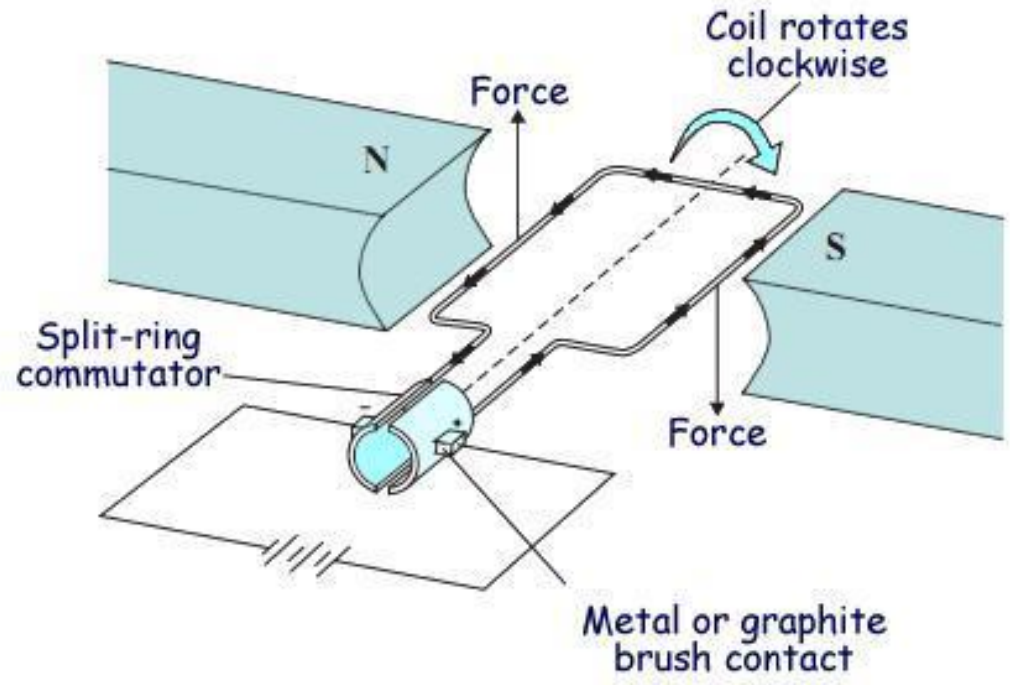
Lecture-29

On

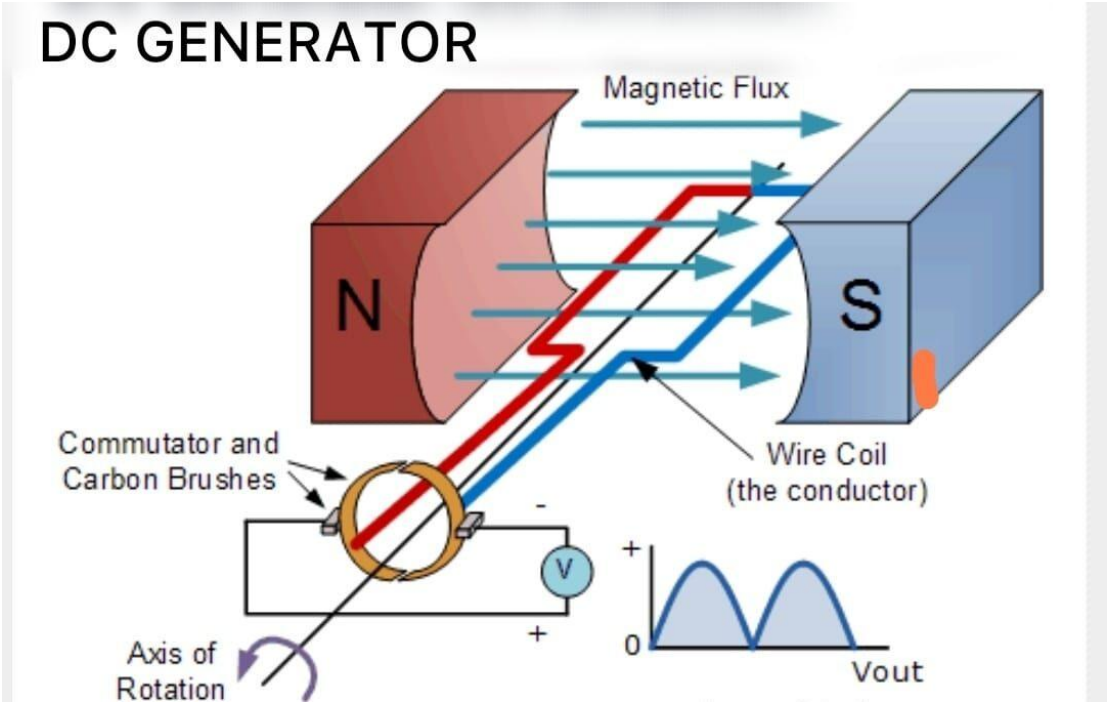
INTRODUCTION TO ELECTRICAL ENGINEERING (ESO203)

- DC generator.

Introduction to Machines (Cont...)

