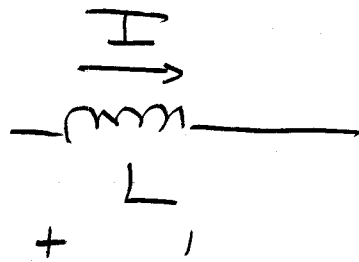


# Review for MID term

Some  
things  
captured  
(CPD 81)



$$E = \frac{1}{2} LI^2$$

$$V_L = L \frac{\Delta I}{\Delta t}$$

BLPCC

S&C  
Physics  
Notes

## Special case Faraday Law

## Lorenz Force

$$E = \beta l v$$

$$F = \beta l I$$

## Faraday Law

$$E = N \frac{d\phi}{dt}$$

## Lifting

$$F_g = 9.8 m$$

$$W = F * d$$

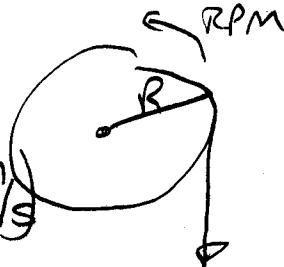
$$P = \frac{W}{t} = F * v$$

RPM  $\rightarrow$  Linear speed

$$T = F * r$$

$2\pi R$

$$0.1 \text{ min} = \frac{m}{s} \cdot 1.0 \text{ sec}$$



13

# Power Triangle

Single Phase

$$S = VI$$

$S$  = Apparent Power

3 Phase

$$S_{3\phi} = VI\sqrt{3}$$

$S$  = Apparent Power

$$P_{1\phi} = VI \cos\theta = \cancel{S \cos\theta}$$

$$= VI (\text{PF}) = \cancel{S}$$

$$P_{3\phi} = VI\sqrt{3} \cos\theta$$

$$= VI\sqrt{3} (\text{PF})$$

$P$  = Real Power  
True Power  
Active Power

$$P = S \cos\theta$$
$$P = S (\text{PF})$$

$$Q_{1\phi} = \sqrt{S^2 - P^2} = \sqrt{VI^2 - VI^2 \cos^2\theta} = VI \sin\theta$$

$$= \sqrt{VI^2 \cdot (1 - \cos^2\theta)} = VI \sqrt{(1 - \cos^2\theta)} = VI \sin\theta$$

$$= S \sin\theta$$

$Q$  = Reactive Power

$$Q_{1\phi} = VI \sin\theta = S_{1\phi} \sin\theta$$

$$Q_{3\phi} = VI\sqrt{3} \sin\theta = S_{3\phi} \sin\theta$$

## Acceleration

if  $T_L$  NOT given  
ASSUME ZERO &  
STATE

$$\Delta t = \frac{J \Delta \omega}{9.55 T_a} \quad \text{where } T_a = (T_m - T_L)$$

$$E_k = \frac{1}{2} m v^2 = 5.48 \times 10^3 \text{ J} \cdot \text{m}^2$$

## Dc machines

$$E = \frac{Z \Phi \omega}{60}$$

if  $\Phi$  CONSTANT

$$\frac{E_1}{N_1} = \frac{E_2}{N_2}$$

$$Z = (\# \text{ coils}) * \left( \frac{\# \text{ turns}}{\text{coil}} \right) * \left( \frac{2 \text{ cond}}{\text{turn}} \right)$$

$$\underline{I_{\text{Brush}}} = I_{\text{DC}} / \text{Brush Pairs} = I_{\text{DC}} / \text{pole Pairs}$$

