5.1 D.C MOTOR PRINCIPLE

A machine that converts D.C power into mechanical power is known as a d.c motor. Its operation is based on the principle that when a current carrying conductor is placed in a magnetic field, the conductor experiences a mechanical force. The direction of this force is given by Fleming's left hand rule and magnitude, Basically, there is no constructional difference between a D.C motor and a D.C generator. The same D.C machine can be run as a generator or motor.

Working of D.C Motor

When the terminals of the motor are connected to an external source of d.c. supply:

(i) the field magnets are excited developing alternate N and S poles;

(ii) the armature conductors carry currents.

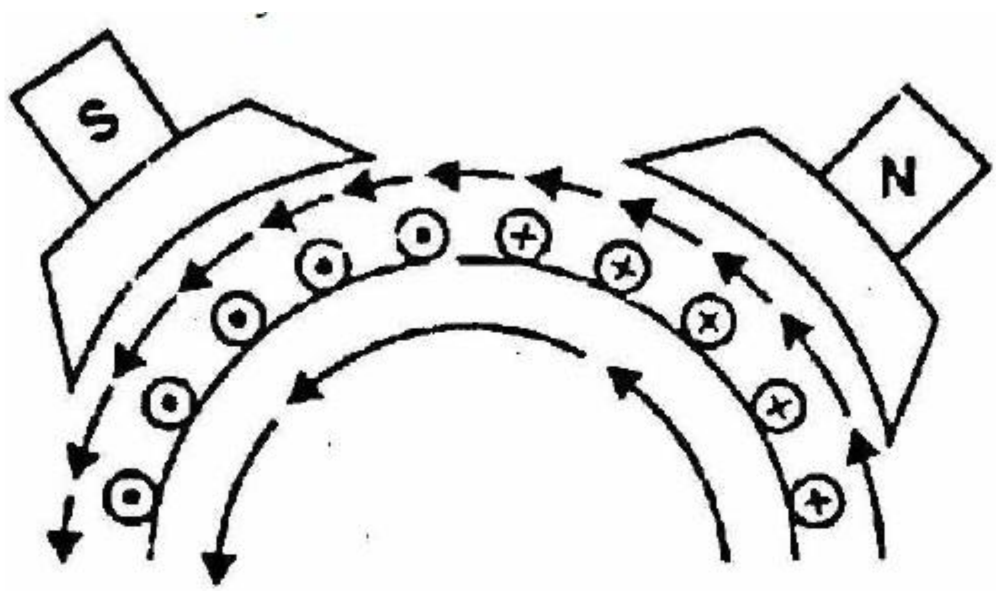

Figure 5.1.1 Armature conductors

[Source: "'Electric Machinery Fundamentals" by Stephen J. Chapman, *Page: 373]*

All conductors under N-pole carry currents in one direction while all the conductors under S-pole carry currents in the opposite direction. Suppose the conductors under N-pole carry currents into the plane of the paper and those under S-pole carry currents out of the plane of the paper as shown in Fig. Since each armature conductor is carrying current and is placed in the magnetic field, mechanical force acts on it. Applying Fleming's left hand rule, it is clear that force on each conductor is tending to rotate the armature in anticlockwise direction. All these forces add together to produce a driving torque which sets the armature rotating. When the conductor moves from one side of a brush to the other, the current in that conductor is reversed and at the same time it comes under the influence of next pole which is of opposite polarity. Consequently, the direction of force on the conductor remains the same.

Types of D.C. Motors

Like generators, there are three types of d.c. motors characterized by the connections of field winding in relation to the armature viz.:

(i) Shunt-wound motor in which the field winding is connected in parallel with the armature. The current through the shunt field winding is not the same as the armature current. Shunt field windings are designed to produce the necessary m.m.f. by means of a relatively large number of turns of wire having high resistance. Therefore, shunt field current is relatively small compared with the armature current.

