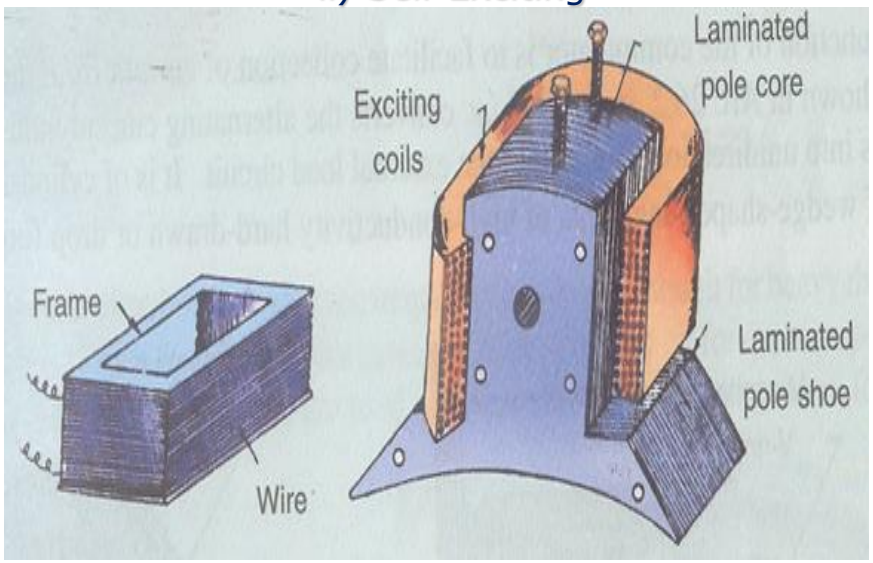
--Number of poles depends speed of armature on and the output for which the machine designed

--Frame to used for design for exciting coils

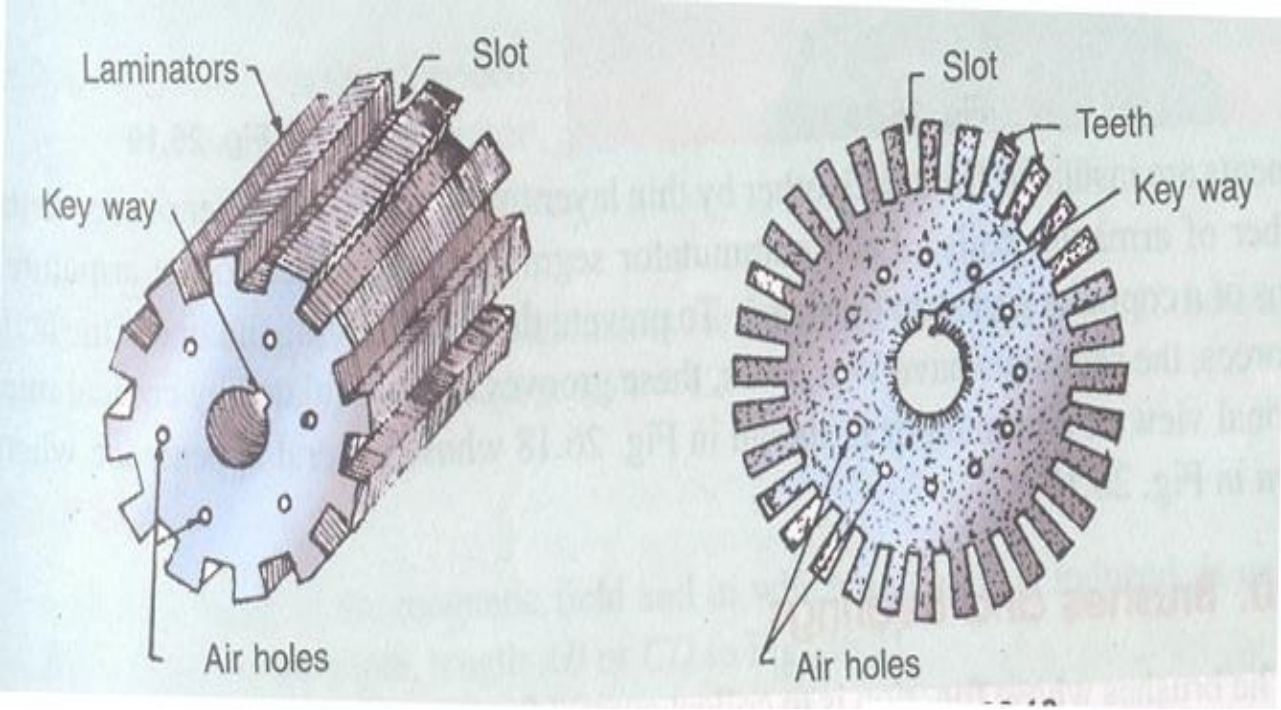
Different types of fields

i) Separately Exciting

ii) Self Exciting



3)Armature core



3)Conductor system:-

a) Armature core (Armature):-

-- To support armature windings

--To rotate conductors in a magnetic field

-- it is cylindrical or drum shaped is built

--Made of high permeability silicon steel stampings (of 0.5 mm thick)