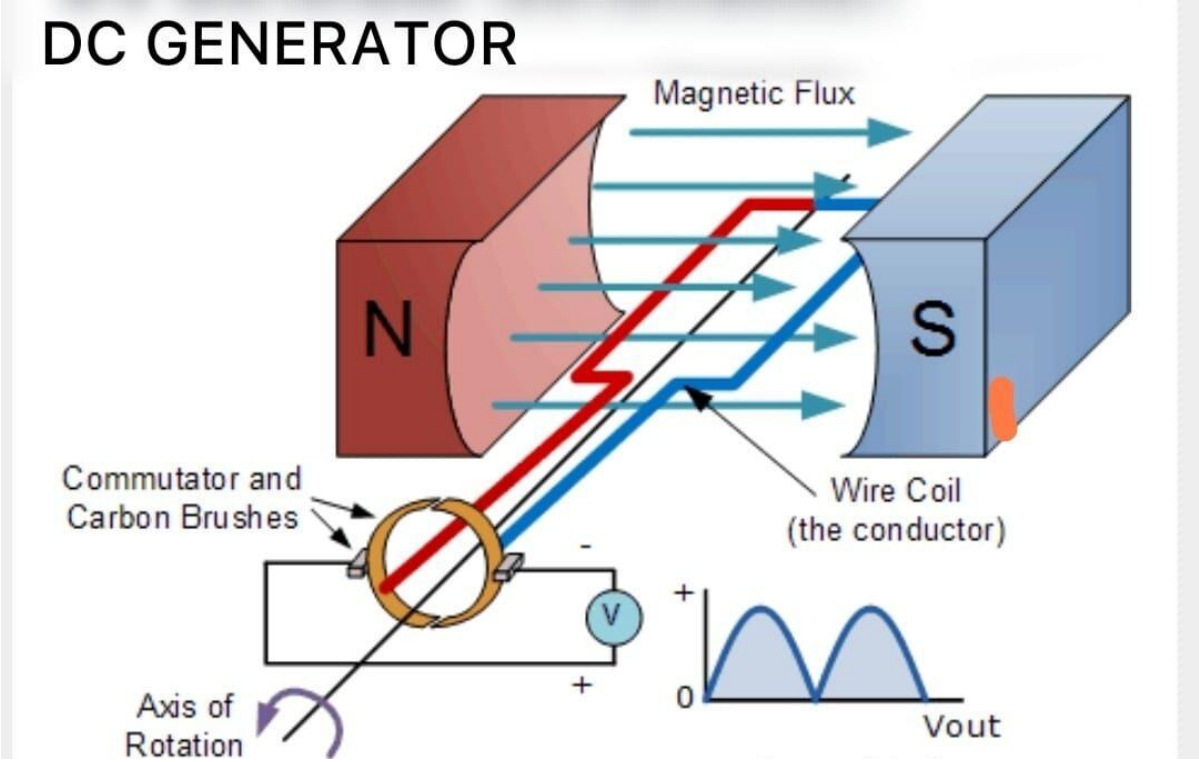


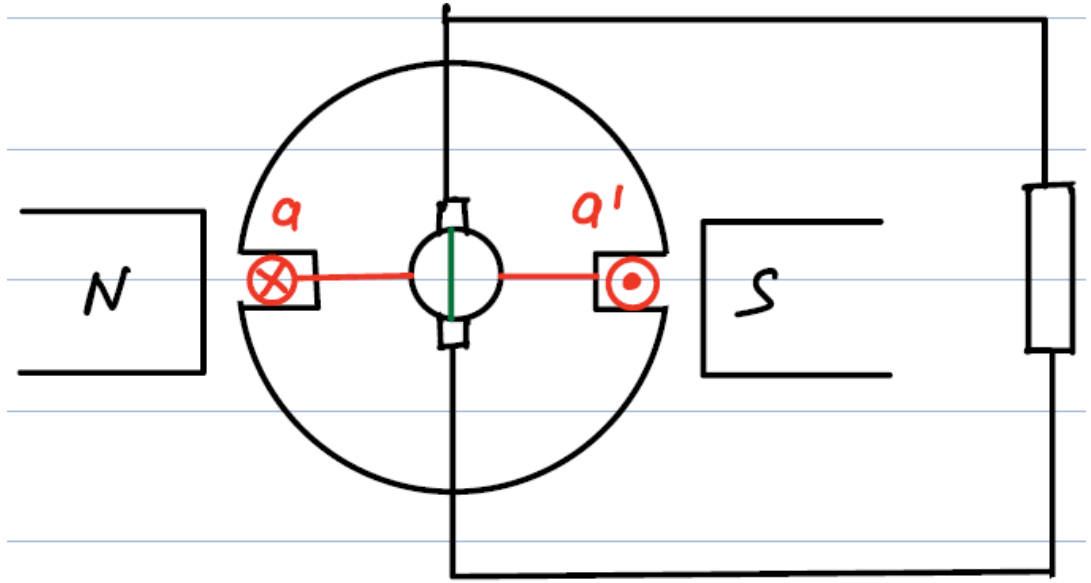
Operation of DC motor



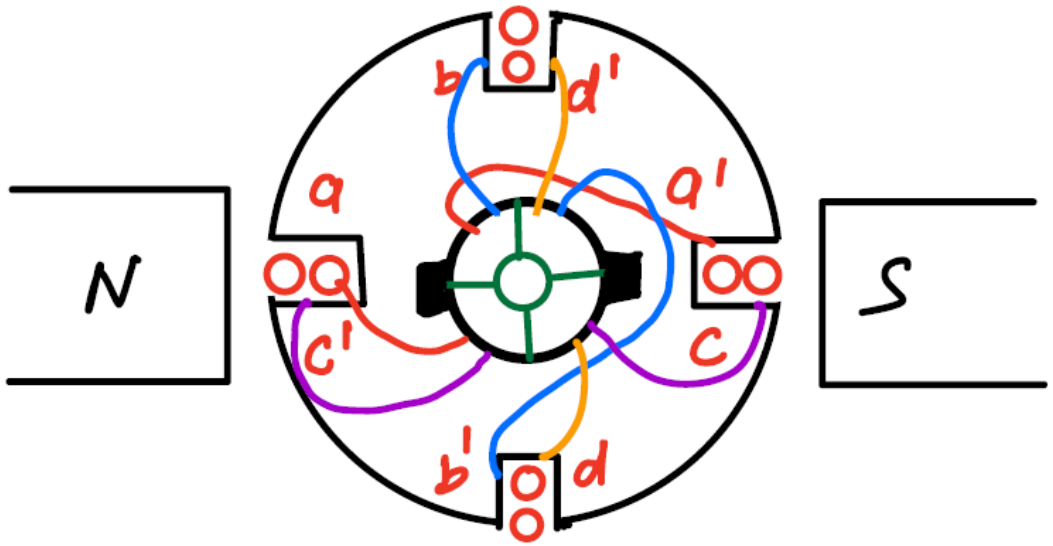
Operation of DC generator

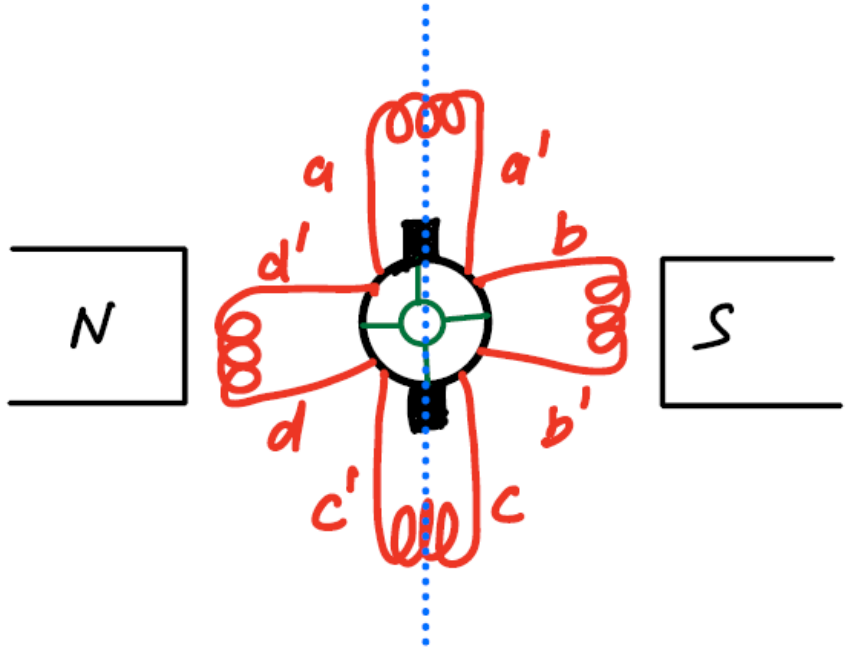
DC Generator

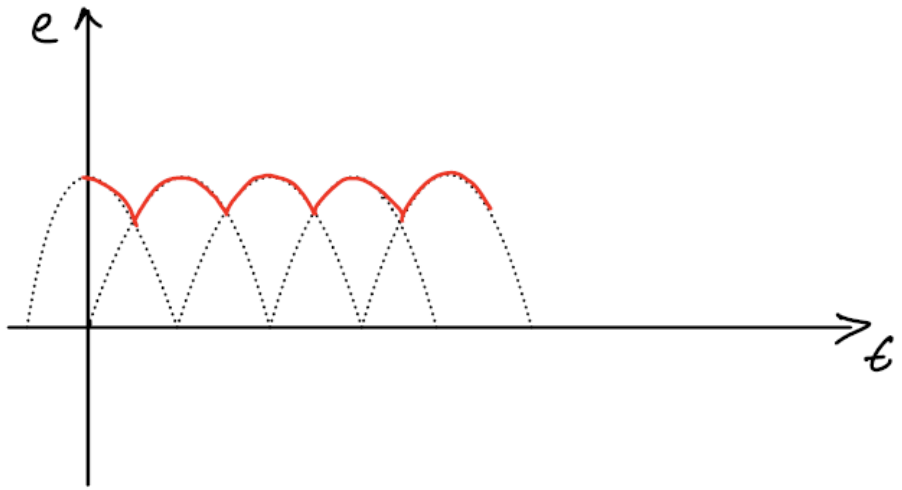




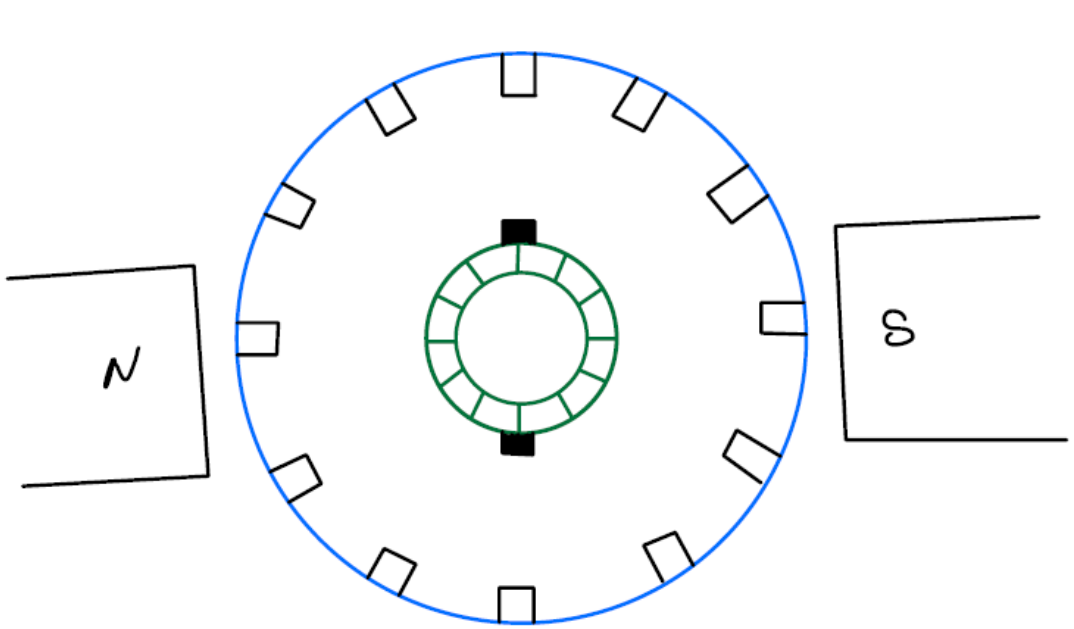
DC Generator (cont...)

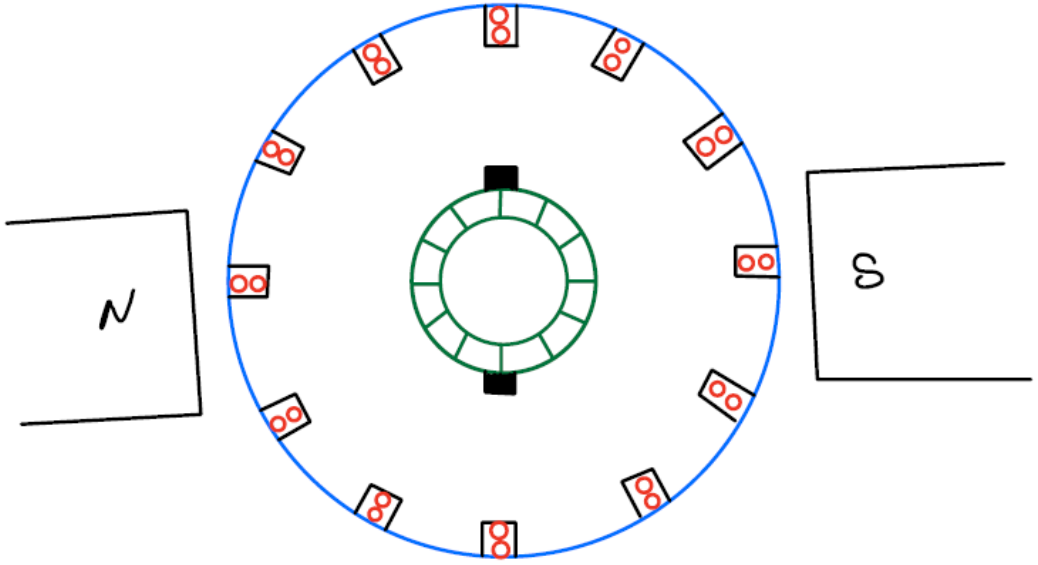


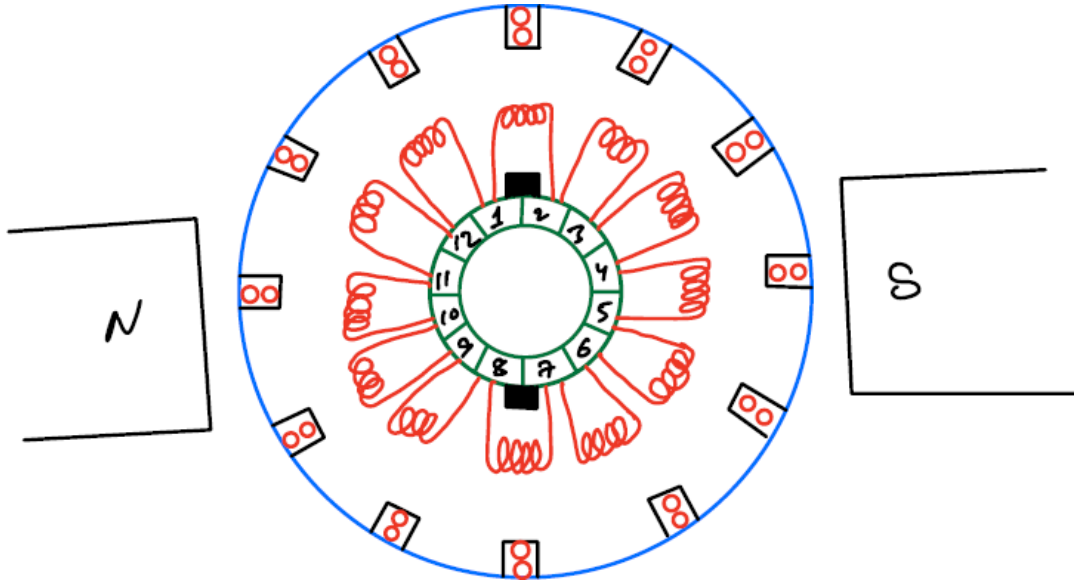


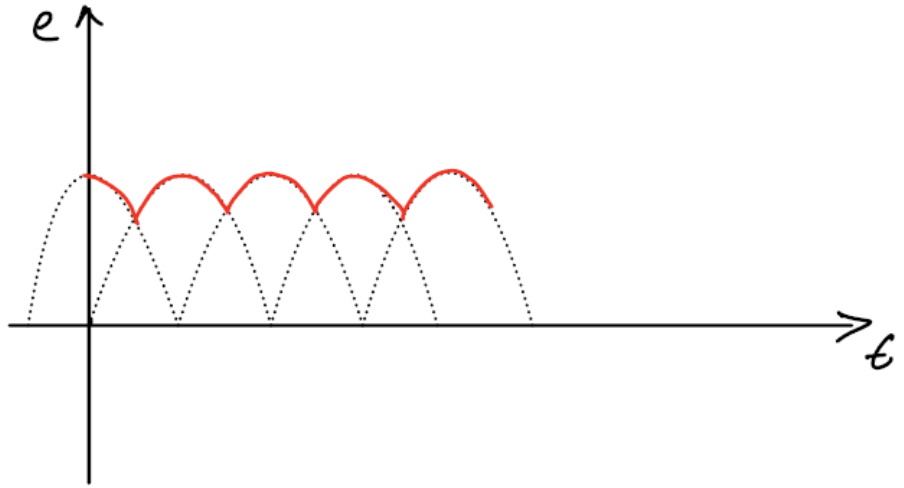


DC Generator (cont...)