$$I_{\text{coil}} = \frac{1}{2} I_{\text{brush}}$$

## Motor Direction

①  $T_a$  or  $I_f$

DIRECTION

NOT BOTH

## Generator Polarity

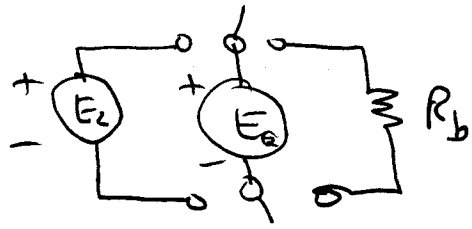
① direction of Rotation

②  $I_f$  direction

NOT BOTH

# Stopping DC Machine

## Dynamic Brake

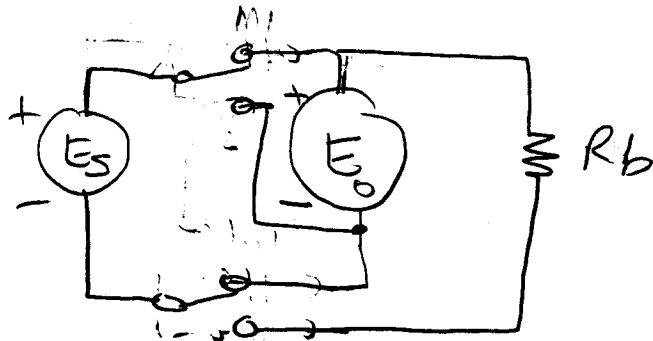


$$I_b = E_o / R_b$$

$$T_o = \frac{J n_1^2}{131.5 P_1} = \text{time to reach } 1/2 \text{ initial speed}$$

## ~~Plugging~~ Plugging

$$I_b = \frac{(E_s + E_o)}{R_b}$$



$$P_1 = E_o I_1$$

$$T_o = \frac{J n_1^2}{131.5 P_1}$$

$$\text{Time to stop} = 2T_o$$

Class	$T_{max}(HotSpot)$	$\Delta T_{max}^{HotSpot}$	$T_{max}(Avg)$	$\Delta T_{max}^{Avg}$
A	105 C	65 C	100 C	60 C
B	130 C	90 C	120 C	80 C
F	155 C	115 C	145 C	105 C
H	180 C	140 C	165 C	125 C

$$t_2 = \left(\frac{R_2}{R_1}\right)(t_1 + 234) - 234 \text{ (Copper)}$$

$$t_2 = \left(\frac{R_2}{R_1}\right)(t_1 + 228) - 228 \text{ (ALUMINUM)}$$

# INDUCTION MOTORS

$$n_s = \frac{120F}{P}$$

$$s = \frac{n_s - n}{n_s}$$

$$n = (1-s)n_s$$

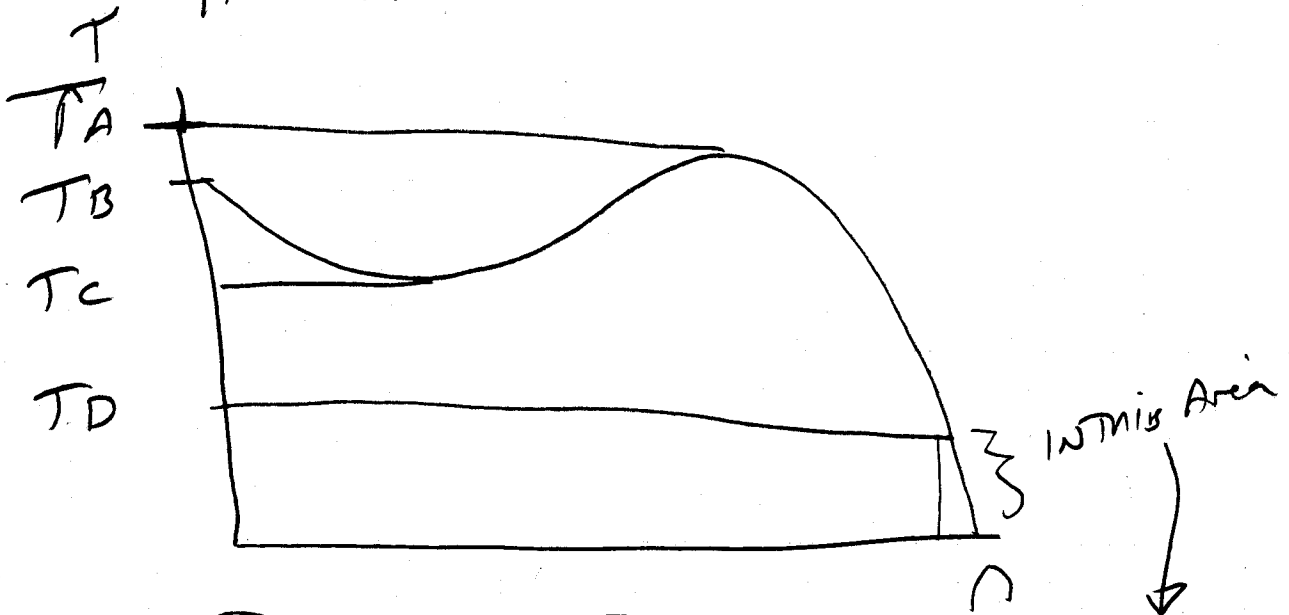
IF  $n$  SAME DIRECTION AS  $n_s$   
 $0 < s < 1$   
 IF  $n$  IN OPPOSITE DIRECTION  
 $s > 1$

