DC motor Equivalent circuit.

The equivalent circuit of DC Motors (and Generators) has two components:

Armature circuit: it can be represented by a voltage source and a resistance connected in series (the armature resistance). The armature winding has a resistance, R_a.

The field circuit: It is represented by a winding that generates the magnetic field and a resistance connected in series. The field winding has resistance R_f.

Classification of DC Motors

Separately Excited and Shunt Motors

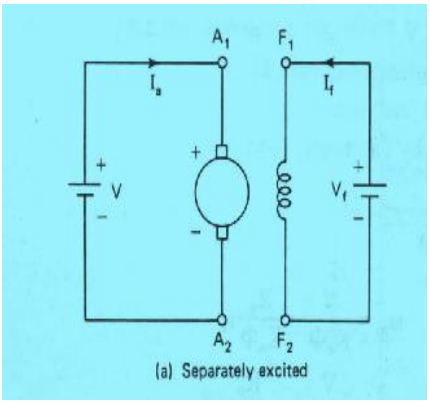
Field and armature windings are either connected separate or in parallel.

Series Motors

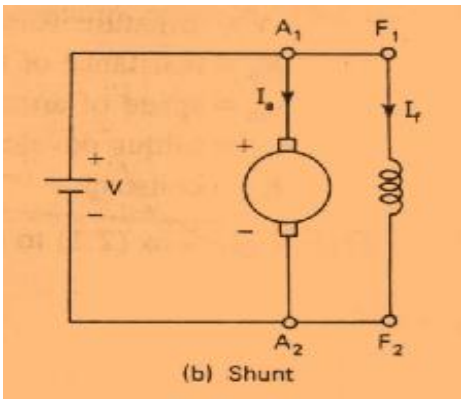
Field and armature windings are connected in series.

Compound Motors

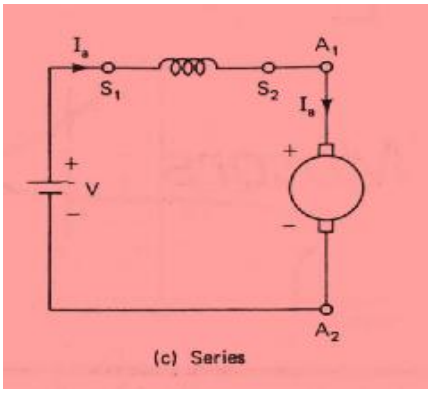
Has both shunt and series field so it combines features of series and shunt motors.



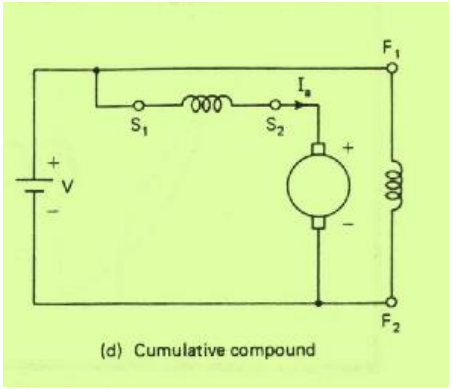
(a) Separately excited



(b) Shunt



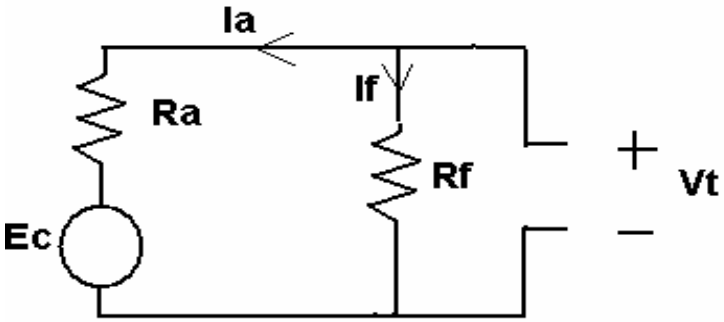
(c) Series



(d) Cumulative compound

Shunt DC Motor

by KVL around the outer loop :