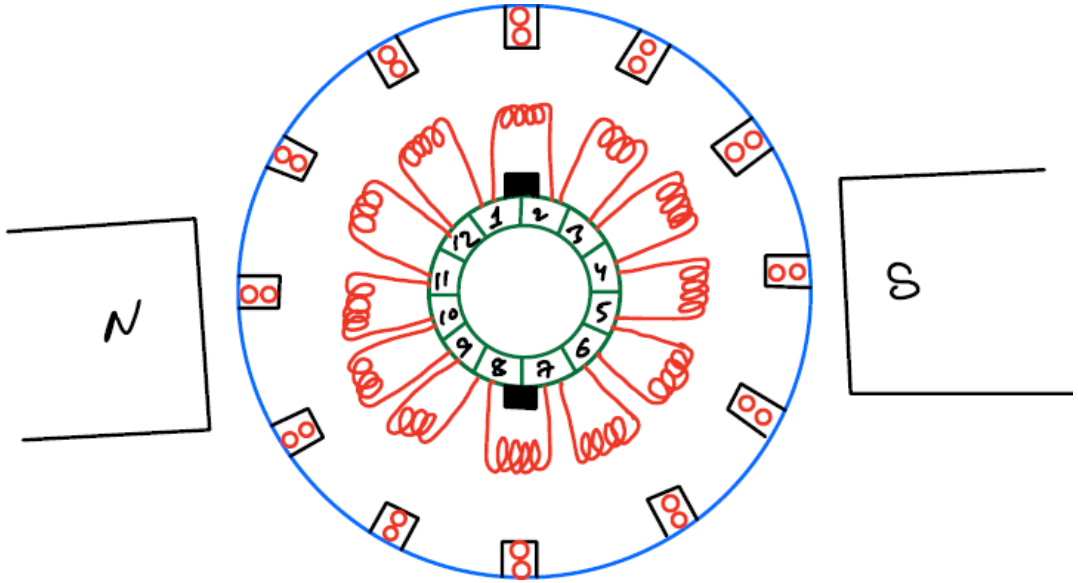




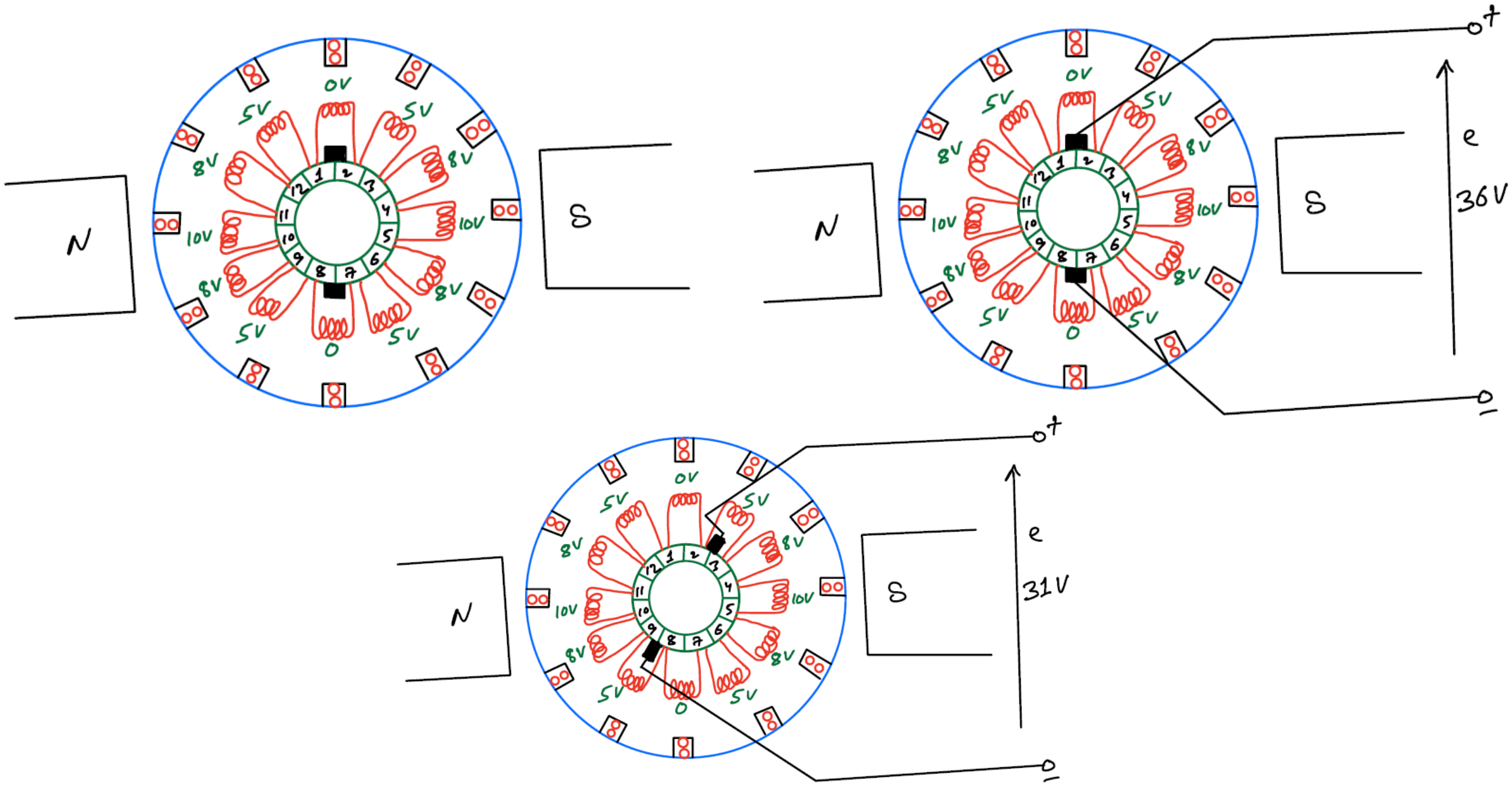




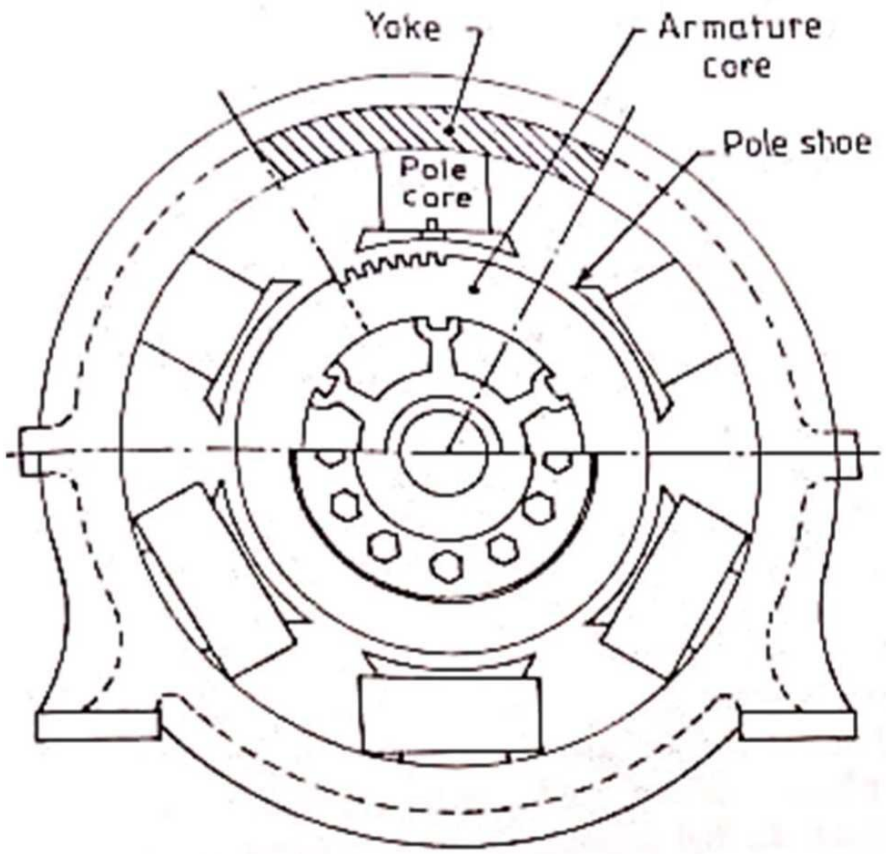
DC Generator (cont...)

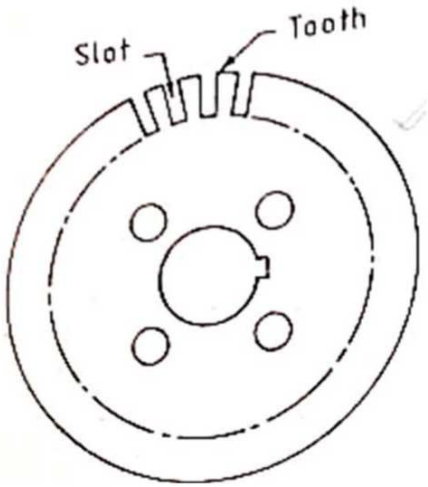


DC Generator (cont...)



DC Machine Construction





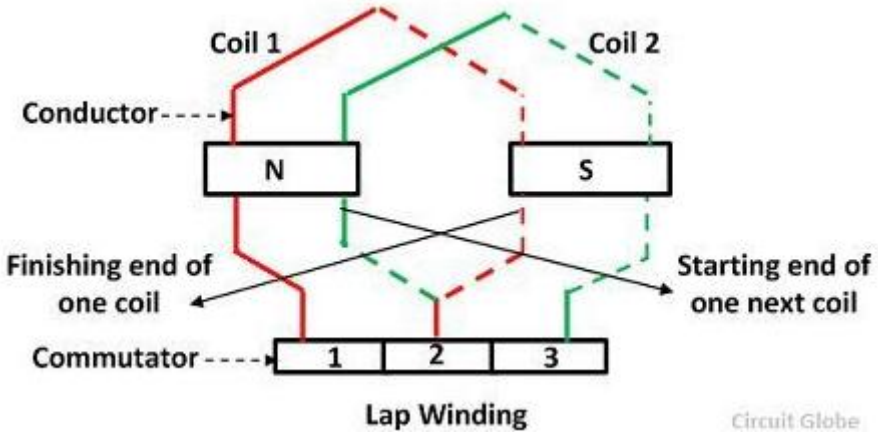
- Flux density in pole core is higher than pole shoes.
- Pole shoes are laminated to avoid heating and eddy current loss.
- Yoke is part of the frame and carries flux from pole to pole.
- Armature teeth are skewed to avoid vibration of teeth.

DC Machine Construction (cont...)