$$f_r = sF$$

$$E_2 = sE_{oc}$$

$$9.55 P_m = T * n$$

$$9.55 P_r = T * n_s$$



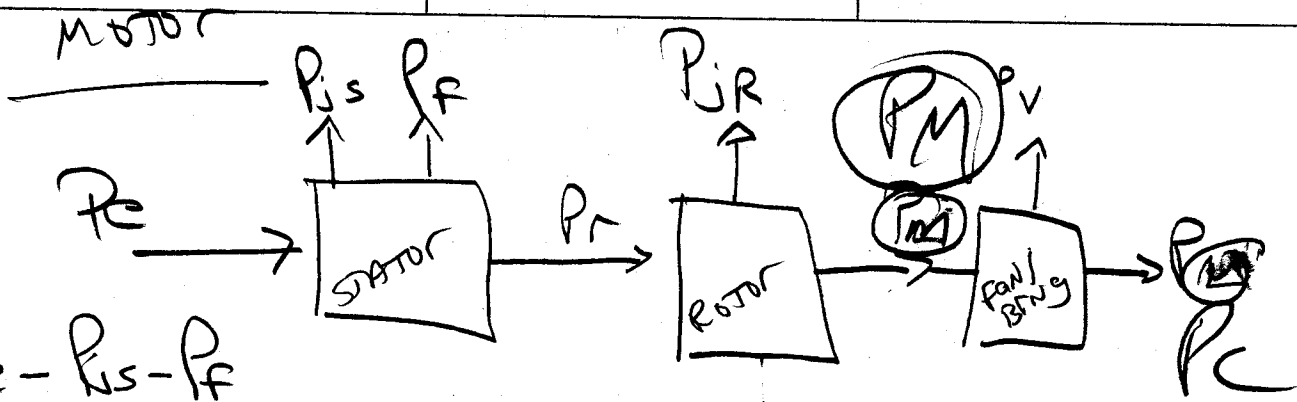
$T_A$  = Break down Torque

$T_B$  = Locked Rotor Torque

$T_C$  = Pull up Torque

$T_D$  = Full Load Torque

$$\frac{s_2}{s_1} = \frac{T_2}{T_1} \cdot \frac{R_2}{R_1} \left[ \frac{E_1}{E_2} \right]^2$$



