thus
$$I_{mf} = \tfrac{1}{2}\left(I_m - jI_a\right) \qquad \text{.... (17–3)}$$

$$I_{mb} = \tfrac{1}{2}\left(I_m + jI_a\right) \qquad \text{.... (17–4)}$$

Suppose that in a two-phase system, the impedances are Z_a and Z_m as shown in Figure 17-2. Then

$$V_m = I_m Z_{1m} + E_m \qquad \text{.... (17–5)}$$

$$V_a = I_a Z_{1a} + E_a \qquad \text{.... (17–6)}$$

where V_m, V_a are the phasor source voltages; I_m, I_a are the phasor phase currents; Z_{1m}, Z_{1a} are each the phasor sum of the external-circuit impedance and the leakage impedance of a stator phase; E_m and E_a are the counter emfs generated in the stator windings by the resultant air-gap flux.

Let N_m and N_a be the effective turns in windings m and a, respectively. Exactly as in a balanced 2-phase motor, a constant-amplitude revolving field would result if the currents in the 2 windings produced equal amplitude mmfs in time quadrature. The direction of rotation of the field would depend on the phase sequence of the currents. A constant-amplitude forward field would result if a set of phasor currents I_{mf} and I_{af} in the windings m and a, respectively, satisfied the phasor relationship

$$N_a I_{af} = jN_m I_{mf} \qquad \text{.... (17–7)}$$

or

$$I_{af} = jI_{mf}/a \qquad \text{.... (17–8)}$$

where a is the effective turns ratio N'_a/N'_m. Similarly, a constant-amplitude backward field would result if another set of phasor currents I_{mb} and I_{ab} satisfied the phasor relationship

$$I_{ab} = jI_{mb}/a$$

f both sets of currents existed simultaneously, the actual winding currents and I_a would be

$$I_m = I_{mf} + I_{mb} \qquad \text{.... (17–9)}$$

$$I_a = I_{af} + I_{ab} = jI_{mf}/a - jI_{mb}/a \qquad \text{.... (17–10)}$$

and both a forward and a backward field would be present. Solution of these equations for the component currents I_{mf} and I_{mb} in terms of the actual winding currents I_m and I_a gives

$$I_{mf} = \tfrac{1}{2}\left(I_m - jaI_a\right) \qquad \text{.... (17–11)}$$

$$I_{mb} = \tfrac{1}{2}\left(I_m + jaI_a\right) \qquad \text{.... (17–12)}$$

Note that a I_a is simply the current in winding a referred to winding m, as in static-transformer theory.

Figure 17-3. Equivalent circuits representing the reactions of (a) the forward and (b) the backward fields as viewed from the main winding.

From the viewpoint of winding m, the internal reactions of the forward and backward fields are just like those in a balanced 2-phase motor. Thus, if the rotor and magnetizing impedances are referred to winding m, the forward-and backward-field impedances Z_f and Z_b as viewed from winding m, are given by the equivalent circuits in Figure 17-3 and the component counter emfs E_{mf} and E_{mb} generated in winding m by the forward and backward fields, respectively, equal the voltages across these impedances. The total counter emf E_m generated in winding m is, as a phasor,

$$E_m = E_{mf} + E_{mb} = I_{mf} Z_f + I_{mb} Z_b \qquad \text{.... (17–13)}$$

Because of the stator turns ratio, the component counter emfs generated in winding a will be a times the corresponding component voltages generated in winding m. Because of the directions in which the fields rotate, the forward-field component generated in winding a leads and the backward-field component lags the corresponding component generated in winding m. The total counter emf E_a generated in winding a by both fields therefore is