❑ Lap & Wave Winding:

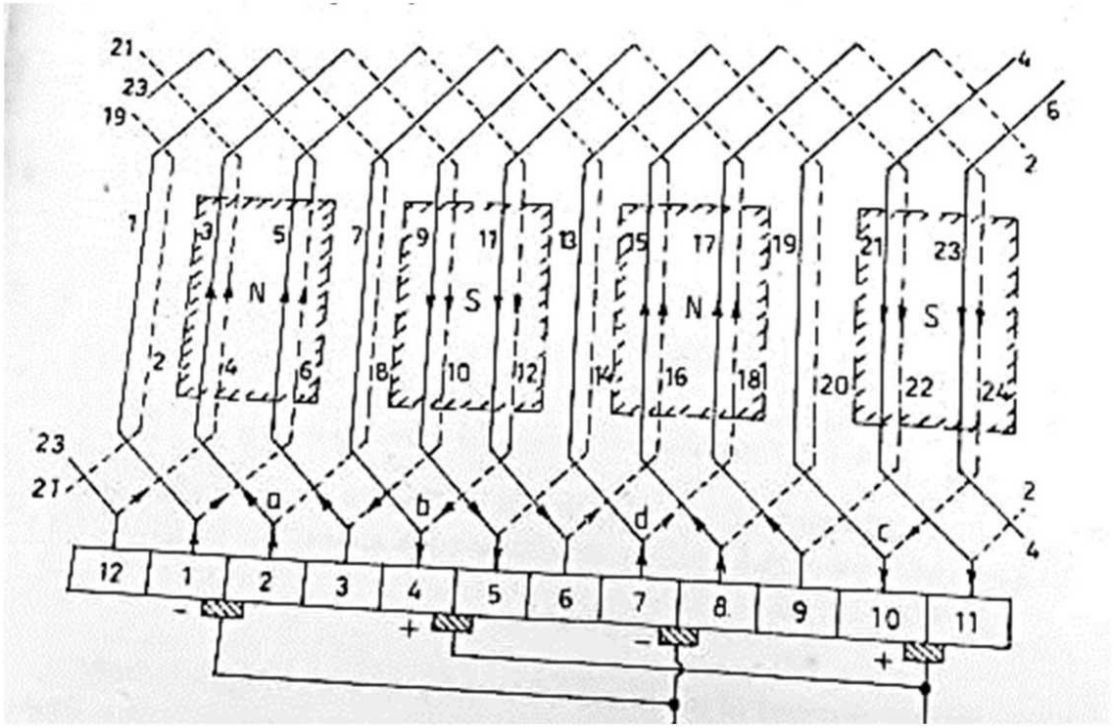
❑ Lap Winding:

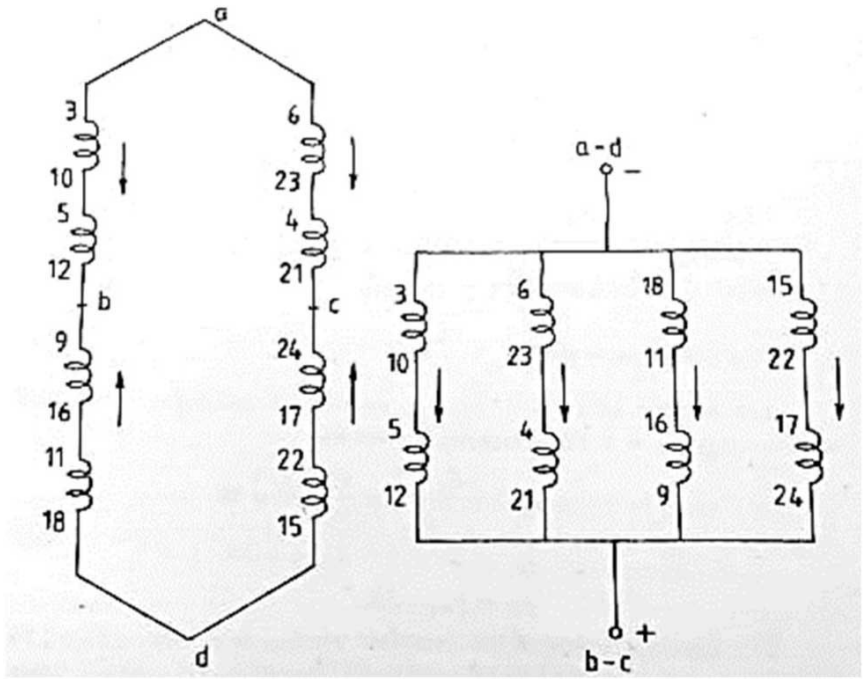
- In lap winding, the conductors are joined in such a way that their parallel paths (a) and poles (p) are equal in number.
- The end of each armature coil is connected to the adjacent segment on the commutator.
- The number of brushes in the lap winding is equal to the number of parallel paths, and these brushes are equally divided into negative and positive polarity.



DC Machine Construction (cont...)

❑ Lap Winding:





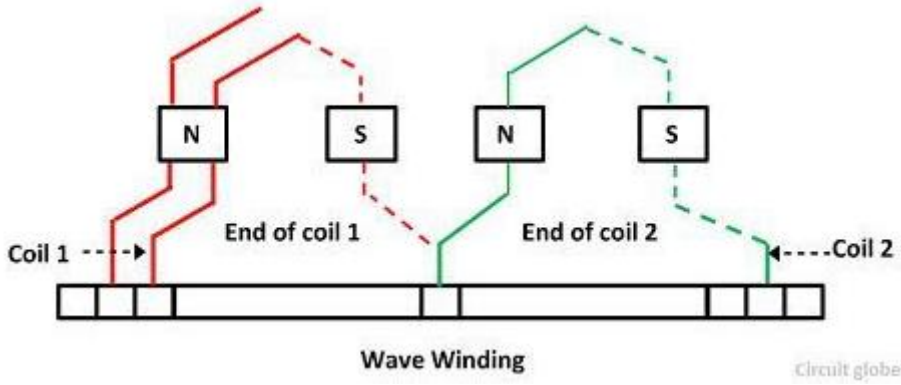
Winding Pitches –

The distance between two coil sides of the coil, measured in terms of coil sides between them.

DC Machine Construction (cont...)

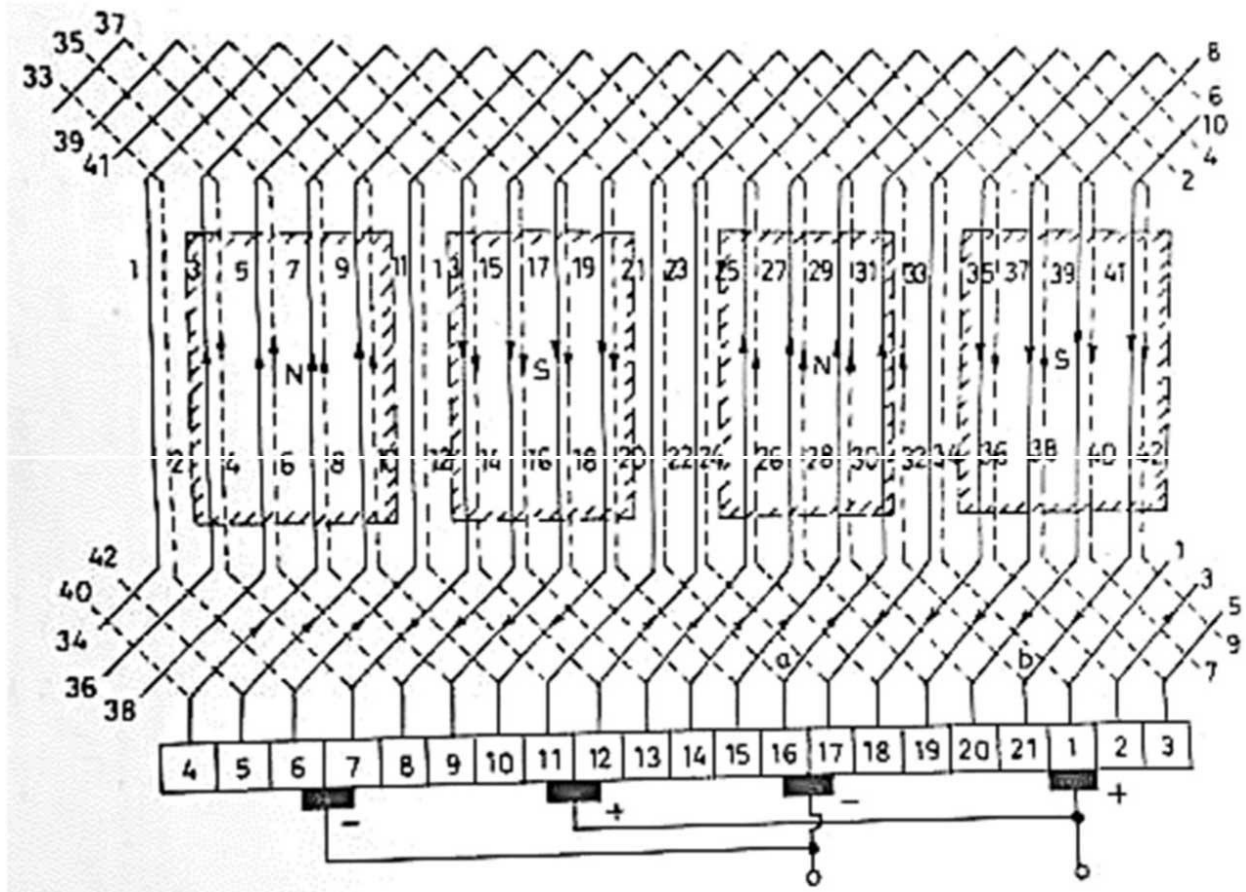
❑ Wave Winding:

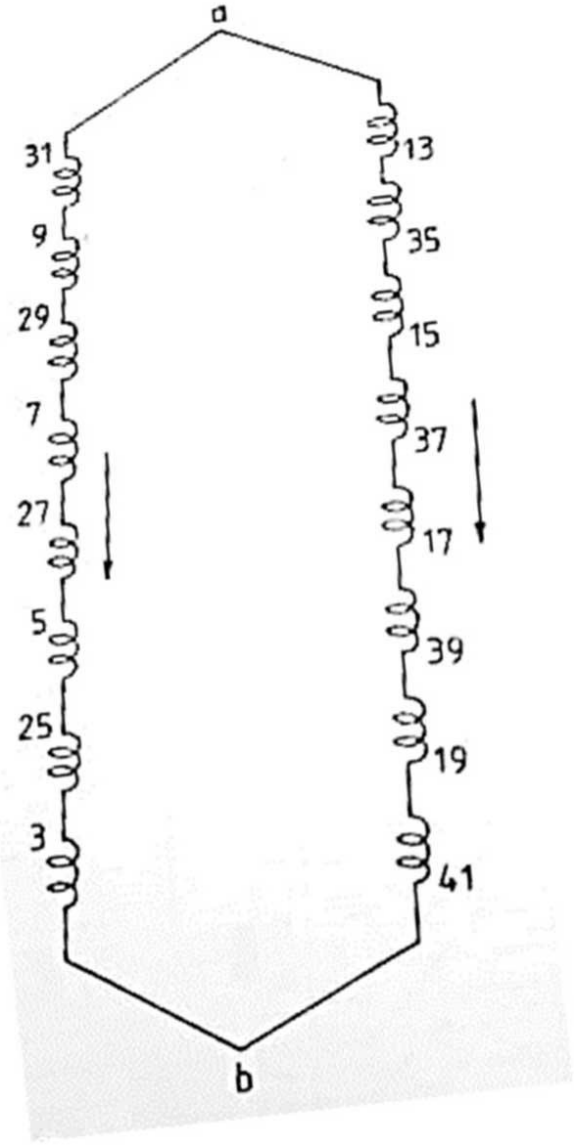
- In wave winding, only two parallel paths are provided between the positive and negative brushes.
- The finishing end of the one armature coil is connected to the starting end of the other armature coil commutator segment at some distance apart.
- In this winding, the conductors are connected to two parallel paths irrespective of the number of poles of the machine.
- The number of brushes is equal to the number of parallel paths. The wave winding is mainly used in high voltage, low current machines.