$$P_r = P_e - P_s - P_f$$

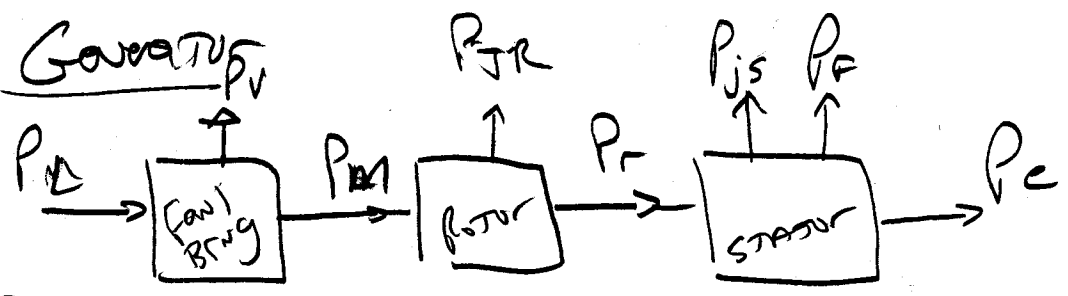
$$P_M = P_r - P_{ir}$$

$$P_L = P_M - P_v$$

$$\eta = \frac{P_M}{P_e}$$

$$P_{ir} = s P_r$$

$$P_L = (1-s) P_r$$



$$P_M = P_{M1} - P_v$$

$$P_r = P_{M1} - P_{jr}$$

$$P_e = P_r - P_s - P_f$$

$$\eta = \frac{P_e}{P_M}$$

$$P_{jr} = s P_r$$

$$P_L = P_r + s P_r$$

$$P_L = (1+s) P_r$$

# Doubly-Fed Machines

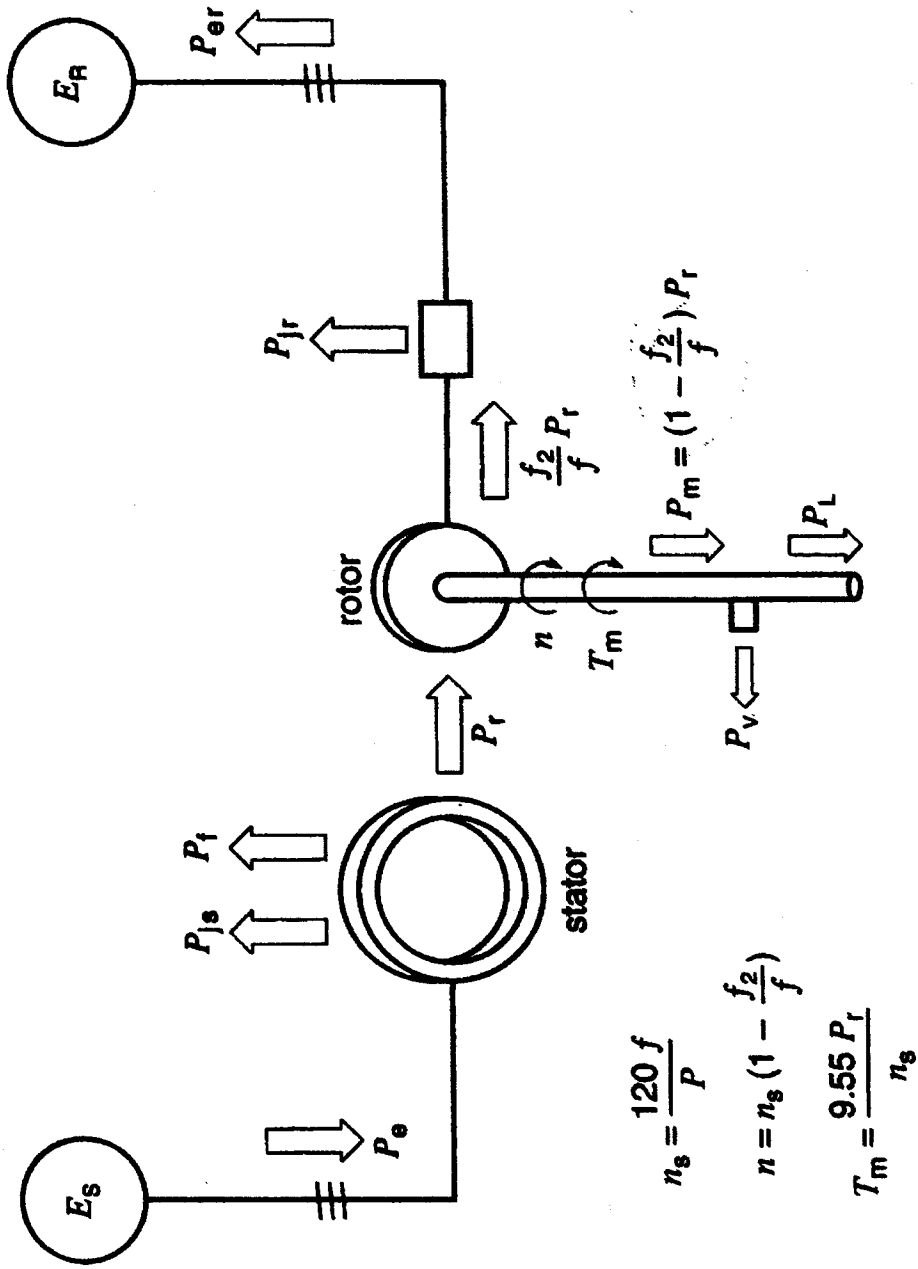
Use figure Based on ① MOTOR or generator

