Necessity and Utilization of direct current:

Advantages:

1. D.C. is generally considered to be three (3) times as safe as a.c. with all other conditions similar.
2. The shock sensation in the case of d.c is very different from that of 50 Hz a.c. Shock does not appear to arise whilst carrying a steady current, the sensation being solely that heating.
3. The d.c. is used for the continuity of service. The d.c. enabled the use of a storage battery reserve which can be readily maintained and immediately put into service.
4. For d.c the terminal voltage remains constant, no fluctuation of voltage. Therefore no fluctuation of current, no inductive and capacitive effect due to d.c. For this reason d.c is used for so many purpouse, like electronic devices.

What is d.c. generator:

An electrical generator is a rotating machine which converts mechanical energy into electrical energy (or power).

An electric generator is based on the principle that whenever flux is cut by a conductor (dynamically or motionally), an e.m.f. is induced (according to Faraday's law of electromagnetic induction) which will cause a current to flow if the conductor circuit is closed. The direction of induced e.m.f. (and hence current) is given by Fleming's right hand rule. Therefore, the essential components of a generator are:

(a) a magnetic field

(b) conductor or a group of conductors

(c) motion of conductor w.r.t. magnetic field.

To turn the armature, diesel engine, gasoline engines, steam engine, steam turbines can be used as mechanical power source which are also called prime mover.

Construction of a Simple Loop Generator:

Construction: **In fig-1 & 2** shown below a single turn rectangular copper coil ABCD moving about its own axix in a magnetic field provided by either permanent magnets or electromagnets. The two ends of the coil are joined to two slip-rings 'a' and 'b' which are insulated from each other and from the central shaft. Two collecting brushes (made of carbon or copper) press against the slip-rings. Their function is to collect current induced in the coil and convey it to the external Load resistance R. Rotating coil called "armature" and the magnets as "field magnets".

Fig-1

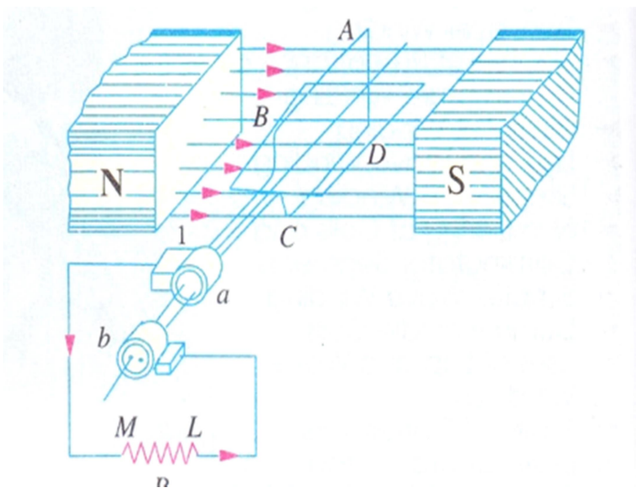
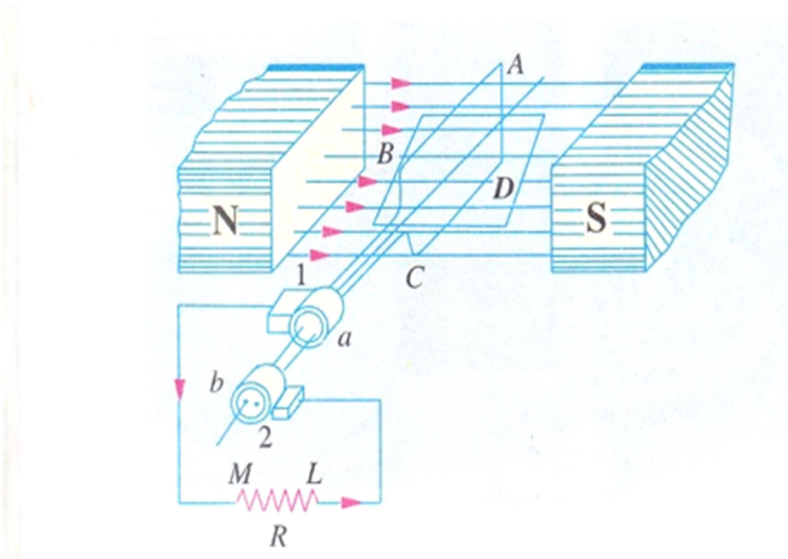