DC Machine Construction (cont...)

❑ Wave Winding:

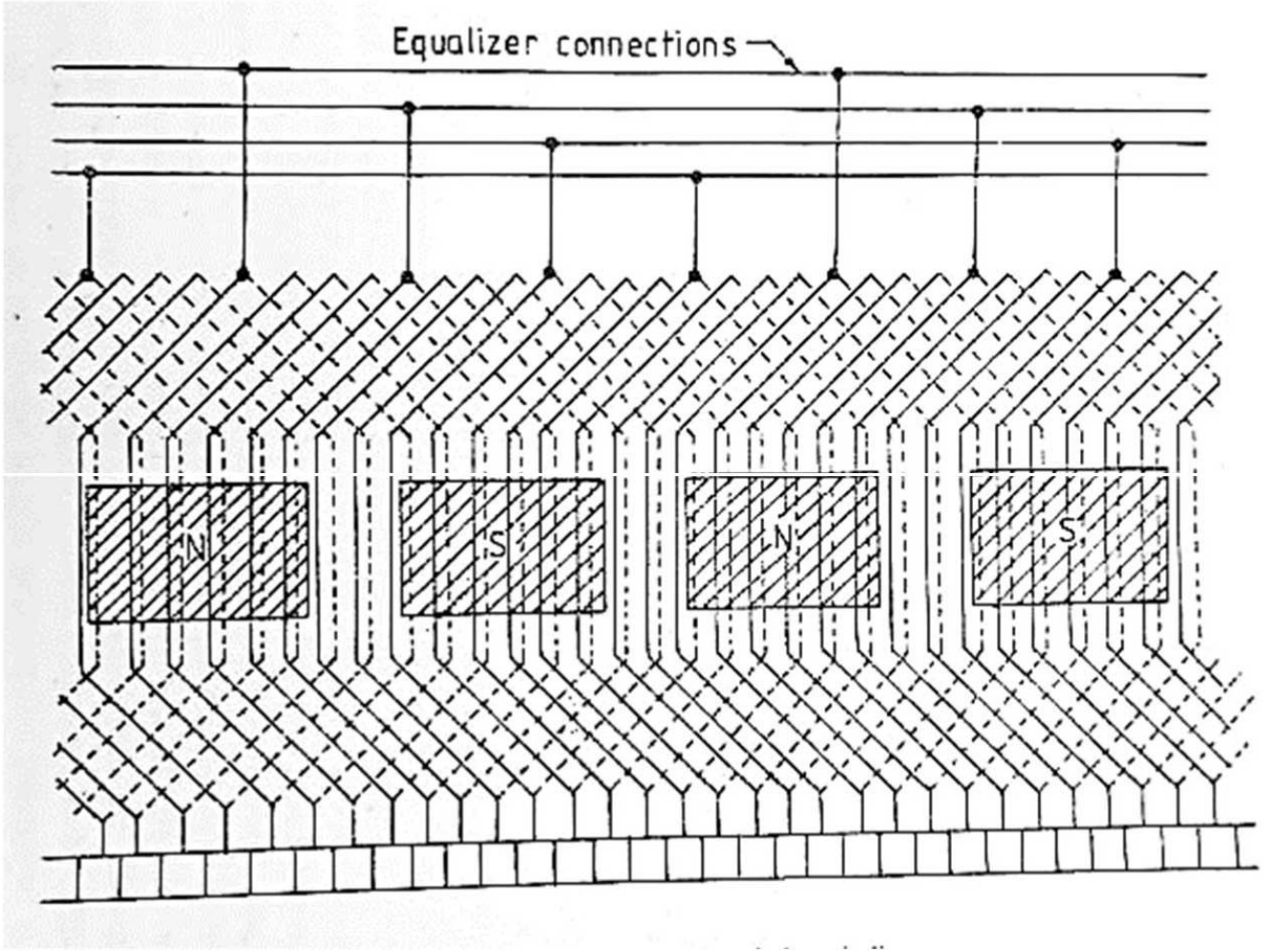




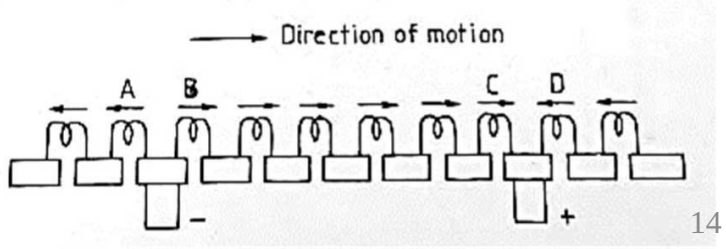
DC Machine Construction (cont...)

DC Machine Construction (cont...)

❑ Equalizer Rings and Commutator

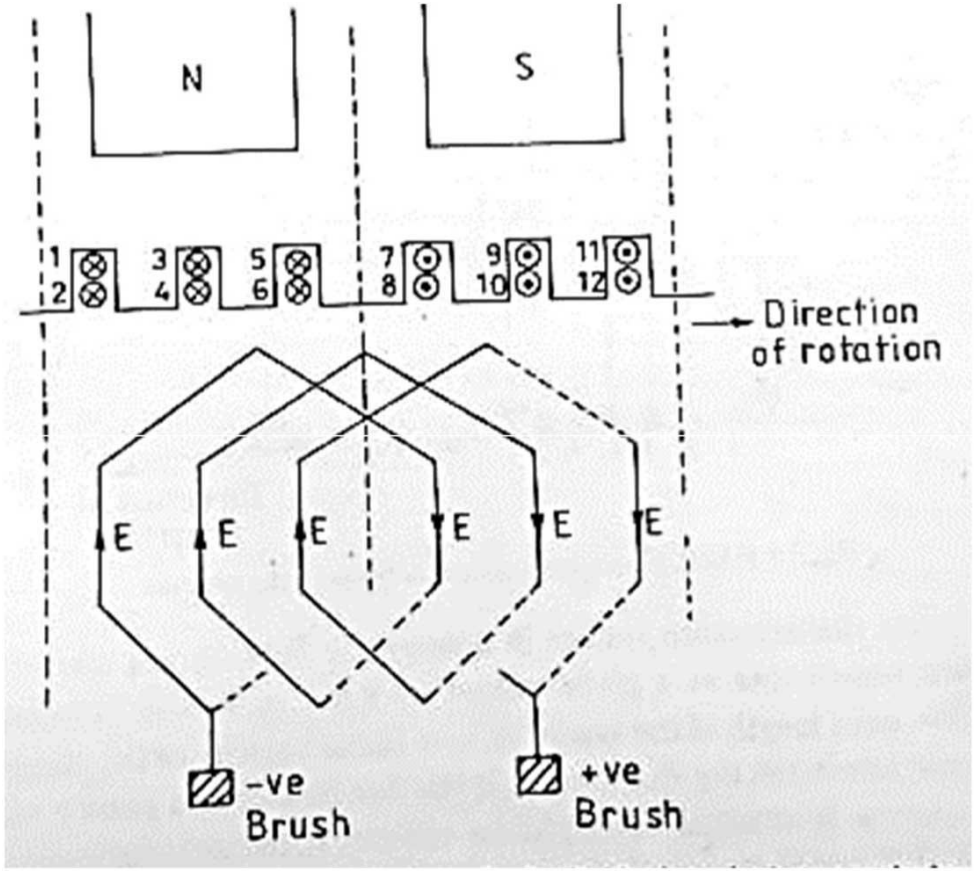


- Armature has multiple parallel paths.
- Different e.m.f. generated in different paths cause circulating current.
- Circulating current is prevented by adding equalizer ring in the armature.
- Commutator is a set of copper bars, insulated from each other, where armature windings are connected.
- The brushes are fixed while commutator moves with the armature.



DC Machine Construction (cont...)

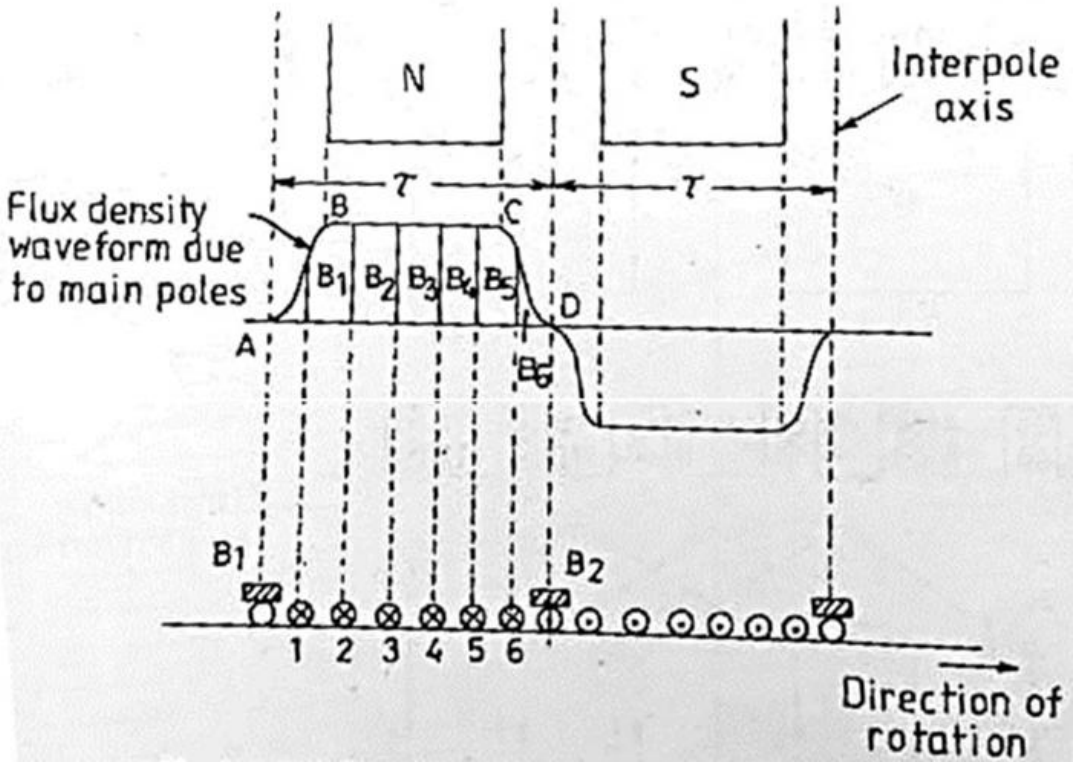
❑ E.M.F in the Coil



- The direction of induced e.m.f. in the armature conductor can be determined with the help of Fleming's right hand rule.
- Two coil sides are always under the influence of opposite poles. Hence induced e.m.f. in both sides of coil is additive.