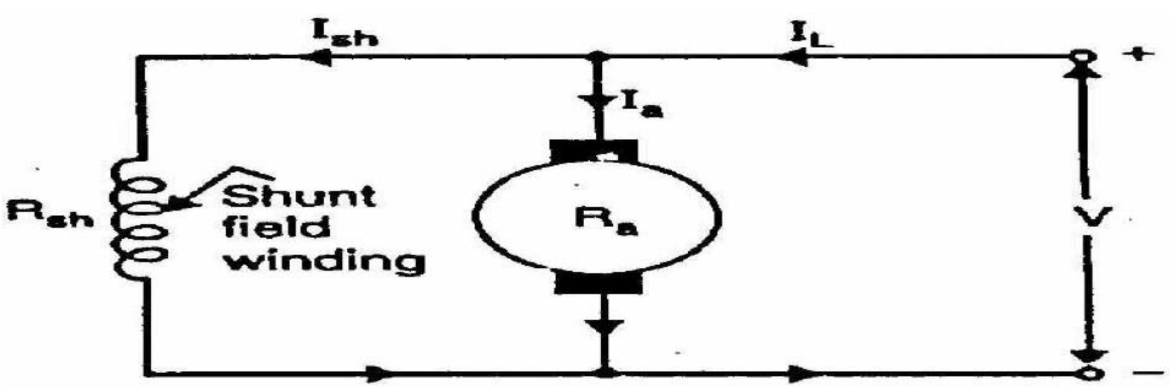

Figure 5.1.2 Shunt Field DC Motor

[Source: "Electric Machinery Fundamentals" by Stephen J. Chapman, *Page: 361]*

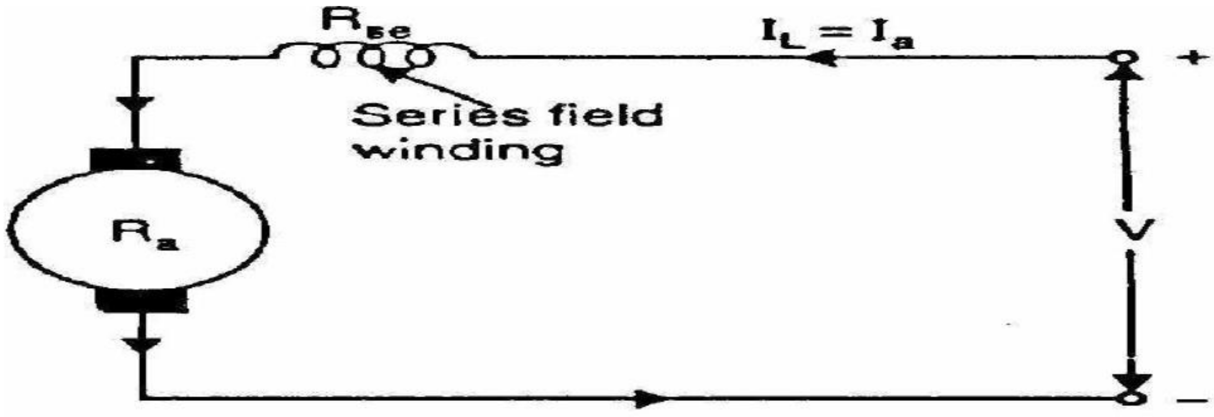

Figure 5.1.3 Series Field Motor

[Source: "'Electric Machinery Fundamentals" by Stephen J. Chapman, *Page: 362]*

(ii) Series-wound motor in which the field winding is connected in series with the armature Therefore, series field winding carries the armature current. Since the current passing through a series field winding is the same as the armature current, series field windings must be designed with much fewer turns than shunt field windings for the same m.m.f. Therefore, a series field winding has a relatively small number of turns of thick wire and, therefore, will possess a low resistance.

(iii) Compound-wound motor which has two field windings; one connected in parallel with the armature and the other in series with it. There are two types of compound motor connections (like generators). When the shunt field winding is directly connected across the armature terminals it is called short-shunt connection. When the shunt winding is so connected that it shunts the series combination of armature and series field it is called long- shunt connection

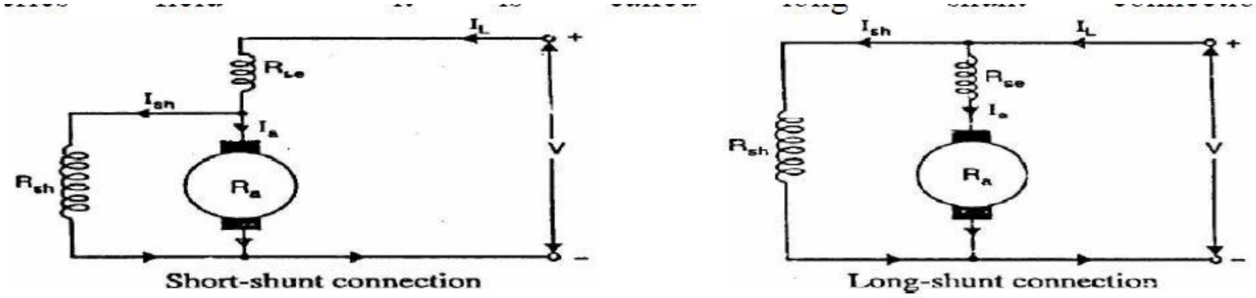

Figure 5.1.4 Long & Short Shunt Field

[Source: "Electric Machinery Fundamentals" by Stephen J. Chapman, *Page: 363]*