of Maxwell's equations are collected in Table 7–2 for easy reference. It is obvious that in non-time-varying cases these equations simplify to the fundamental relations in Table 7–1 for electrostatic and magnetostatic models.

EXAMPLE 7–5 An a-c voltage source of amplitude V_0 and angular frequency ω, $v_c = V_0 \sin \omega t$, is connected across a parallel-plate capacitor C_1, as shown in Fig. 7–7. (a) Verify that the displacement current in the capacitor is the same as the conduction current in the wires. (b) Determine the magnetic field intensity at a distance r from the wire.

Solution

a) The conduction current in the connecting wire is

$$i_C = C_1 \frac{dv_C}{dt} = C_1 V_0 \omega \cos \omega t \qquad \text{(A)}.$$

For a parallel-plate capacitor with an area A, plate separation d, and a dielectric medium of permittivity ϵ the capacitance is

$$C_1 = \epsilon \frac{A}{d}.$$

With a voltage v_C appearing between the plates, the uniform electric field intensity E in the dielectric is equal to (neglecting fringing effects) $E = v_C/d$, whence

$$D = \epsilon E = \epsilon \frac{V_0}{d} \sin \omega t.$$

The displacement current is then

$$i_D = \int_A \frac{\partial \mathbf{D}}{\partial t} \cdot d\mathbf{s} = \left(\epsilon \frac{A}{d}\right) V_0 \omega \cos \omega t$$
$$= C_1 V_0 \omega \cos \omega t = i_C. \qquad \text{Q.E.D.}$$

b) The magnetic field intensity at a distance r from the conducting wire can be found by applying the generalized Ampère's circuital law, Eq. (7–54b), to contour

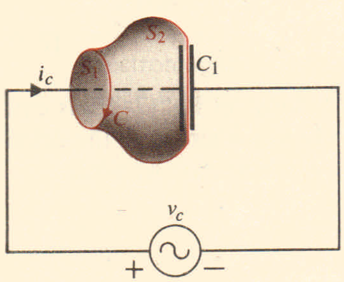

FIGURE 7–7
A parallel-plate capacitor connected to an a-c voltage source (Example 7–5).