2-3 Constructional Element

1-Armature: hollow cylinder assembled from silicon lamination, with slots to contain the windings open slots with parallel sides with double layer lap winding for voltage up to 11 KV

Semi open slots with single layer lap winding for voltage up to 33 KV

2-Salient poles or non-salient (cylindrical) rotors.

3-Damper winding, separate or complete.

It is starting winding in the motor and in the alternators:

a- Weakening the negative effect of unbalance loads.

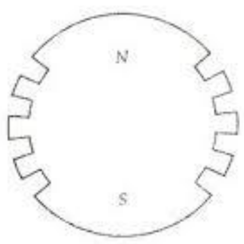
b-damps the rotor swinging due to sudden load change.

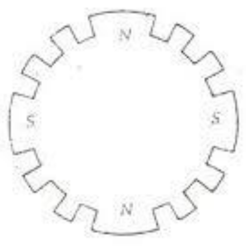
4- Excitation – from external source (250v) through the slip rings or brushes (diodes). Using (AVR) usually the winding from copper stripes

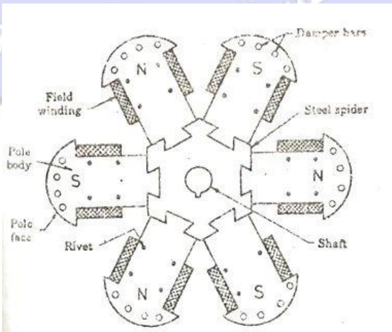
5-Cooling-close system used for cylindrical machines up to 25 µw. The advantage is:

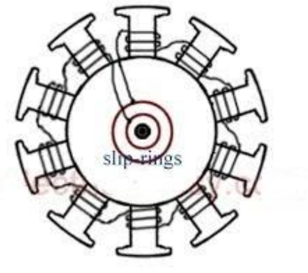
a-It is density is 10% of the air

b-high thermal conductivity, which loads to 30% increase in loading.









Salient pole type rotor

2-4 Armature Reaction:

Armature reaction is the effect of armature flux on the mean field flux. In the case of alternator, the power factor of the load has a considerable effect on the armature reaction

1-Direct Axis, Quadrature Axis

$V_e \rightarrow I_e \rightarrow F_e \rightarrow \emptyset_e$

At $n_r \rightarrow E_{oA}, E_{oB}, E_{oC}$

At load $\rightarrow I_a \rightarrow F_a \rightarrow \emptyset_a$

$F_a = 1.35\, I_a\, Kw\, T_s$

Ψ- phase shift between I_a and E_o

From $\emptyset_e$ and $\emptyset_a$ result $\emptyset_g$- air gap flux

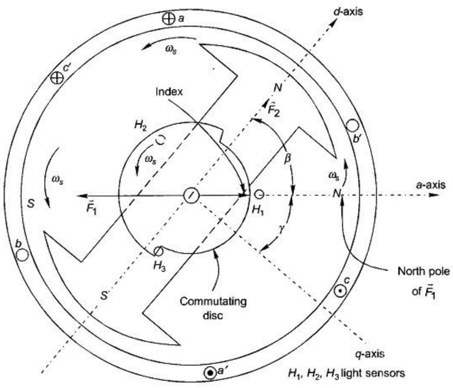
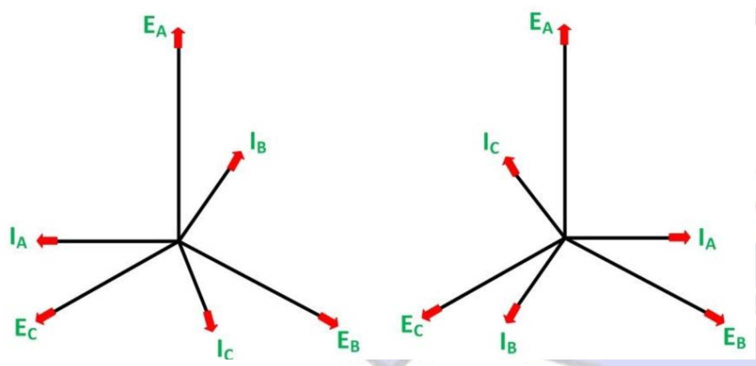


Fig. 8.84 *Brushless dc motor arrangement of sensors; 120° elect sensor code switching from 101 to 100*



2-Pure inductive load(R=0) then Ψ=90

$$I_A = 0 \quad , I_B = -\frac{\sqrt{3}}{2} \times I_m \quad , \quad I_C = \frac{\sqrt{3}}{2} \times I_m$$

