LECTURE NOTES

On

Energy Conversion - I I

On

5th Semester of Electrical Engineering Branch

Prepared by
Bijaya Kumar Barik (PTGF Electrical)

CHAPTER-1

D.C Generator

1.1 Operating principle of Generator :→

principle of D.C Generator :-

It states as whenever a rotating conductor is placed inside a magnetic field an Emf is induced in the conductor.

The generated voltage in a d.c generator is alternating. By the help of commutator and brushes. The brush voltage i.e the external voltage is made d.c.

Fig (1) indicates the position of conductors AB & CD when the voltage is just increasing and the conductor AB is moving down against the flux lines under the South pole. on the other hand fig (2). indicates the position of the above conductors, when the conductors AB moving up against the line under the North pole.

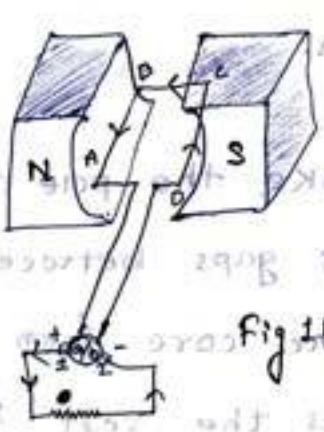


Fig 1(a)

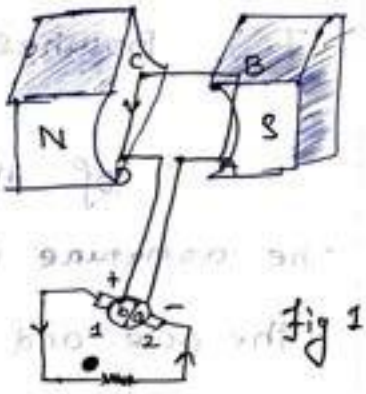


Fig 1 (b)

Thus during this complete one revolution it is observed that the brush 1 and 2 are kept +ve & negative all through due to the change of position commutator segments (a) and (b) as shown.

Thus d.c voltage in generated in a d.c generator.

1.2 Constructional features of D.C Machine: →

1.2.1 Yoke, pole & Field winding, Armatures, commutator.

Constructionally there is no difference between Generator & Motor of d.c type only diff. in principle.

So the dc machine wheather it is a generator or Motor, generally consists of the following Essential parts.

1. Magnetic frame or yoke.
2. pole core & pole shoes.
3. pole coils & field coils.
4. Armature core.
5. Armature winding or conductor.
6. commutator
7. Brushes & Bearings.

of these, the yoke the pole cores the armature core and air gaps between the pole and the armature core form the magnetic circuit where, as the rest form the Electrical circuit.

(1) Yoke :→

The outer frame or yoke serves double purpose. (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.

(2) pole cores and pole shoes :→

The field magnets consist of pole cores and pole shoes. The pole shoes serve two purpose (i) They spread out the flux in the air gap and also, being of larger cross-section, reduce the reluctance of the magnetic path (ii) They support the Exciting coils (or field coils).

There are two main types of pole construction

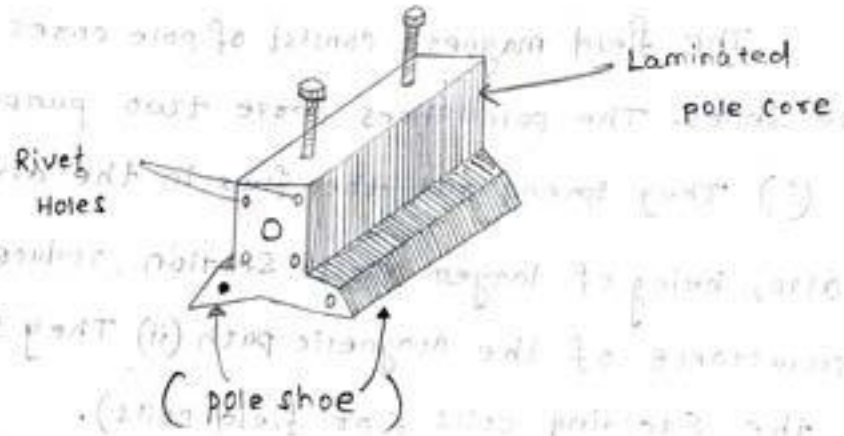
(a) The pole core itself may be a solid piece made out of either cast iron or cast steel but the pole shoes in laminated and in fastend to the pole face by means of cutter sunk screws.

(b) In modern design, the complete pole cores and pole shoes are built of then laminations of annealed steel which are rivetted together under hydraulic pressure.

The thickness of laminations varies from 1mm to 0.25mm. The laminated poles may be secured to the yoke in any of the following two ways.

→ Either the pole is secured to the yoke by means of screws bolted through the yoke and in to the pole body, or -

→ The holding screws are bolted in to a steel bar which passes through the pole across the plane of laminations.

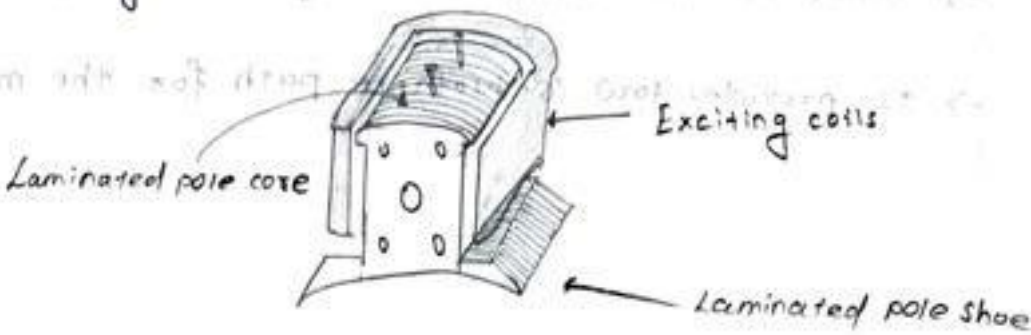


(3) pole coils :→

The field coils or pole coils, which consist of copper wire or strip, are former-wound for the correct dimensions. then the former is removed and wound coil in put into place over the core.

when current is passed through these coils, they Electromagnetise the poles which

produce the necessary flux that is cut any revolving armature conductors.