$V_T - I_A R_A - E_C = 0$

$I_f = V_T / R_f$

$E_C = K_g \phi n$

$I_f \propto \phi$,

$\phi = m I_f$

$E_c = k_g m I_f n = K_m I_f n$

$V_T = I_A R_A + E_C$

$V_T = I_A R_A + K_m I_f n$

n = $\frac{V_t - I_a R_a}{K_m I_f}$ **(** speed formula for shunt DC motor**)**

Starting 0f shunt DC motor

At the starting of a DC motor, EC = 0 s0:

$I_A = V_T / R_a$

To limit I_A , a resistance is inserted in series with R_a then removed after the development of E_c .

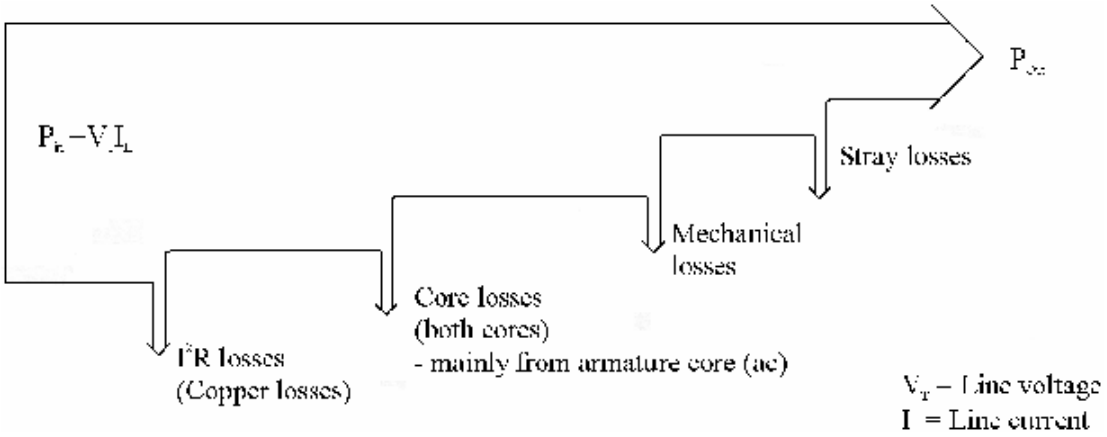
Speed regulation

Speed regulation is the percentage change in speed from no-load

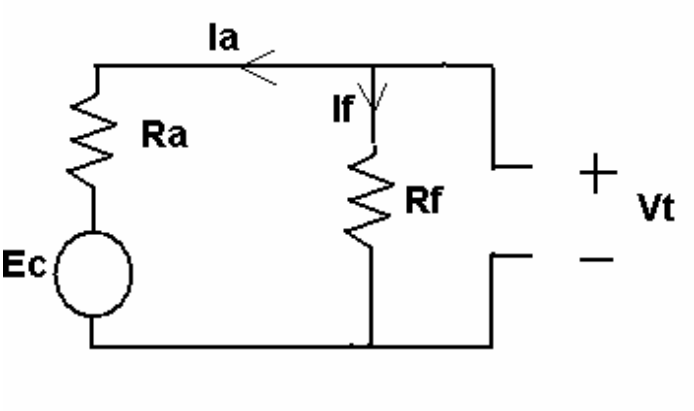
to full-load as a function of the full load speed.

$SR = [(n_{NL} - n_{F\,L}) / n_{F\,L}] * 100\%$

Power flow and losses in DC motors



EX 1) A 240 V, shunt DC motor takes an armature current of 20 A when running at 960 rpm. The armature resistance is 0.2 Determine the no load speed if the no load armature current is 1 A.



$V_T = I_A R_A + E_C$

E_c (full load)= 240 – 20*0.2 = 236 V

E_c (no load)= 240- 1* 0.2 = 239.8V

Assuming I_f is constant

$[E_c (nl)/ E_c (fl)] = [n (nl)/ n (fl)]$

n(nl)= 239.8 * 960 / 236 =975.45 rpm