DC Machine Construction (cont...)

❑ e.m.f. induced between brushes



- Brushes are connected to armature conductors in the interpolar axes
- When armature rotates, at any instant, e.m.f. induced in every armature conductor is –

$$e_x = B_x l v$$

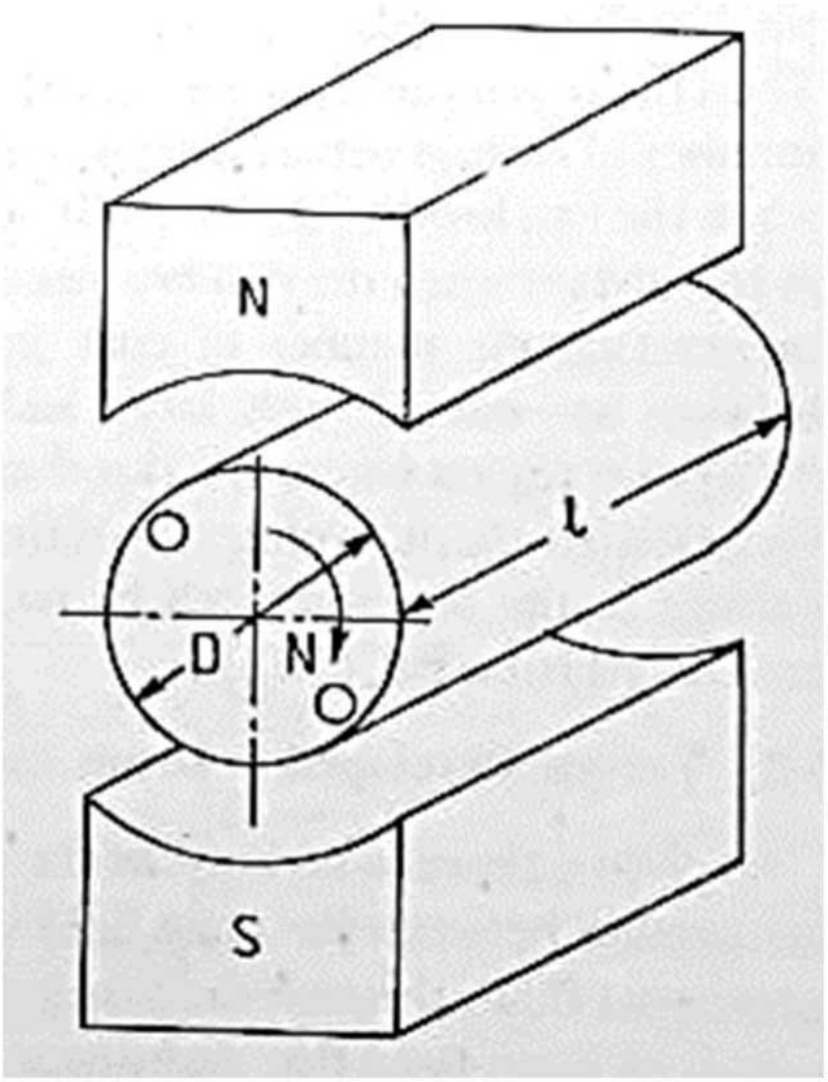
- If there are total Z conductors in armature winding and a parallel paths, total induced e.m.f. is –

$$E = e_1 + e_2 + e_3 + \cdots + e_{\frac{z}{a}}$$

$$E = \left(B_1 + B_2 + \cdots + B_{\frac{z}{a}}\right) lv$$

$$E = lv \sum_{x=1}^{z/a} B_x$$

DC Machine Construction (cont...)



- With large number of coil sides between the brushes :-

$$\sum_{x=1}^{z/a} B_x = \frac{Z}{a} B_{av}$$

$$E = lv \sum_{x=1}^{z/a} B_x = lv \frac{Z}{a} B_{av}$$

Area over one pole pitch $= \frac{\pi D l}{p}$

So, $B_{av} = \phi/(\frac{\pi D l}{p})$ and $v = \frac{\omega D}{2} = \frac{\pi D n}{60}$

So, $E = l(\frac{\pi D n}{60})\ \phi/(\frac{\pi D l}{p})(\frac{Z}{a})$

$$E = \frac{\phi Z n p}{60 a}$$

where ‘n’ is speed of armature in rpm, ‘p’ is number of poles of the machine.

DC Machine Construction (cont...)

$$E = \frac{\phi Z n p}{60 a}$$

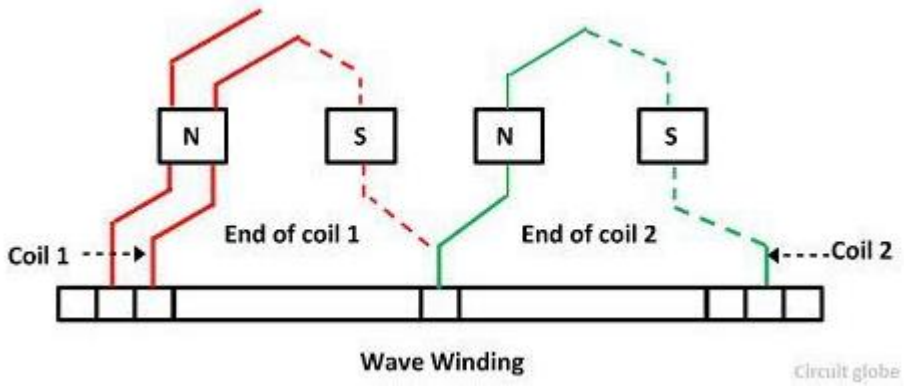
$$E = K \phi N$$

where ‘K’ is

$$K = \frac{Z \times p}{60 \times a}$$

DC Machine Construction (cont...)

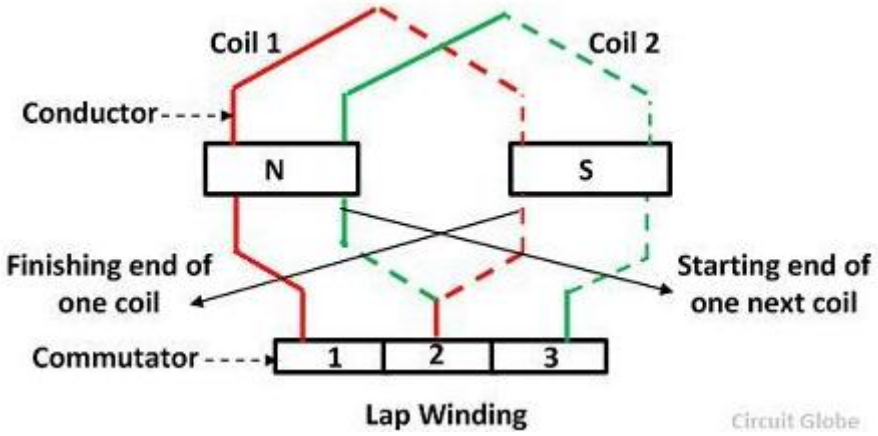
❑ Wave Winding:



$$E = \frac{\phi Znp}{60a}$$

∴For wave winding a=2

❑ Lap Winding:



$$E = \frac{\phi Znp}{60a}$$

∴For lap winding p=a

$$E = \frac{\phi Zn}{60}$$

DC Machine Construction (cont...)

❑ Example

A lap winding connected DC-generator has 6-poles in armature, 600 rpm, 0.04 wb flux per pole, 90-slots and 4 turns per coil. Find the induced voltage by generator?

❑ Solution:

$$Z = 90 \text{ coils} \times 4\frac{\text{turns}}{\text{coil}} \times 2\frac{\text{conductors}}{\text{turns}} = 720$$

∴For lap winding p=a

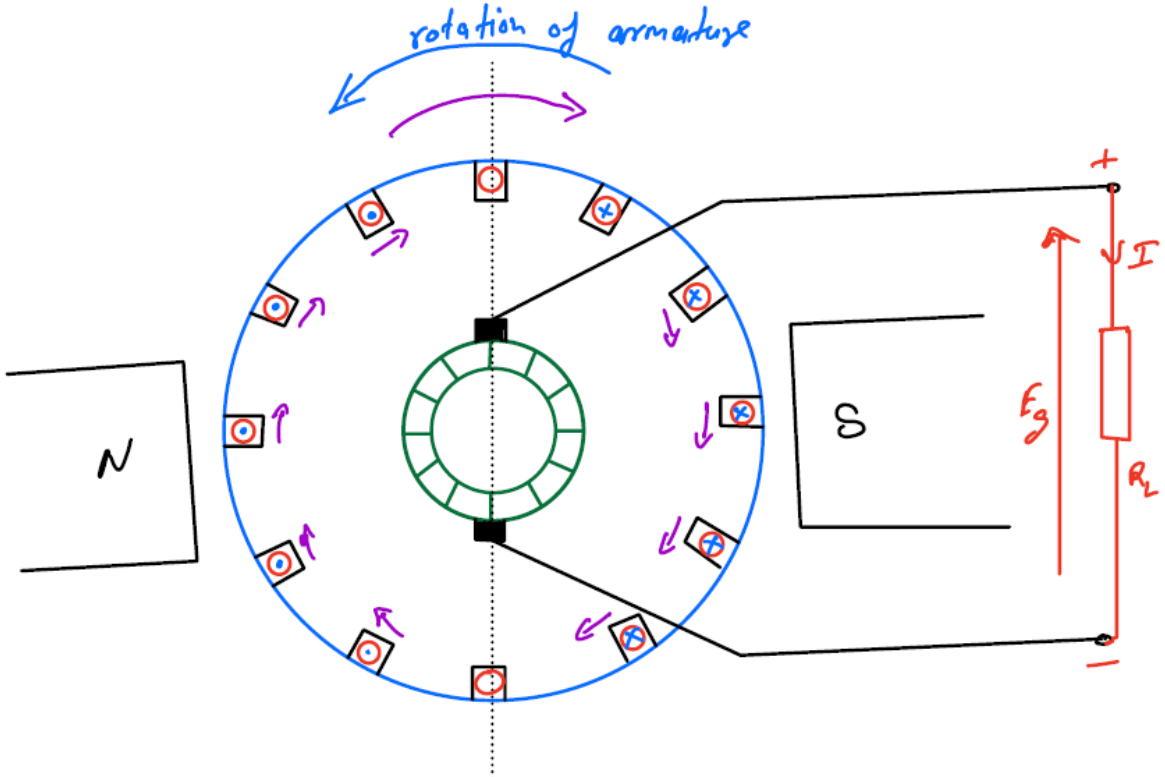
$$E = \frac{\phi ZN}{60} = \frac{0.04\times720\times600}{60} = 288V$$