Direct armature reaction and demagnetizing armature reaction.

$$\mathrm{I_a} \uparrow, \emptyset_{\boldsymbol{a}} \uparrow \rightarrow \emptyset_{\boldsymbol{g}} \downarrow, \boldsymbol{E_g} \downarrow$$

4-Pure capacitive load

Ψ=-90°

$\mathbf{I_A = 0}$, $\boldsymbol{I_B = \frac{\sqrt{3}}{2} \times I_m}$, $\boldsymbol{I_C = -\frac{\sqrt{3}}{2} \times I_m}$

Direct armature reaction magnetizing A.R

$\mathrm{I_a} \uparrow, \emptyset_a \uparrow \rightarrow \emptyset_g \uparrow \rightarrow E_g \uparrow$

4-Pure Ohmic (resistive) load.

Ψ=0° ,, $\mathrm{I_a}$ in phase with E_a

$\mathrm{I_A} = \mathrm{I_m}$, $\mathrm{I_B}$, $\mathrm{I_C} = -\frac{I_m}{2}$

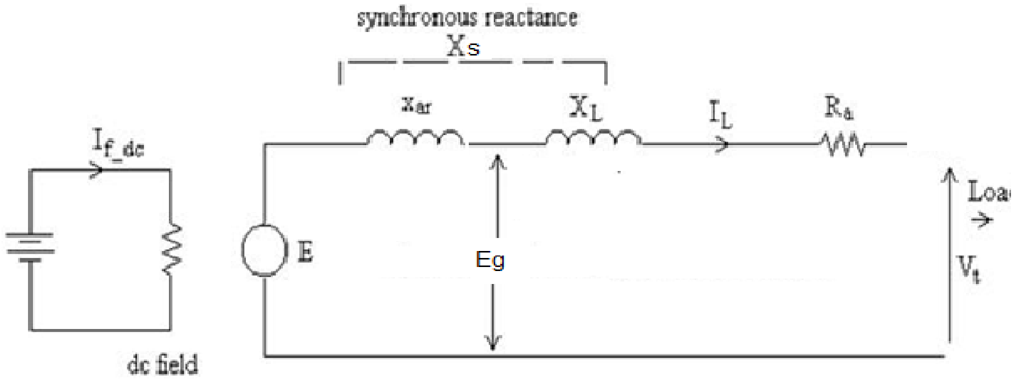
<u>2-5 Phasor Diagram for Cylindrical Rotor Generator</u>

1-saturated cylindrical rotor SM

$R_1, X_L, I_1, V_1, \cos\varphi$ and OCC

$F_e = \mathrm{F_g} - \mathrm{F_a}$, $F_e = I_e T_e$

$\mathrm{F_a} = 1.35\, I_1\, K w T_s$



Per Phase Equivalent Circuit

-voltage regulation ($VR\%$)

$$VR\% = \frac{E_o - V_r}{V_r} \times 100\%$$

$$E_o = \mathrm{E_g} + (-E_a)$$

Advantages:

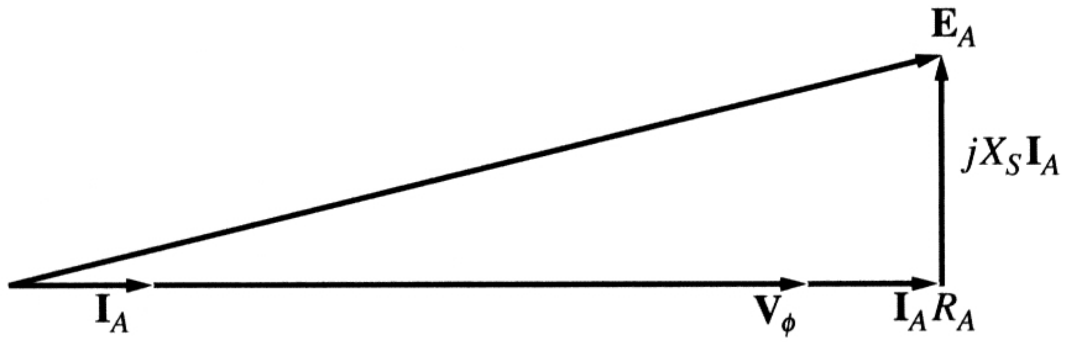
• Simple no load tests (for obtaining OCC and SCC) are to be conducted
• Calculation procedure is much simpler