Fig-2



Working principal of D.C generator or how an Alternating e.m.f. is produced in the armature:

Consider a single turn loop ABCD rotating clockwise in a uniform magnetic field with a constant speed as shown in Fig.(1.1). As the loop rotates, the flux linking the coil sides AB and CD changes continuously. Hence the e.m.f. induced in these coil sides also changes but the e.m.f. induced in one coil side adds to that induced in the other.

(i) When the loop is in position no. 1 [See Fig. 1.1], the generated e.m.f. is zero because the coil sides (AB and CD) are cutting no flux but are moving parallel to it.

(ii) When the loop is in position no. 2, the coil sides are moving at an angle to the flux and, therefore, a low e.m.f. is generated as indicated by point 2 in Fig. (1.2).

(iii) When the loop is in position no. 3, the coil sides (AB and CD) are at right angle to the flux and are, therefore, cutting the flux at a maximum rate. Hence at this instant, the generated e.m.f. is maximum as indicated by point 3 in Fig. (1.2).

(iv) At position 4, the generated e.m.f. is less because the coil sides are cutting the flux at an angle.

(v) At position 5, no magnetic lines are cut and hence induced e.m.f. is zero as indicated by point 5 in Fig. (1.2).

(vi) At position 6, the coil sides move under a pole of opposite polarity and hence the direction of generated e.m.f. is reversed. The maximum e.m.f. in this direction (i.e., reverse direction, See Fig. 1.2) will be when the loop is at position 7 and zero when at position 1. This cycle repeats with each revolution of the coil.

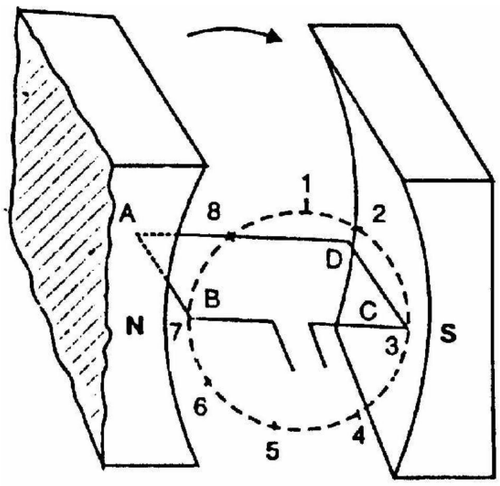


Fig. (1.1)

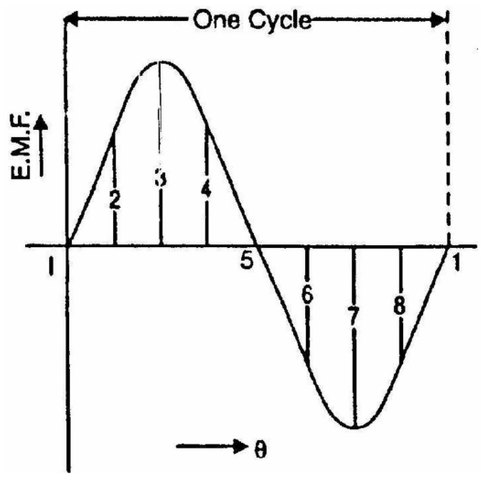


Fig. (1.2)

Therefore, e.m.f. generated in the loop is alternating one. It is because any coil side, say AB has e.m.f. in one direction when under the influence of N-pole and in the other direction when under the influence of S-pole. If a load is connected across the ends of the loop, then alternating current will flow through the load. The alternating voltage generated in the loop can be converted into direct voltage by a device called commutator. We then have the d.c. generator. In fact, a commutator is a mechanical rectifier.