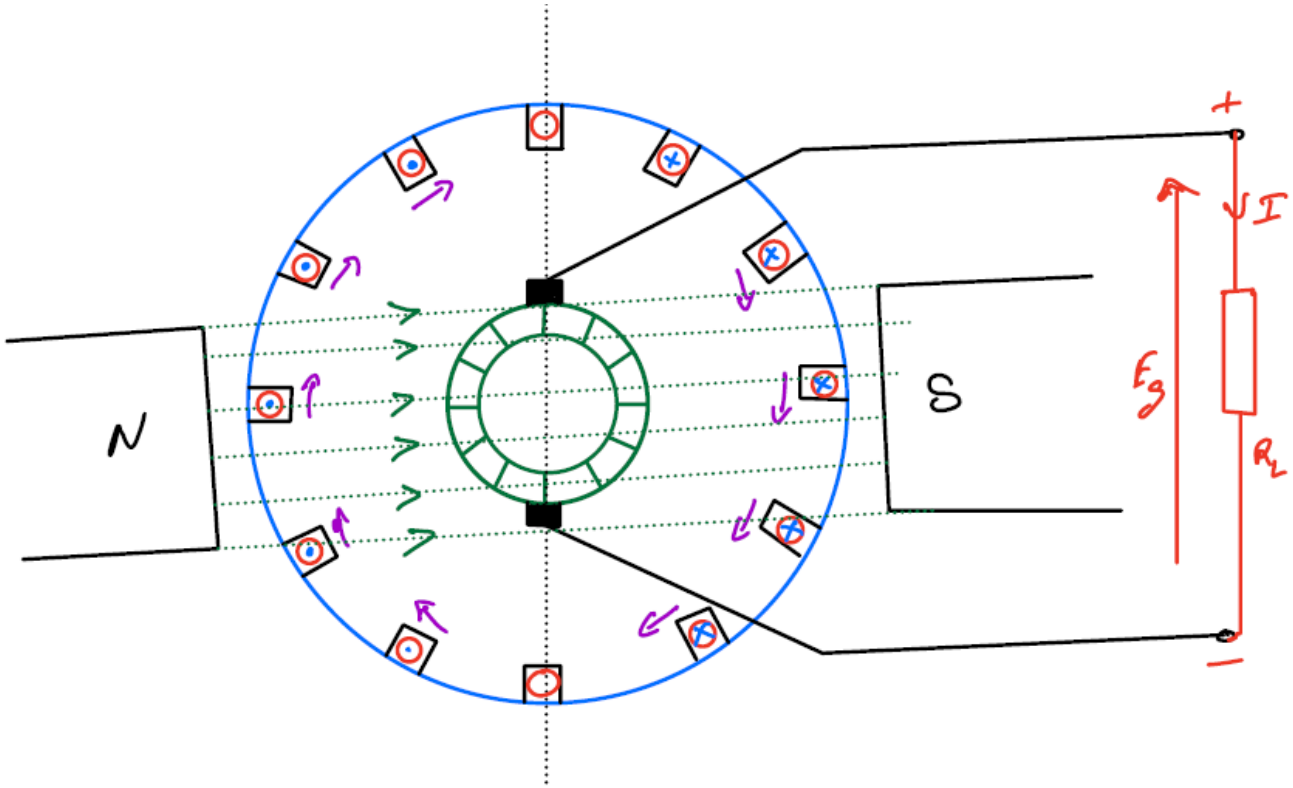
∴For wave winding a=2

$$E = \frac{\phi ZNP}{60\times a} = \frac{0.04\times720\times600\times6}{60\times2} = 864V$$

DC Generator (cont...)

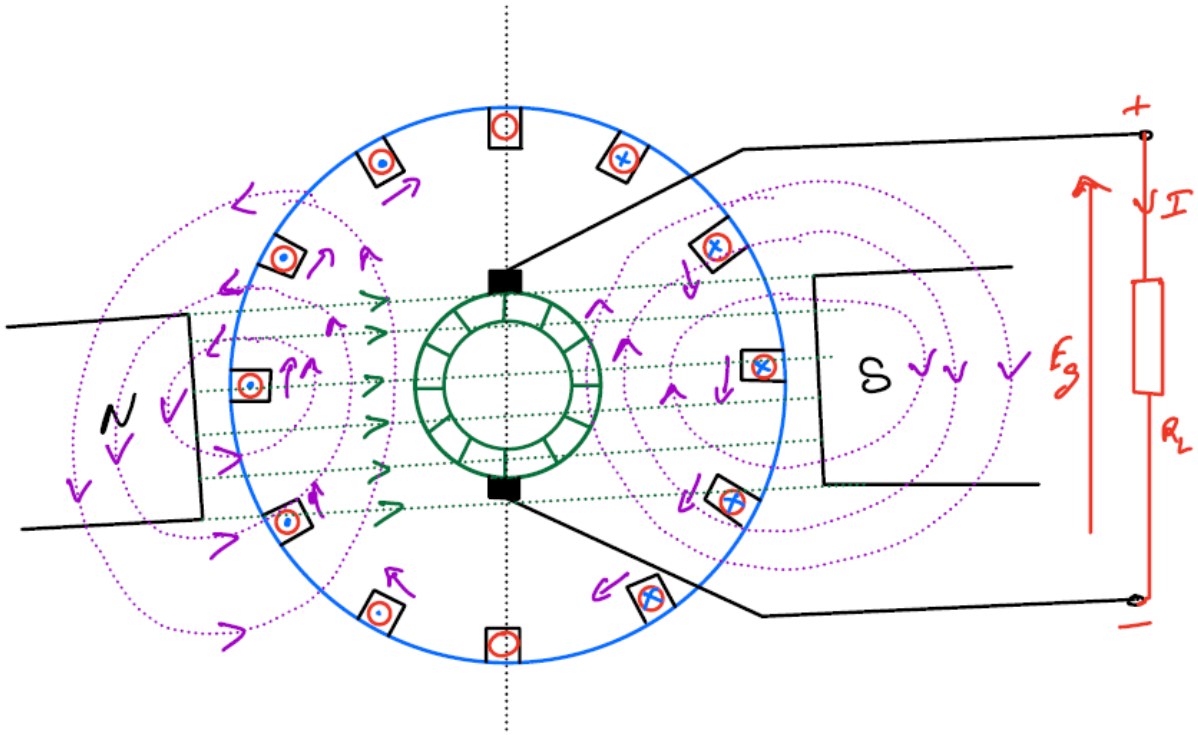
- Loading on DC generator:

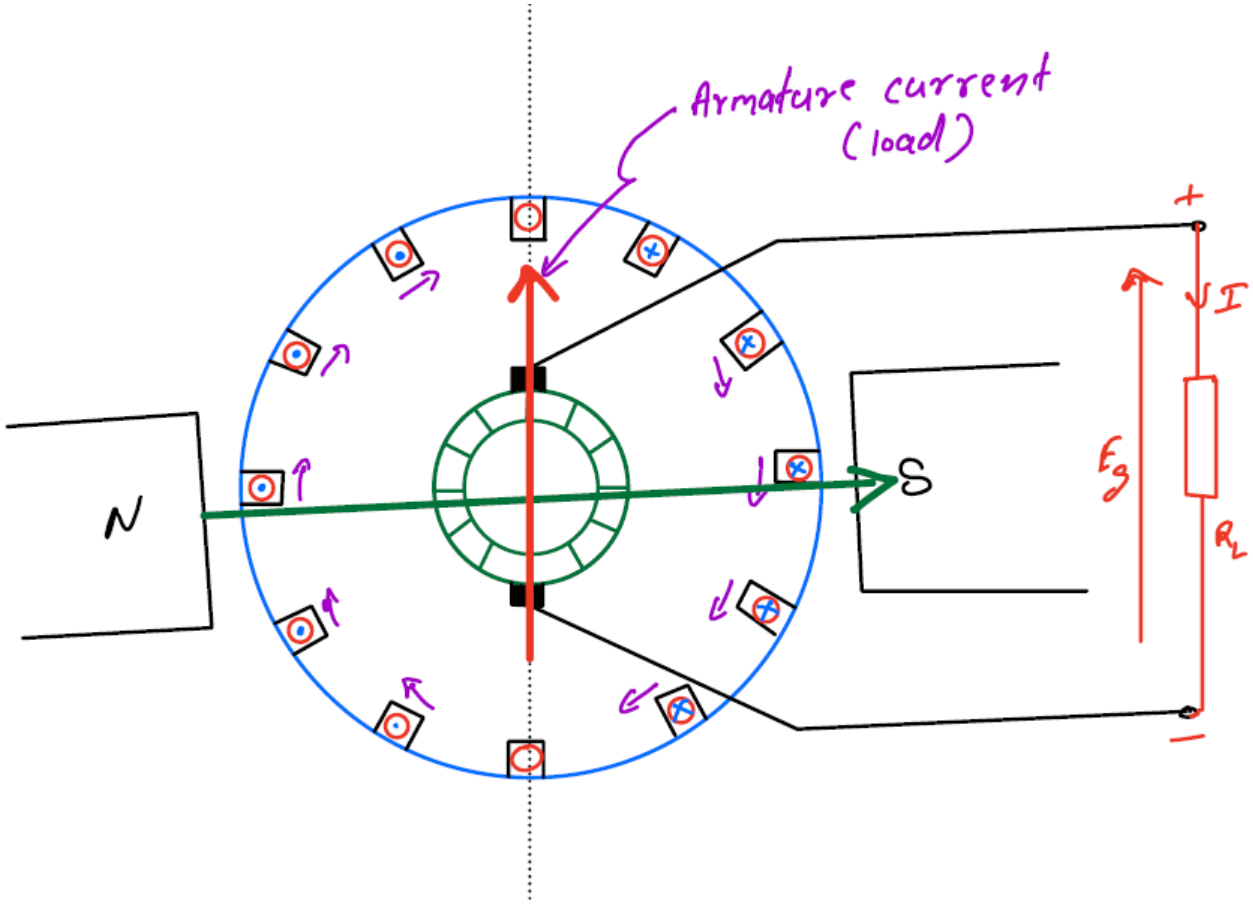




DC Generator (cont...)