(pole coils)

(4) Armature core :→

The Armature core is keyed to the machine shaft and rotates between the field poles. It consist of slotted soft-iron laminations (about 0.4 to 0.6 mm thick) that are stacked to from a cylindrical core. The laminations are individually coated with a thin insulating films so that they don't come in Electrical contact with each other. The pupose of laminating the core is to reduce the eddy current loss. The laminations are slotted to accmodate and provide Mechanical Security to the armature coinding and to give shorter air gap for the flux to cross between the pole face and the armature teeth.

The armature of the d.c generator performs the following three major functions.

→ It permits rotation for mechanical generator action

→ Since it has conductor, emf is induced in them,

→ It provides low reluctance path for the magnetic flux

(5) Armature windings (conductor) :→

The slots of the armature core hold insulated conductors that are connected in a suitable manner. This is known as armature winding. This is the winding in which "working" emf is induced. The armature conductor are connected in series - parallel. The conductors being connected in series so as to increase the voltage and in parallel paths so as to increase the current. the armature winding of a dc machine is a closed circuit winding, the conductors being connected in a symmetrical manner forming a closed loop or series of closed loops

(6) Commutator :→

A commutator is a mechanical rectifier which is converts the alternating voltage generated in the armature winding in to direct voltage across the brushes. The commutator is made of copper segments insulated from each other by mica sheets and mounted on the shaft of the machine. The armature conductrs are soldered to the commutator segments in a suitable manner to give rise to the armature winding.

Depending upon the manner in which the armature conductors are connected to the commutator segments, there are two types of armature winding in a d.c machine i.e (i) Lap winding (ii) Wave winding.

(7) Brushes and Bearings :→

The purpose of the brush is to Ensure Electrical connections between the rotating commutator and stationary external load ckt. The brushes are made of carbon and rest on the commutator. The brush pressure is adjusted by reans of adjustable springs.

If the brush pressure in very large. The the friction produces heating of the commutator and the brushes. on the otherhand. If it in too weak the inperfect contact with the commutator may produce. sparking.

1.2.2 Armature winding, back pitch, front pitch Reswtant pitch, and commutator pitch.

General features of D.C Armature winding

i) A d.c machine (generator or motor) generally Employes windings distributed in slots over the circumference of the armature core. Each conductor lies at right angles to the magnetic flux and to the direction of its movement. Therefore, the induced E.m.f in the conductor in given by

$$e = B l v \text{ volts}$$

where. B = magnetic flux density in wb/m²

l = Length of the conductor in meters.

v = velocity in (m/s) of the conductor.

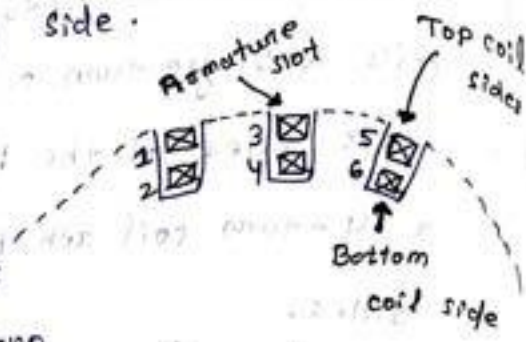
(ii) The armature conductors are connected to form coils a single turn coil has two conductors or coils sides at the back of the armature shows a 4-turn coil which has 8 conductors or coil sides.

The coil sides of a coil are placed a pole span i.e one coil side of the coil in under N-pole and the other coil side in under the next S-pole at the corresponding position as shown consequently. The Emfs of the coil sides add together. If the Emf induced in one conductor in 2.5 volts, then the Emf of a single turn coil will be $= 2 \times 2.5 = 5$ volts

For the same flux and speed, the emf of a 4-turn coil will be $= 8 \times 2.5 = 20$ V.

Most of the d.c armature windings are double layer windings: i.e there are two coil sides per slot. one coil side of a coil lies at the top of a slot and the other coil side lies at the bottom of some other slot. The coil ends

will then lie side by side.



In the desirable to number the coils sides rather than slots in a two layer winding. The coil sides at the top of slots are given odd numbers and these at the bottom are given Even no. The coils sides are no in order round the armature (figure)

Pole pitch

It is the distance measured in terms of number of armature slots (or armature conductors) i.e pole. Thus if a 4-pole generator has 16 coils, then number of slots = 16

$$\text{pole pitch} = \frac{16}{4} = 4 \text{ slots}$$

Also $$\text{pole pitch} = \frac{\text{No. of conductors}}{\text{No. of poles}}$$

$$= \frac{16 \times 2}{4} = 8 \text{ conductors.}$$

* The pole pitch is an important factor in the design of armature winding.

Coil Span or Coil pitch (Y_s):

It is the distance measured in terms of the number of armature slots

(or armature conductors) spaned by a coil.

Thus if a coil span is 9 slots, it means one side of the coil in slot -1 and the