-- Each stamping is separated from its neighboring one by thin varnish as insulation

--Laminated to reduce eddy current losses

-- A small air gap between pole pieces and armature so that no rubbing between them

-- High grade silicon steel used to reduce

i) Hysteresis loss

ii) Eddy current loss

-- Ventilating ducts are provided to dissipate heat to dissipate heat generated by above losses

b) Armature Winding:-

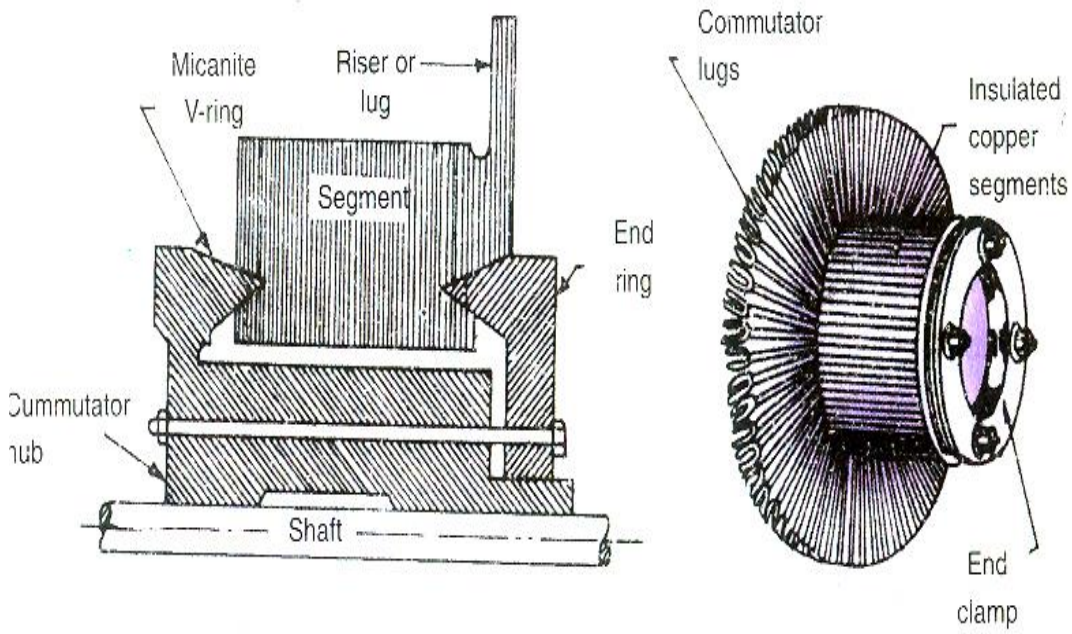
Main flux cuts armature and hence E.M.F is induced

--winding made of Copper (or) Aluminum

--windings are insulated each other

4)commutator

4) Commutator:--Hard drawn copper bars segments insulated from each other by mica segments (insulation)
-- Between armature & External circuit
-- Split-Rings (acts like Rectifier AC to DC)



5&6 Bearings and Brushes

5)Brushes and brush gear:-

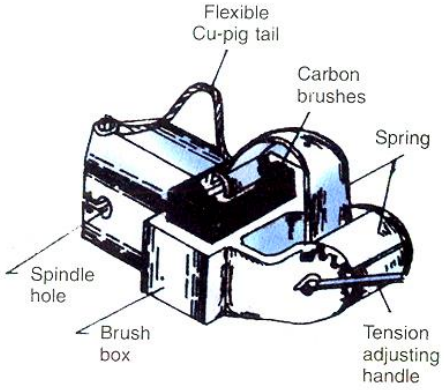
Carbon, Carbon graphite, copper used to Collects current from commutation (in case of Generator)

