Armature Reaction

4-1 Introduction

In a d.c. generator, the purpose of field winding is to produce magnetic field (called main flux) whereas the purpose of armature winding is to carry armature current. The armature winding will also produce magnetic flux (called armature flux). The armature flux distorts and weakens the main flux posing problems for the proper operation of the d.c. generator. The action of armature flux on the main flux is called armature reaction.

4.2 What is the "Armature Reaction"

This term means the effect of the magnetic field produced by the armature on the machine operation

Under such a condition, the armature reaction produces the following two effects:

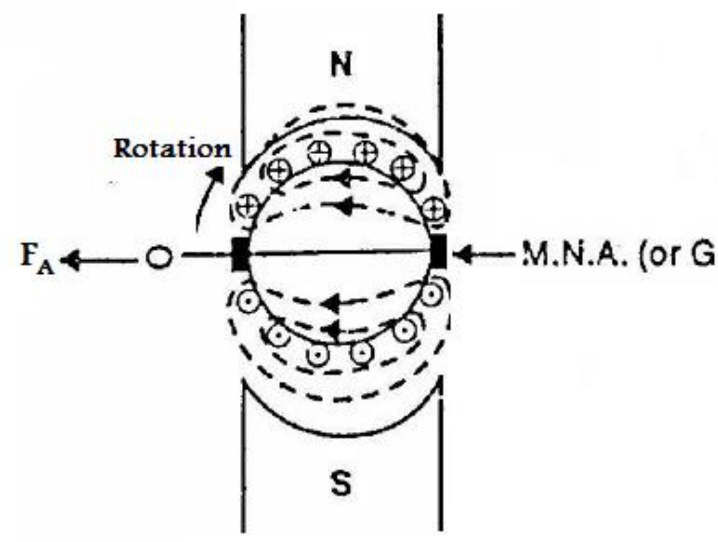
1. It demagnetizes or weakens the main flux.
2. It cross-magnetizes or distorts the main flux.

When the machine (motor or generator) loaded, a considerable current will pass through the armature and this armature will produce magnetic field .To declare this Fig.(4.1) is showing a 2-pole machine at no load and at load. Fig. (a) shows the normal distribution of field lines of d-c machine at no load, but at loading the current pass through armature winding, and this armature will produce a flux as shown in Fig. (b), hence this will deflect the resultant flux as shown in Fig. (c). Fig. (d) represents how the new field is being where;

