ELEMENTARY ELECTRICAL ENGINEERING.

L. W. Gill, M.Sc.

CHAPTER IV.

DIRECT CURRENT APPARATUS AND SYSTEMS.

This series of articles will be continued for some months. They will be of particular interest to the student of electrical work and the civil engineer anxious to secure some knowledge of the simpler electrical problems.

Direct Current Generator.—When the current in any circuit or system flows in one direction only, it is referred to as a "direct" current in contradistinction to an "alternating" current, the direction of which changes periodically. To obtain a uniform and continuous flow of current requires a constant unidirectional e.m.f. Any machine which will generate such an e.m.f. is known as a "d.c." (direct current) generator. It may be here noted that this term is misleading, since it is e.m.f. which is generated and not electricity.

The essential elements of a direct current generator are shown in Fig. 32. Referring to this figure, it will be noted that this generator consists of a circular frame

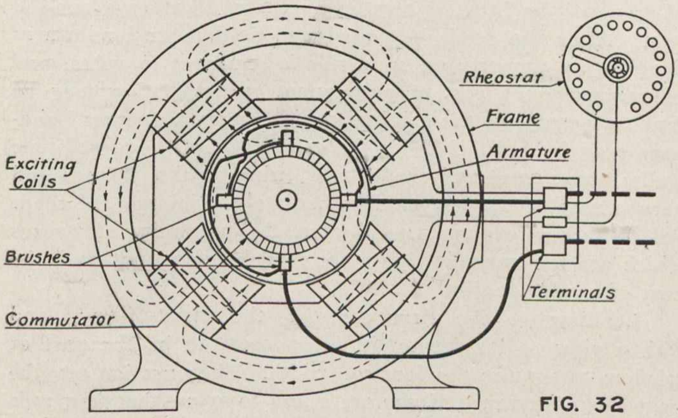

FIG. 32

or yoke, from which four "poles" project radially inwards. The number of poles is not fixed, but increases with the size of the machine. There must always be an even number, however, since for each north pole there must be a corresponding south pole. On each pole is placed a coil of wire, and these coils are connected in series in such a way that when a current passes through the circuit thus formed, the m.m.f. of every alternate coil causes a magnetic flux to flow into the frame, while that of every coil causes a magnetic flux to flow out of the frame. Under these conditions a current passing through the coils will cause a flux to flow through the poles and frame as shown by the dotted lines in Fig. 32. In the central space, which is made concentric with the frame by machining, there is an iron drum mounted on a shaft so that it can be rotated. This drum is made up of thin sheets of iron or steel of high permeability, and consequently provides a path of low reluctance for the flux, which passes from pole to pole. The magnetic circuits are thus composed entirely of magnetic material with the exception of the small clearance between the drum and poles. On the surface of the drum there are a large number of slots, in which copper wires or "conductors" are placed. (These slots and wires are not shown in Fig. 32, but may be clearly seen in Fig. 33, which shows two of these drums with part of the wires in place.) These wires are cross-connected at one end of the drum, and at the other end they are connected to a series of copper bars, which are arranged like the staves of a barrel, and held firmly together, each bar being completely insulated from its neighbor and its support by some nonconducting material. After being clamped in place, these bars are turned down to a smooth surface,

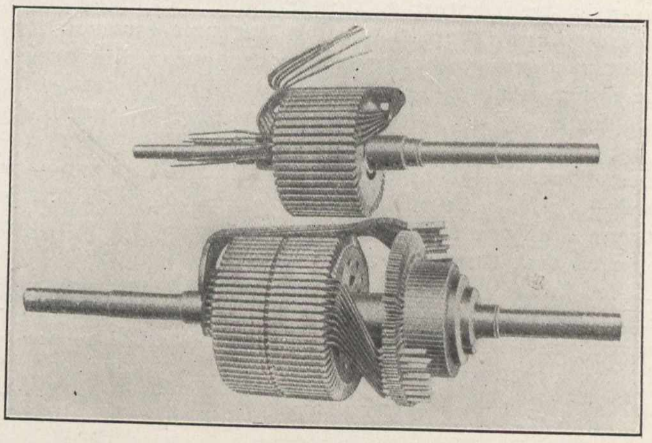

Fig. 33.

on which rubbing contact is made by stationary fingers or "brushes," usually made of carbon. The iron drum, with its complement of wire, is known as the "armature," and the ring of copper bars, with which the brushes make contact, is known as the "commutator." The partially-wound armatures shown in Fig. 33, are shown completely connected to their commutators in Fig. 34.

One method of connecting the conductors to the commutator is shown in Fig. 35. Here the armature winding and the commutator is developed into a plane (the plane of the paper). The dotted lines represent the position of the poles, and the dots and crosses represent the magnetic flux passing at right angles to the plane of the paper. In this case a motion of the conductors in the plane of the paper will correspond to actual rotation of the armature. When such motion occurs, the conductors will cut the lines of force which pass between pole and armature. There will thus be generated in each conductor an e.m.f.,

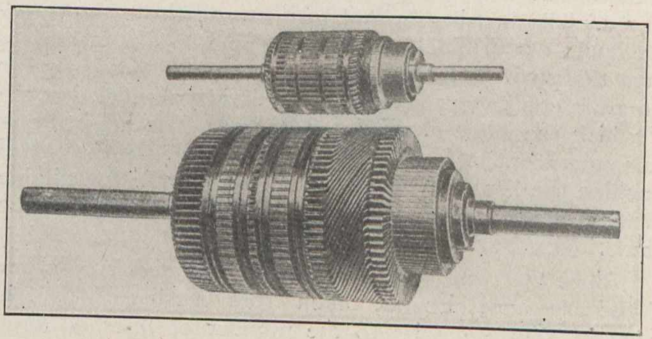

Fig. 34.

the direction of which will change as the conductor passes successive poles. The point at which the change takes place will obviously be midway between the poles. At this point the conductor does not cut any lines of force, and consequently there will be no e.m.f. generated in it. This point, which is called the "neutral point," is not a fixed point on the armature, but is that particular point at which there is no e.m.f. being generated. The point on