6)Shaft and bearings:-

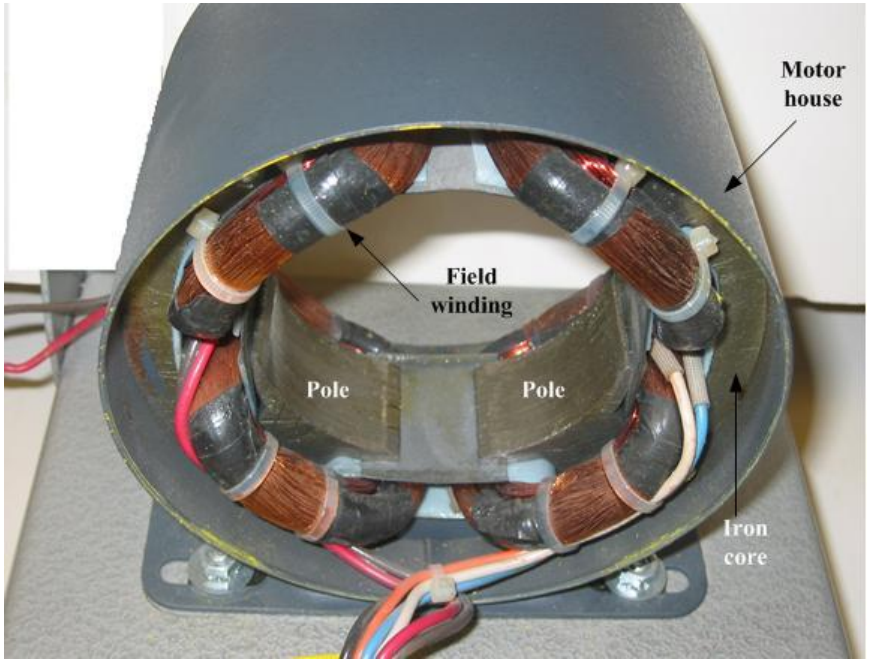
Shaft-- Mechanical link between prime over and armature