Disadvantages:

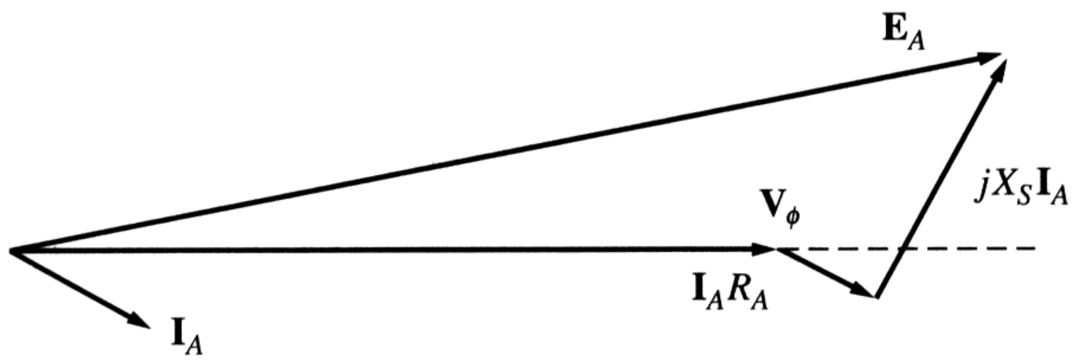
• The value of voltage regulation obtained by this method is always higher than the actual value.

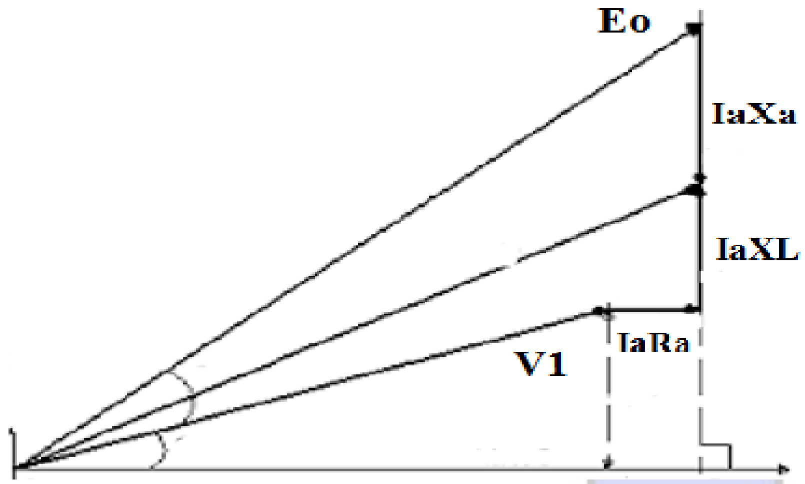
$$E_a = -jI_aX_a \quad , \quad E_g = V_1 + I_1(R_a + jX_L$$
$$\mathrm{E_o} = \mathrm{V_1} + \mathrm{I_a R_a} + jI_a(X_L + X_a) = V_1 + I_a(R_a + jX_s$$

For unity power factor: pure resistive load



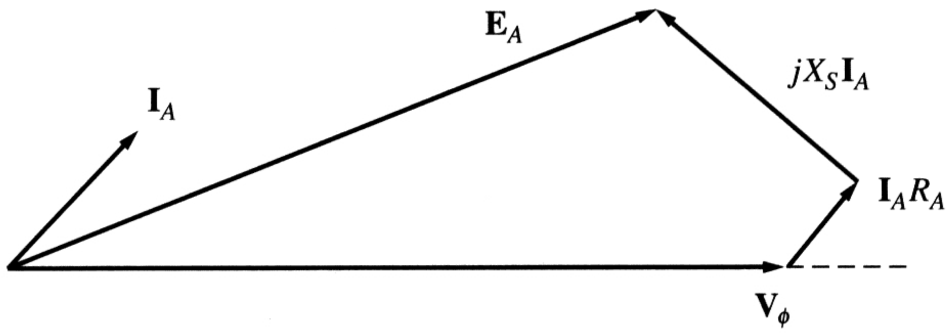
For lagging power factor: inductive load.





$$E_o = \sqrt{V_1 \cos\theta_1 + I_a R_a)^2 + (V_1 \sin\theta_1 + I_a X_s)^2}$$

For leading: capacitive load



$$E_o = \sqrt{v_1\ \cos\theta_1 + I_a R_a)^2 + (V_1 \sin\theta_1 - I_a X_s)^2}$$