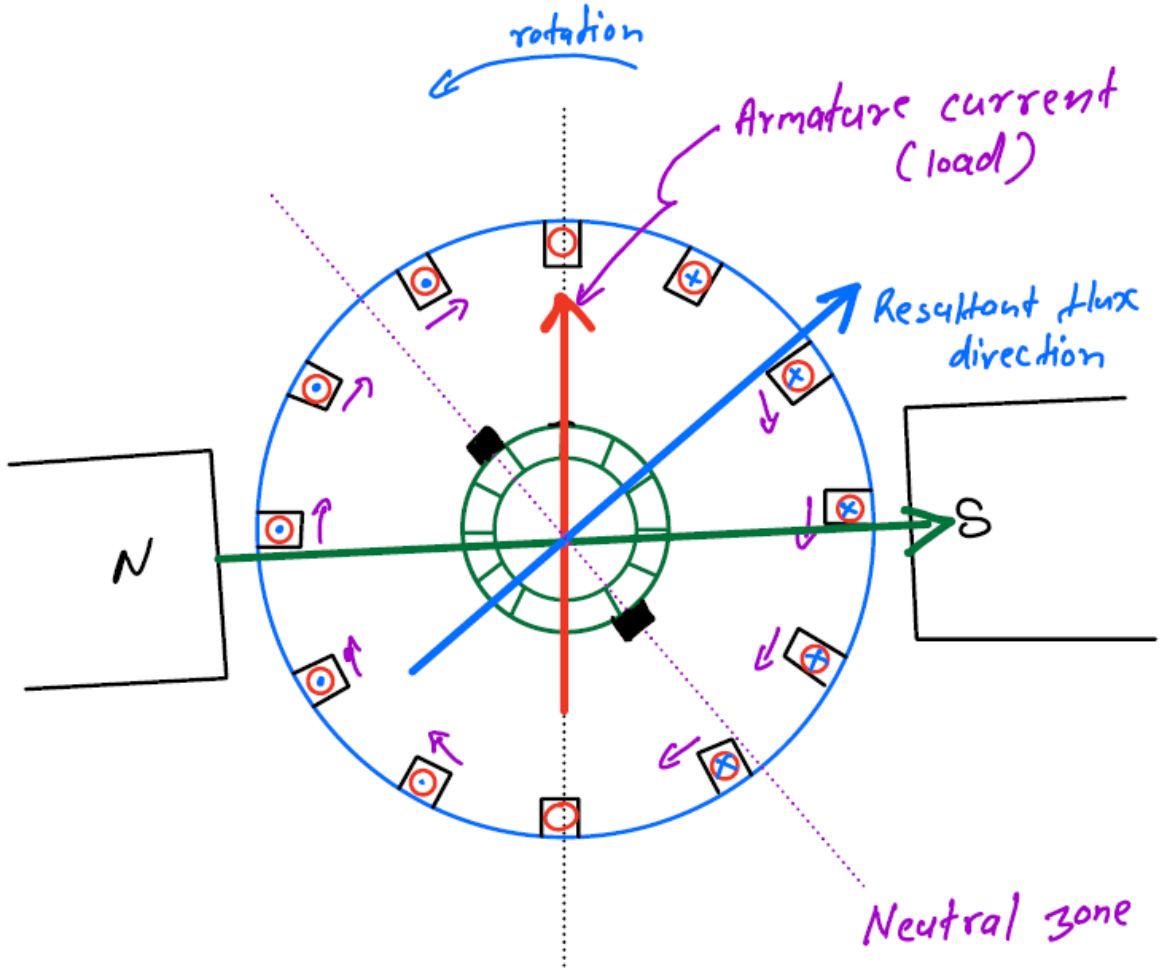
- Loading on DC generator:





DC Generator (cont...)

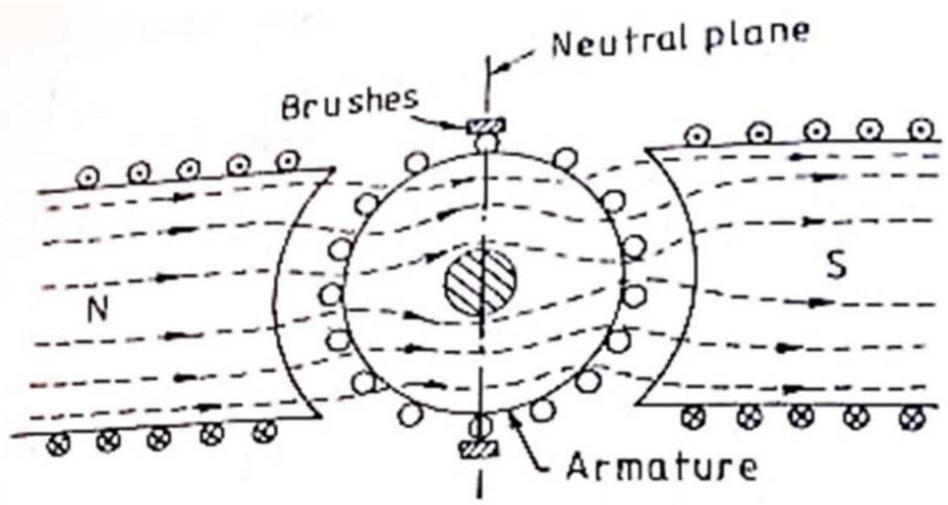
- Loading on DC generator:

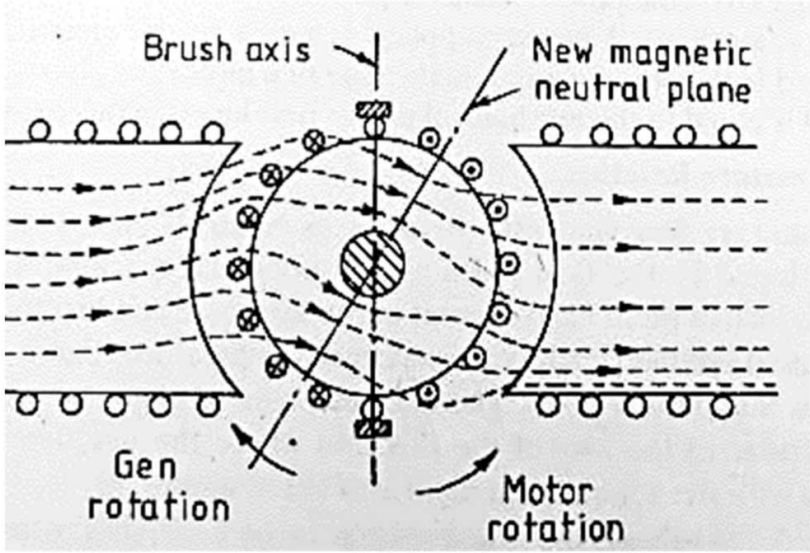


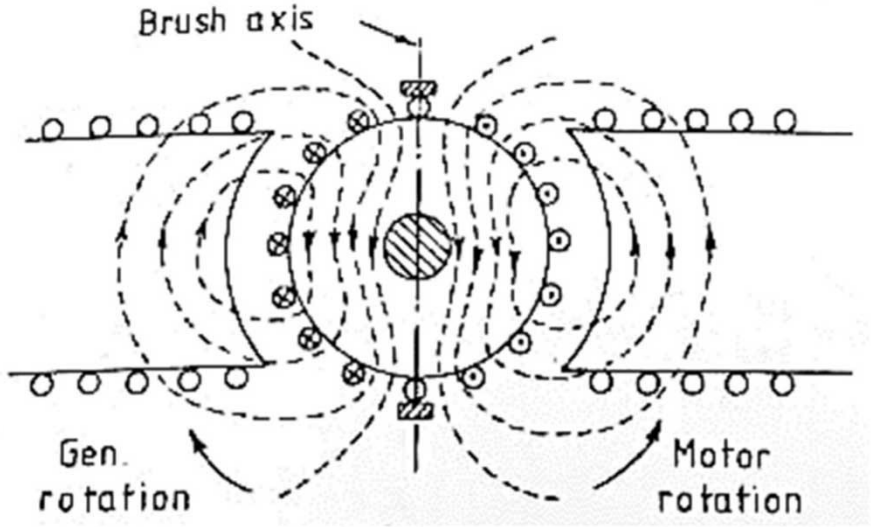
- Armature Reaction:

DC Generator (cont...)

❑ Armature Reaction:



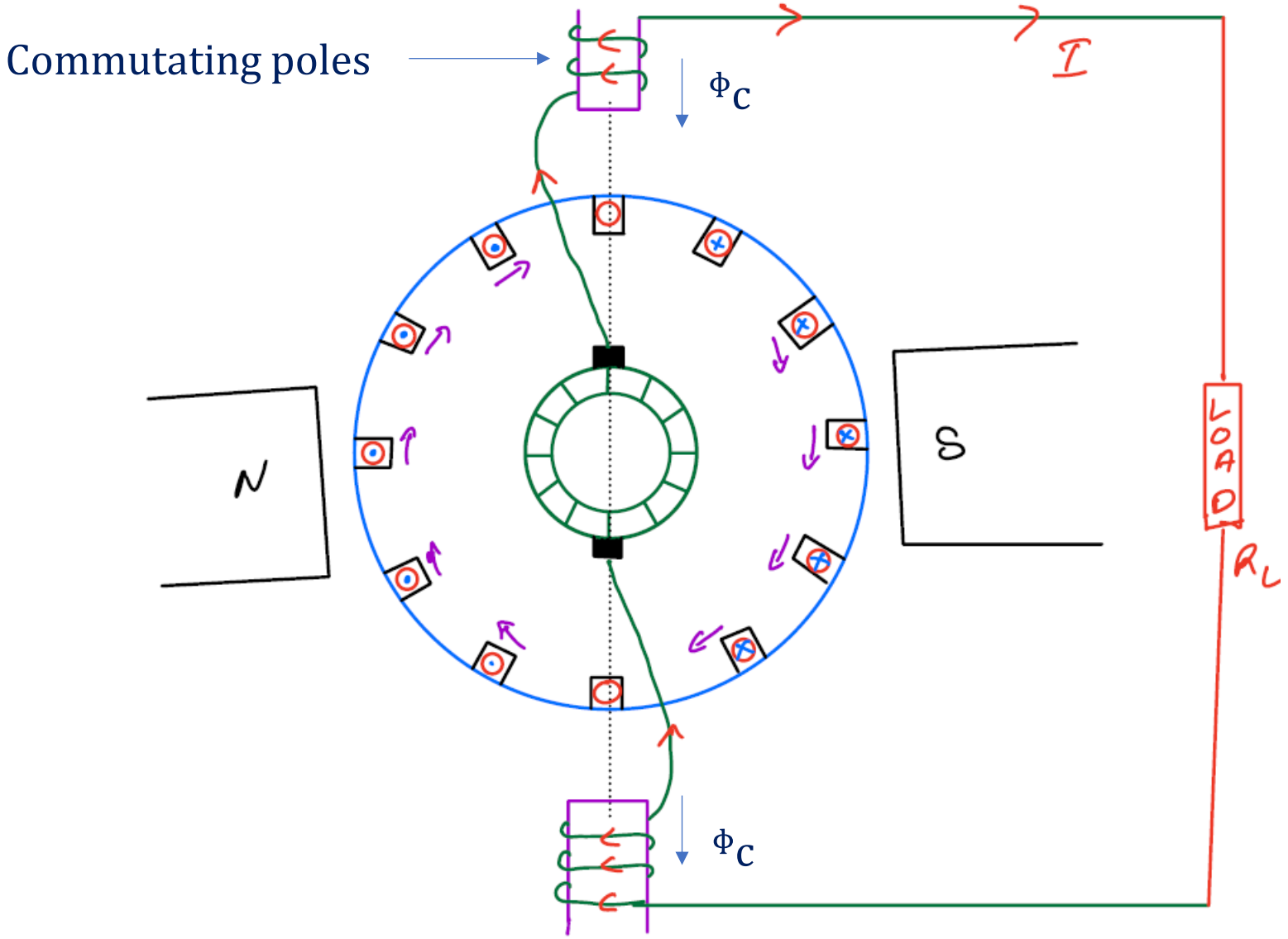




- Armature reaction causes mainly the cross magnetism.
- The armature current displaces the resultant field flux in the direction of generator and against the direction of rotation in motor.
- Here, the flux is displaced by the armature current, not the mechanical motion.

DC Generator (cont...)

❑ Armature Reaction:




THANKS
FOR YOUR
ATTENTION