Bearings– For free rotation

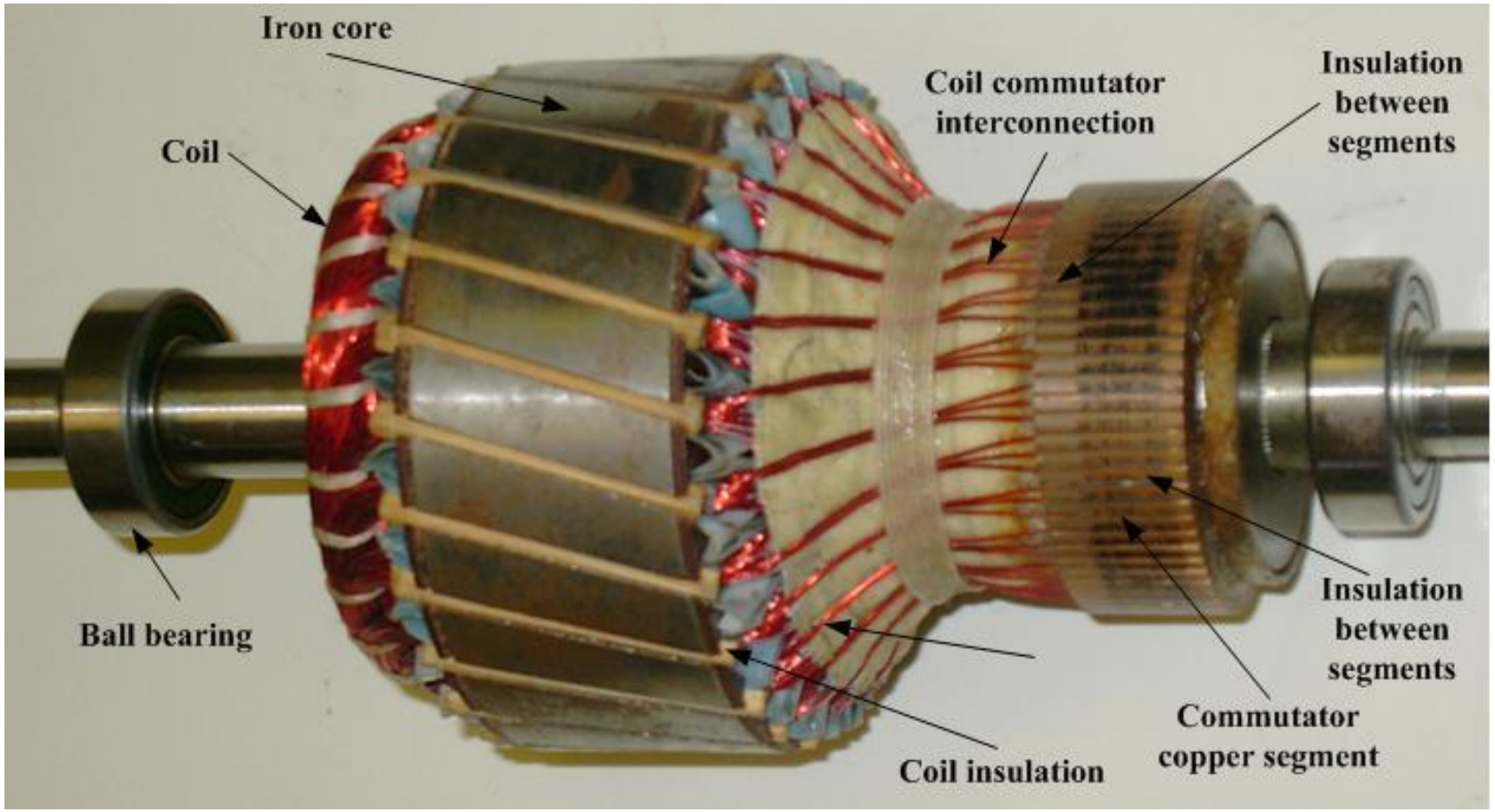
Bearing



DC Machine Construction



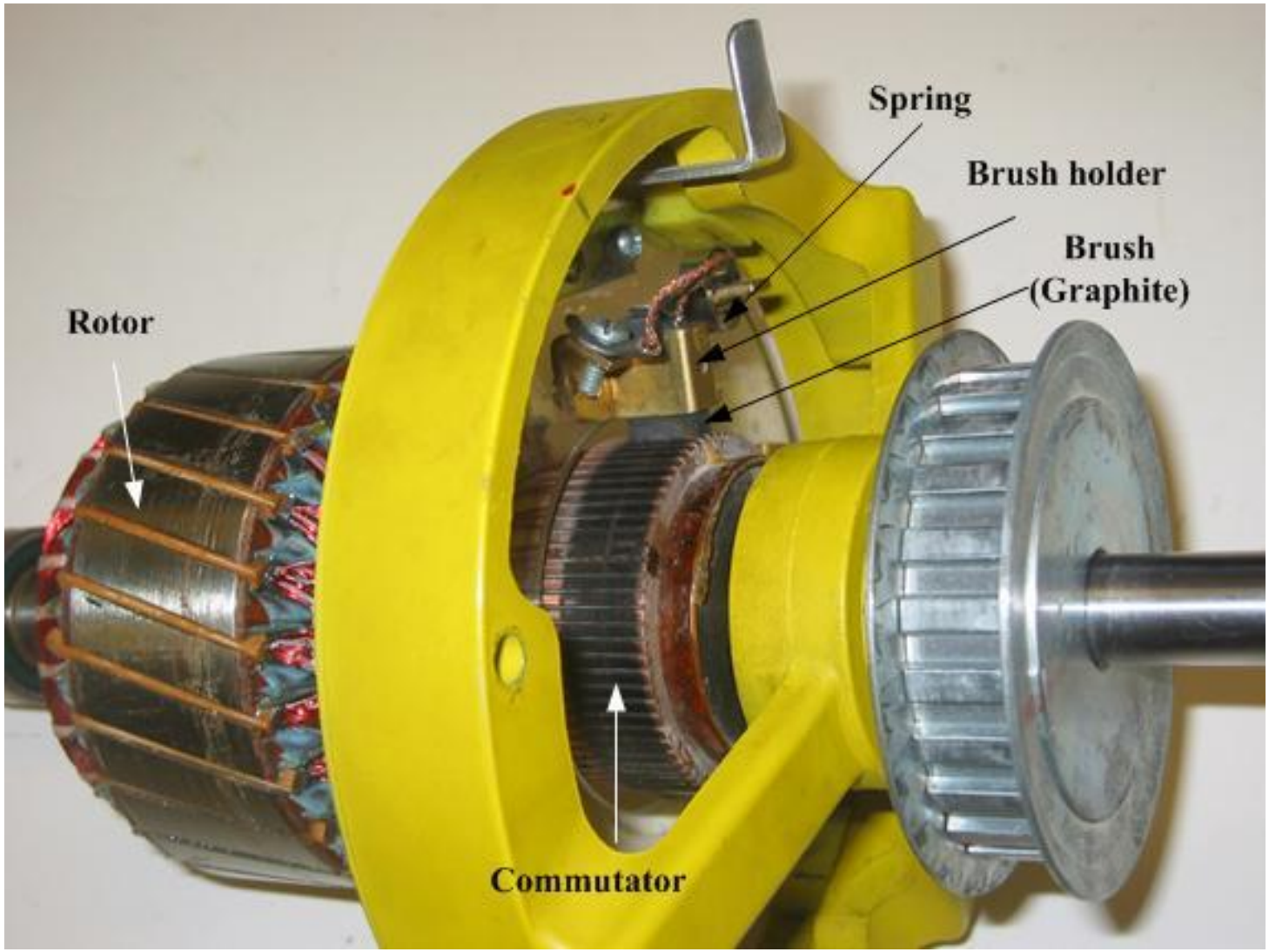
DC Machine Construction



Rotor of a dc machine

DC Machine Construction

Cutaway view of a dc machine



Summary

- Elementary generators
- Construction of a DC machine
- Types