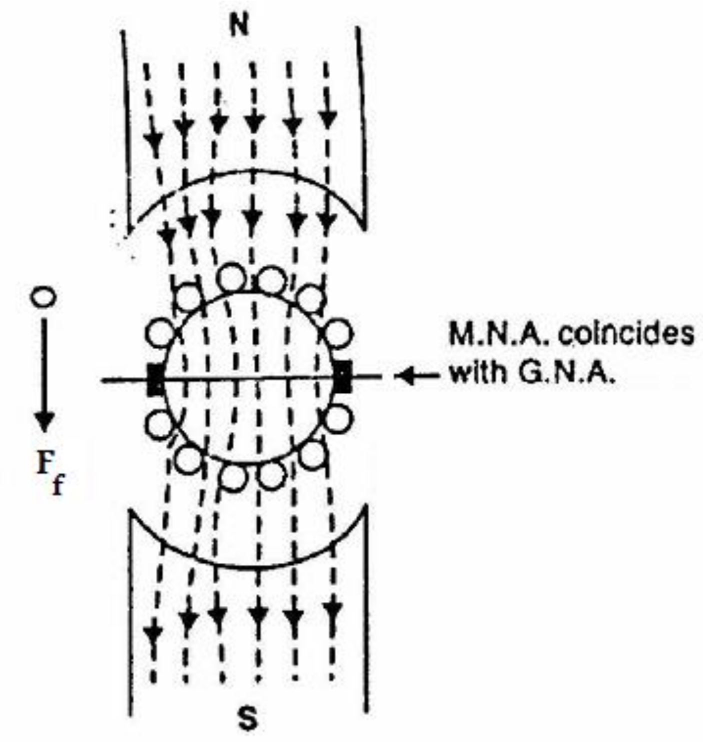
F_A : armature mmf

F_f : field winding mmf

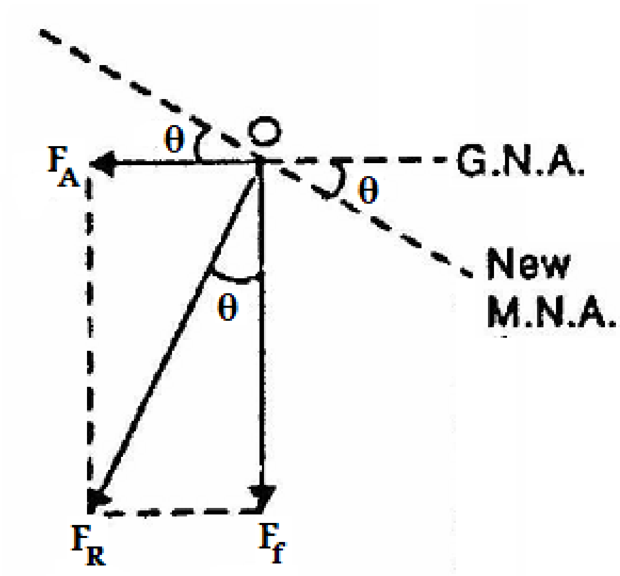
F_R : resultant mmf.



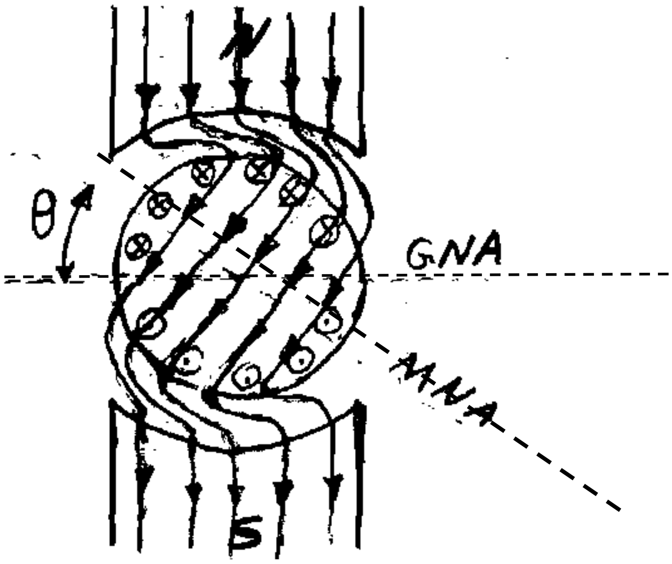
b) The armature only (at load)



a) The machine (at no load)



d) The vector diagram



c) The machine (at load)

Fig.(4.1)

It is clear in (c) that the new field direction rotates the magnetic neutral axis an angle θ in cw direction which is unaccepted due to the brush position selected before loading, and this will have a bad effect on machine operation

4.2 Brush Shifting:

To solve this problem in a constant load machine, a brush shifting is considered. By shifting means rotates the brush axis the same angle θ shown in Fig. (4.1.c) in order to achieve normal operation of the machine but the shifting needs to increase the Amper turns of the main field winding to compensate demagnetizing component of F_A (defined as F_d) An initiated to shifting as shown in Fig. (4.2).

Since F_A rotates by angle θ it resolved to a demagnetizing component F_d and to a distorting component F_q

$$F_A = \frac{1}{2}\frac{Z}{P}\frac{I_A}{a}$$

Where;

Z : the total number of conductors in armature.

I_A : total current of the machine.

a : number of parallel paths.