② subsynchronous or  
super synchronous

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SATY → Two winding motor when driven from  
one winding energizes other winding



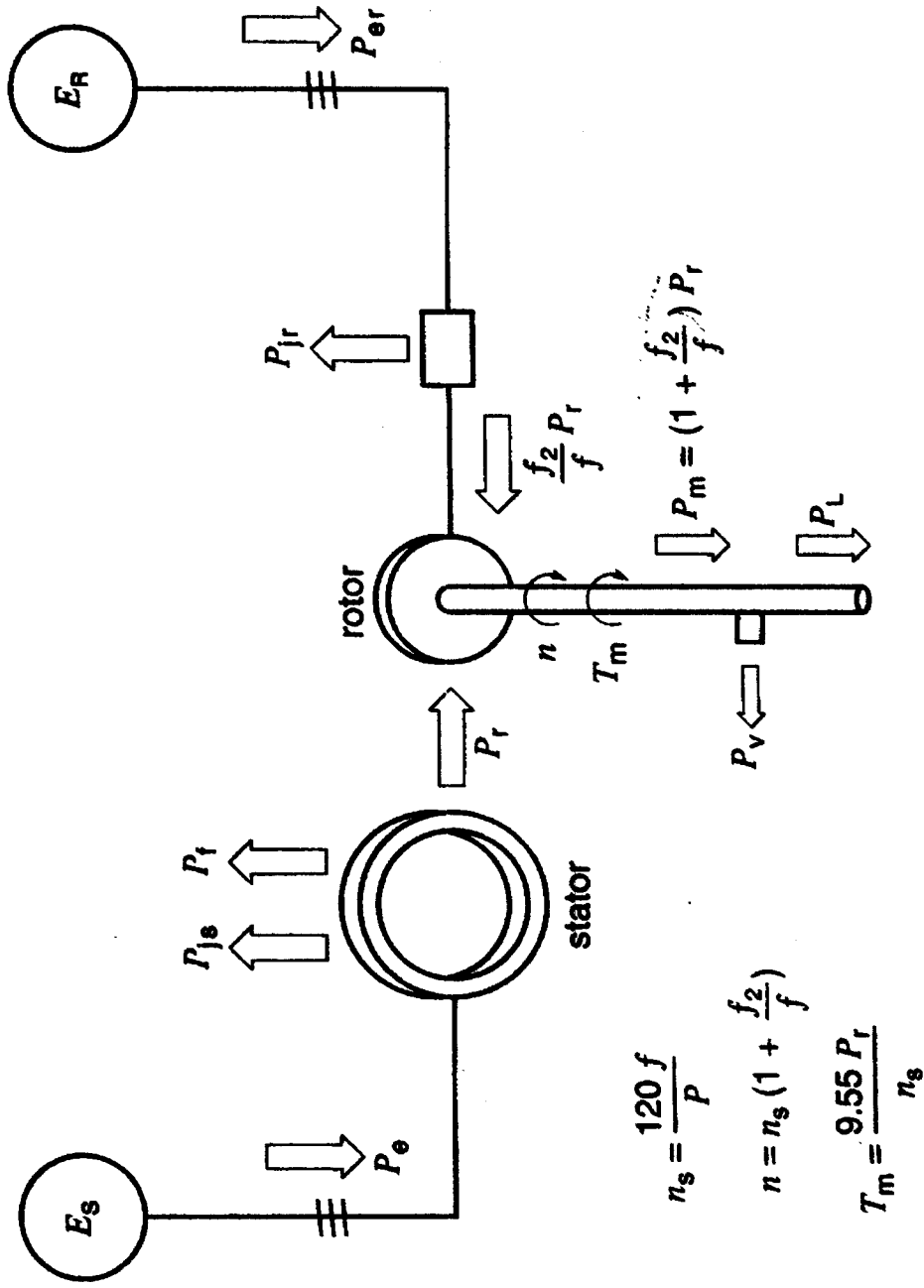


$$n_s = \frac{120 f}{P}$$

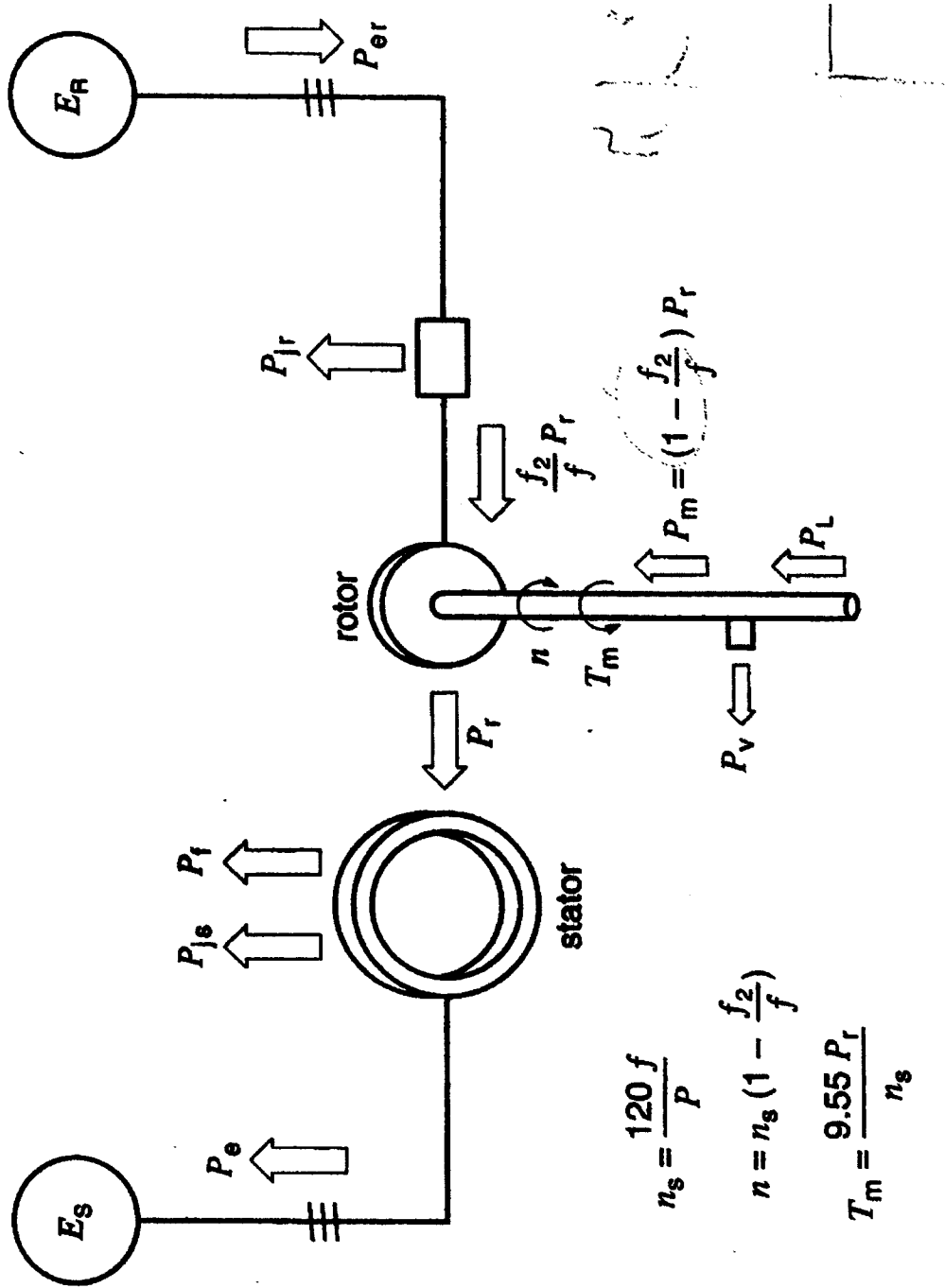
$$n = n_s \left(1 - \frac{f_2}{f}\right)$$