How an induced (or produced) A.C. in the armature can be converted to D. C. by commutator:

For making the flow of current unidirectional in the external circuit, the slip rings are replaced by split-rings (commutator) is shown in **fig-8**. The split rings are made out of a conducting cylinder which is cut into two halves or segments insulated from each other by a thin sheet of mica or some other insulating materials is shown in **fig-9.** As before, the coil ends are joined to these segments on which rest carbon or copper brushes.

Fig-8

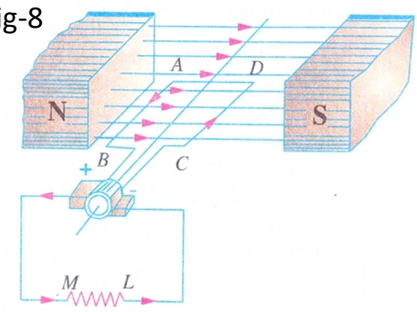
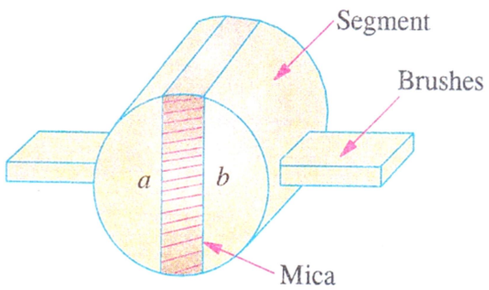


Fig. 26.4

fig-9



It is seen from **fig-10(a)** that in the first half revolution current flows along ABLMCD i,e the **brush No.1** in contact with segment **'a'** acts as a positive end of the supply and **'b'** as the negative end. In the next half revolution [**is shown in fig-10(b**)] the direction of the induced current in the coil has reversed. But at the same time, the positions of segments **'a'** and **'b'** have also reversed with the result that **brush No.1** comes in touch with that segment which is **positive** i.e segment **'b'** in this case.

Fig-10(a)

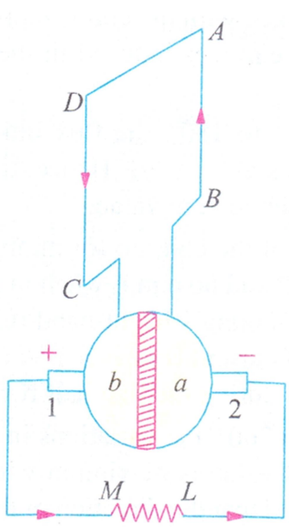
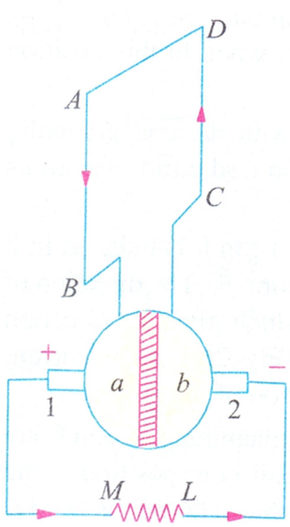
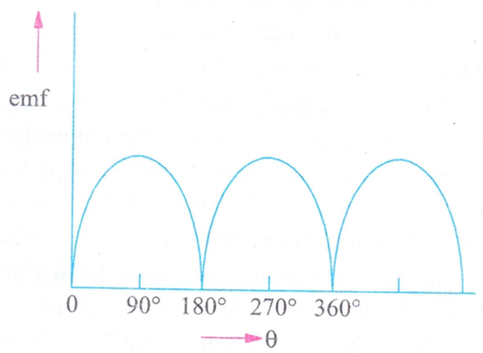


fig-10(b)



Hence, the current in the load resistance again flows from L to M. The wave-form of the current through the external circuit is as shown **in fig-11**. This current is unidirectional but not continuous like pure direct current.

Fig-11



It should be noted that the position of brushes is so arranged that the changeover of segments **'a' and 'b'** from one brush to the other takes place when the plane of the rotating coil is at right angles to the plane of the lines of flux. It is so because in that position, the induced e.m.f in the coil is zero.

Another important point worth remembering is that even now the current induced in the coil sides is **alternating** as before. It is only due to the rectifying action of the **split-rings (also called commutator)** that it become unidirectional in the external circuit. Hence, it should be clearly understood that even in the armature of a d.c. generator, the **induced voltage is alternating**.