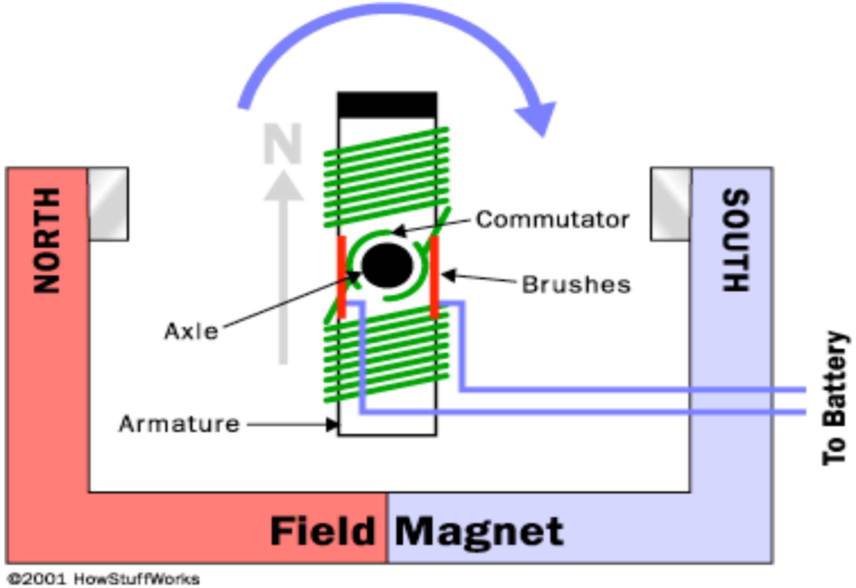
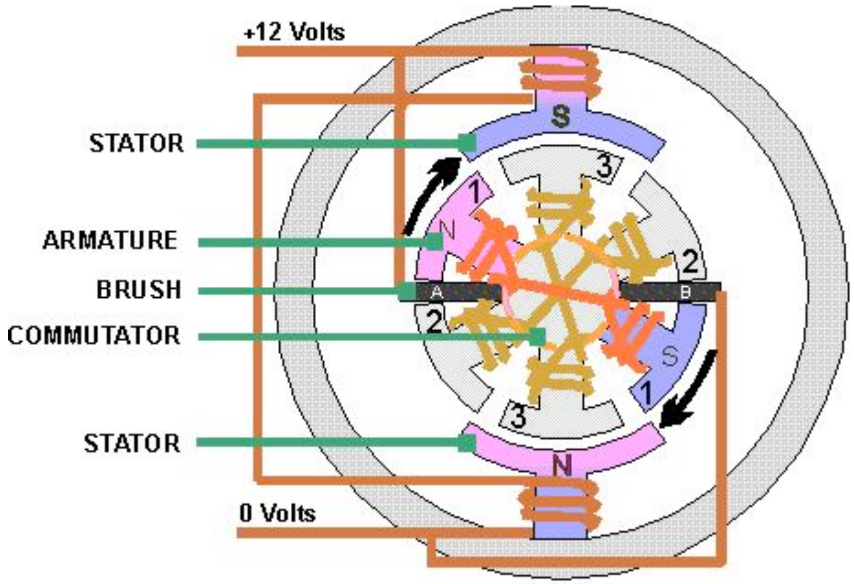
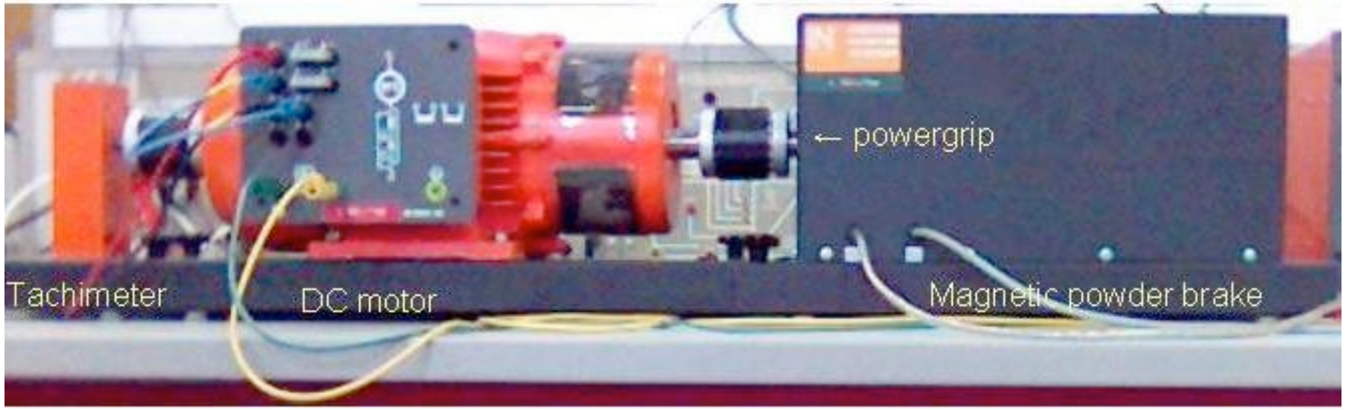
DC Machine: Basic Principles