$$T_m = \frac{9.55 P_r}{n_s}$$

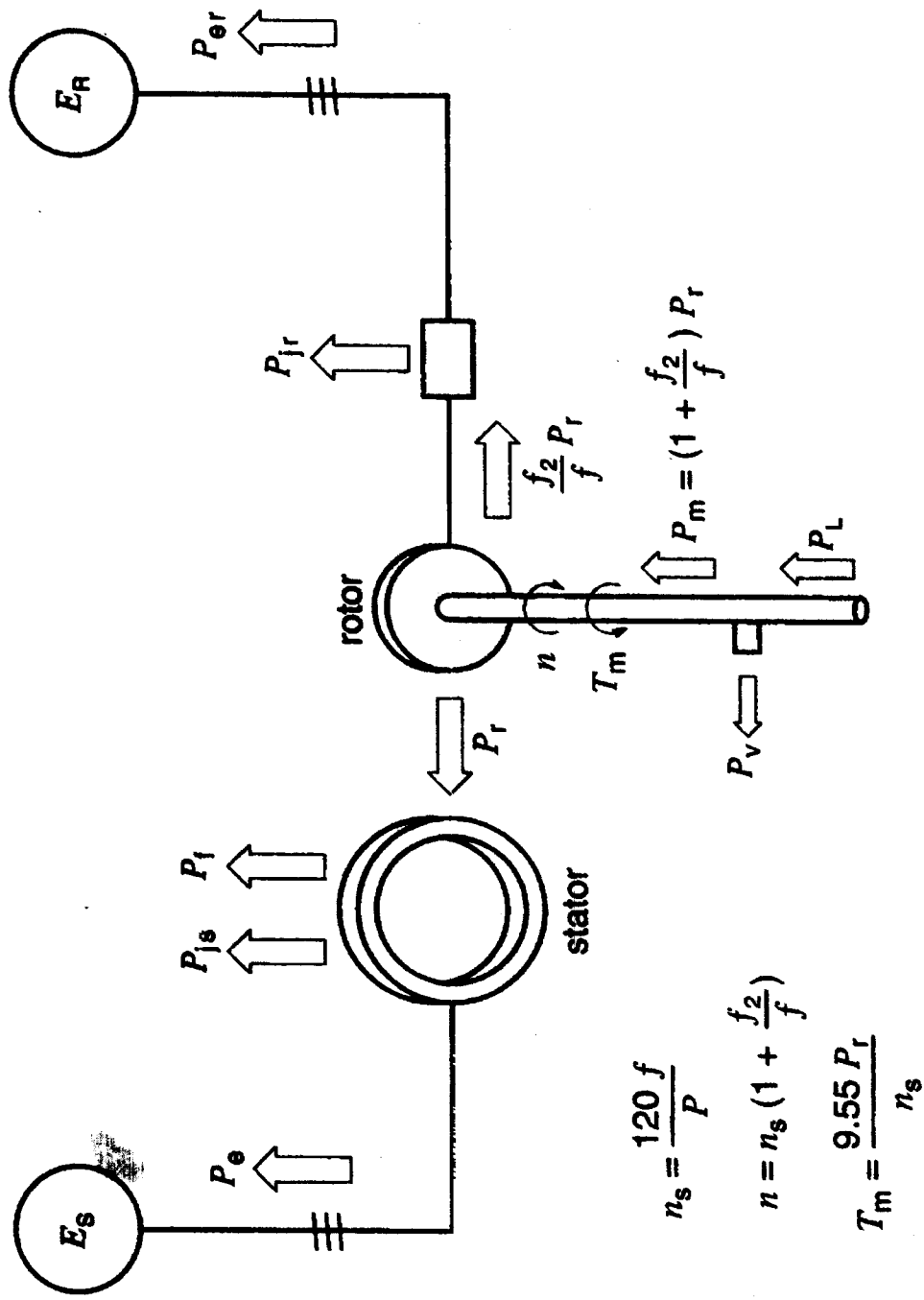
**Figure 13.35** Power flow in a doubly-fed wound-rotor induction motor in subsynchronous mode.



**Figure 13.36** Power flow in a doubly-fed wound-rotor induction motor in supersynchronous mode.



**Figure 13.37**  
 Power flow in a doubly-fed wound-rotor induction generator in subsynchronous mode.



**Figure 13.38** Power flow in a doubly-fed wound-rotor induction generator in supersynchronous mode.