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∴ The armature current I_a is given by

$$I_a = \frac{E - E_b}{R_a} \quad \text{--- (1)}$$

At starting speed $\omega = 0$.

$\Rightarrow E_b = 0$.

so,
$$I_a = \frac{E}{R_a}$$

Since, the armature winding electrical resistance (R_a) is very small, this motor has a very high starting current in absence of back emf. So a circuit we need to a starter to start the motor.

Types of DC motors

There are five types of DC motors.

i) permanent magnet DC motor
ii) Separately excited DC motor
iii) Series wound DC motor
iv) Shunt wound DC motor
v) Compound wound DC motor

permanent magnet DC motor

It consists of an armature and one or several permanent magnet encircling the armature. Field coils are usually not required. However some of these motor do have coils around on the poles. If they exits, those coils are intended only for recharging the magnets in the event that they loose

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strength.

II) **Separately-Excited DC motors.** These motor have field coils similar to those of a shunt wound machine, but the armature and field coils are fed from different sources as shown below.

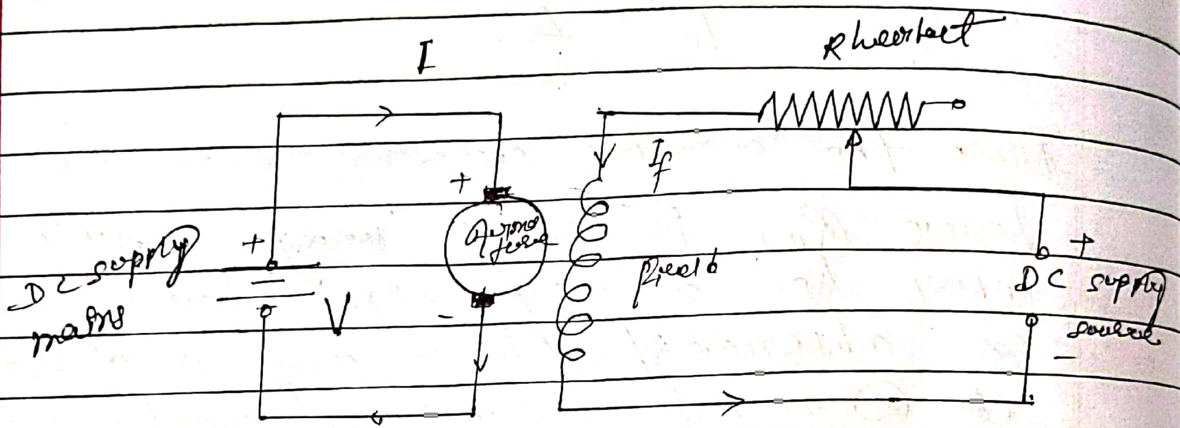

Fig: Separately-Excited DC motor

Let

Armature current, I_a = Line current

$I_L = I$ (say)

Back emf developed, $E_b = V - IR_a$

where R_a = Armature resistance

So, power drawn from supply,

$P = IV$

So, Mechanical power developed, P_m = I/P power − power lost in armature

$$= VI - I^2 R_a$$

$$= I(V - IR_a)$$

$$[P_m = IE_b]$$

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③

III) Series wound DC Motors.

In this DC motor, the field coils, consists of few turns of thick wire, are connected in series with the armature as shown below

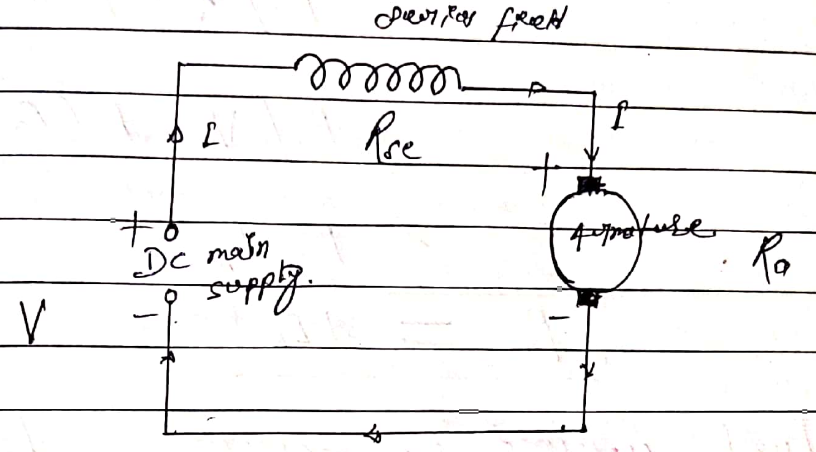

Fig: Series wound DC motor.

The cross-sectional area of the wire used for field coil are large to carry the armature current, but owing to higher current the no. of turns of wire need not be large.

From figure, we have,

Let, Armature current I_a = Series field current I_{se} = Line current $I_L = I$

∴ Back emf developed in the coil,

$$E_b = V - I(R_a + R_{se}) \quad \text{--- (1)}$$

So, The power drawn from source

$$P = IV.$$

∴ The mechanical power delivered = I/p power − power dissipated in armature and field

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$$P_m = IV - I^2(R_a + R_{se})$$

$$= I[V - I(R_a + R_{se})]$$

$$= I[V - I(R_a + R_{se})]$$

$$= I[V - I(R_a + R_{se})]$$

$$= I \cdot E_b$$

$$\boxed{P_m = I E_b}$$