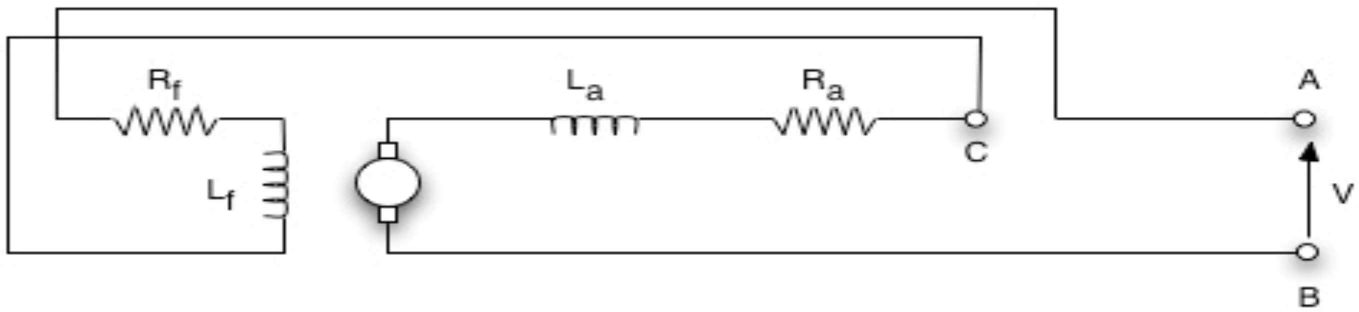




DC Machine: Equivalent Circuit

Assumption 1: there is an infinite number of commutators

=> modeling may be done from the circuit



Two basic equations for this circuit

$$\begin{cases} V_{AC} = R_f \times I_f + \frac{dI_f}{dt} \times L_f \\ V_{CB} - E = R_a \times I_a + \frac{dI_a}{dt} \times L_a \end{cases}$$

DC Machine: First Equation

When the circuit is connected in series

$$\begin{cases} V_{AC} + V_{CB} = V \\ I_a = I_f = I \end{cases}$$

Then

$$L\frac{dI}{dt} = V - RI - E$$

With

$$\begin{cases} L = L_a + L_f \\ R = R_a + R_f \end{cases}$$

DC Machine: Second Equation

Mechanical balance of the load:

$$J\frac{d\omega_r}{dt} = T_{em} - B\omega_r - T_l$$

Where

$$\begin{cases} E = K_{m,1}\phi_f(I_f)\omega_r \\ T_{em} = K_{m,2}\phi_f(I_f)I_a \end{cases}$$

Assumption 2: the motor is operated below saturation
Assumption 3: Ideal efficiency in energy conversion

$$\begin{cases} \phi_f(I) = L_{af}I \\ K_{m,2} = K_{m,1} \end{cases}$$

Model of the series-connected DC motor

Finally the model is

$$\begin{cases} \frac{dI}{dt} = V - RI - L_{af} I \omega_r \\ \frac{d\omega_r}{dt} = L_{af} I^2 - B\omega_r - T_l \\ y = I \end{cases}$$

$K_m L_{af}$ Is denoted L_{af}