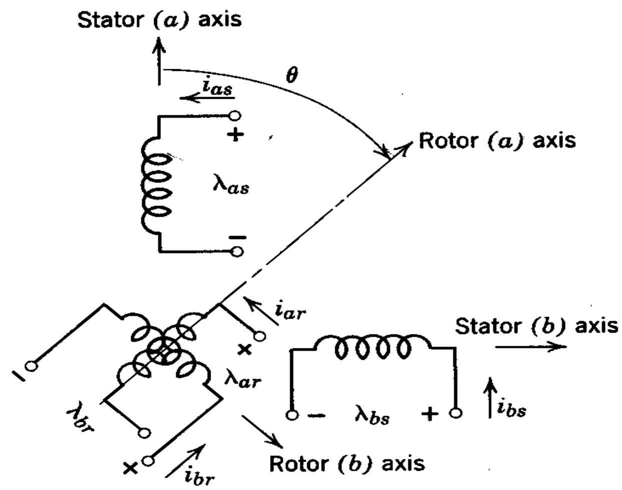

Fig. 4.1.7*b* Schematic representation of balanced two-phase machine in (*a*) showing relative orientations of magnetic axes.

sinusoidally varying mutual inductances discussed before, the terminal relations are now written as

$$\lambda_{as} = L_s i_{as} + M i_{ar} \cos\theta - M i_{br} \sin\theta, \tag{4.1.19}$$

$$\lambda_{bs} = L_s i_{bs} + M i_{ar} \sin\theta + M i_{br} \cos\theta, \tag{4.1.20}$$

$$\lambda_{ar} = L_r i_{ar} + M i_{as} \cos\theta + M i_{bs} \sin\theta, \tag{4.1.21}$$

$$\lambda_{br} = L_r i_{br} - M i_{as} \sin\theta + M i_{bs} \cos\theta, \tag{4.1.22}$$

$$T^e = M[(i_{ar} i_{bs} - i_{br} i_{as}) \cos\theta - (i_{ar} i_{as} + i_{br} i_{bs}) \sin\theta]. \tag{4.1.23}$$

Study of the relative winding geometry in Fig. 4.1.7*a* verifies the correctness of the mutual inductance terms in the electrical terminal relations. Once again, the torque T^e has been found by using the techniques of Chapter 3 [see (g) in Table 3.1].

Figure 1

Taken from Herbert H. Woodson and James R. Melcher, "Electromechanical Dynamics, Part 1: Discrete Systems," page 113, John Wiley & Sons, 1968, demonstrates the classic textbook study for all electric machines begins with the symmetrical mathematical relationships (i.e., 4.1.19, 4.1.20, 4.1.21, 4.1.22, and 4.1.23) describing the synchronized moving magnetic fields of a symmetrical multiphase wound-rotor doubly-fed electric machine with two phase winding sets on the rotor and stator, respectively, and the hypothetical application of brushless and bi-directional speed synchronized power at the winding terminals.