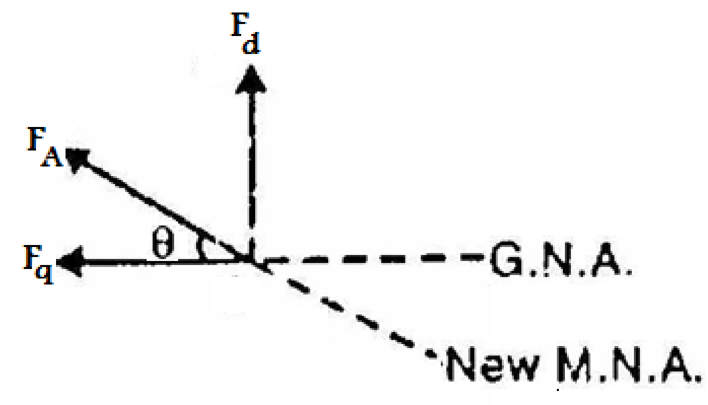
p : number of poles.

$$F_d = \frac{2\theta e}{180}F_A \qquad \text{and} \qquad Fq = \left(\frac{180-2\theta e}{180}\right)F_A$$

$$\theta e = \frac{p}{2}\theta m$$

θe= electrical degree

θm =mechanical degrees



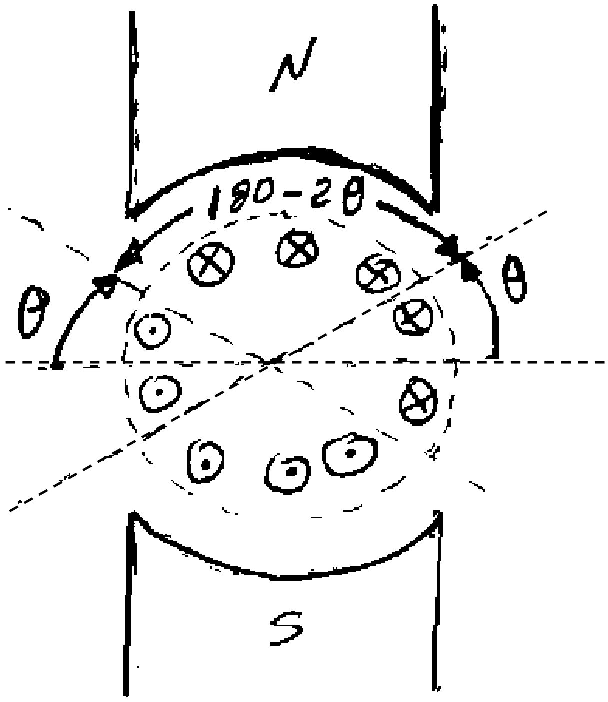


Fig. (4.2)

4.3 Compensating Winding:

If the machine load changes continuously so the brush shifting is useless. Another flexible, but expensive, method used to overcome the armature reaction suitable for highly rated machines operating on different loads that is the usage of a compensating winding located at the pole faces as shown in Fig. (4.3) such that it will produce an mmf equal in magnitude, and opposite in direction, and on the same line of action to that of the armature, and these winding fed by the armature current itself, so it will be always equal in magnitude to F_A. By, the experience of the designers the impirical formula of the compensating winding is

$$F_{CW} = 0.7 \frac{Pole \;\; Arce}{Pole \;\; Pitch} F_A$$

Where, F_{CW} = Compensating winding mmf

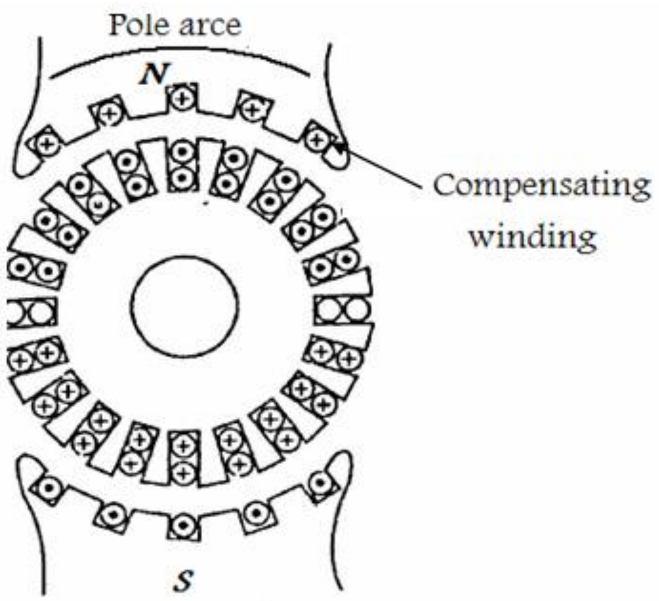


Fig. (4-3)