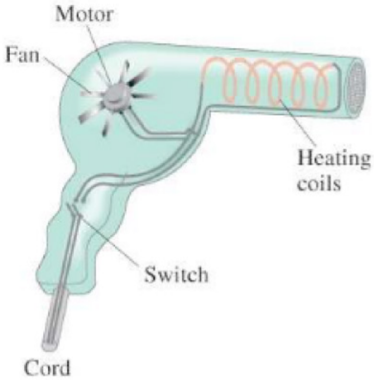

FIGURE 18–23 A hair dryer. Most of the current goes through the heating coils, a pure resistance; a small part goes to the motor to turn the fan. Example 18–12.

EXAMPLE 18–12 Hair dryer. (*a*) Calculate the resistance and the peak current in a 1000-W hair dryer (Fig. 18–23) connected to a 120-V line. (*b*) What happens if it is connected to a 240-V line in Britain?

APPROACH We are given $\overline{P}$ and V_{rms}, so $I_{\text{rms}} = \overline{P}/V_{\text{rms}}$ (Eq. 18–9a or 18–5), and $I_0 = \sqrt{2}\, I_{\text{rms}}$. Then we find R from $V = IR$.

SOLUTION (*a*) We solve Eq. 18–9a for the rms current:

$$I_{\text{rms}} = \frac{\overline{P}}{V_{\text{rms}}} = \frac{1000\ \text{W}}{120\ \text{V}} = 8.33\ \text{A}.$$

Then

$$I_0 = \sqrt{2}\, I_{\text{rms}} = 11.8\ \text{A}.$$

The resistance is

$$R = \frac{V_{\text{rms}}}{I_{\text{rms}}} = \frac{120\ \text{V}}{8.33\ \text{A}} = 14.4\ \Omega.$$

The resistance could equally well be calculated using peak values:

$$R = \frac{V_0}{I_0} = \frac{170\ \text{V}}{11.8\ \text{A}} = 14.4\ \Omega.$$

(*b*) When connected to a 240-V line, more current would flow and the resistance would change with the increased temperature (Section 18–4). But let us make an estimate of the power transformed based on the same 14.4-Ω resistance. The average power would be

$$\overline{P} = \frac{V_{\text{rms}}^2}{R} = \frac{(240\ \text{V})^2}{(14.4\ \Omega)} = 4000\ \text{W}.$$

This is four times the dryer's power rating and would undoubtedly melt the heating element or the wire coils of the motor.

EXAMPLE 18–13 Stereo power. Each channel of a stereo receiver is capable of an average power output of 100 W into an 8-Ω loudspeaker (see Fig. 18–14). What are the rms voltage and the rms current fed to the speaker (*a*) at the maximum power of 100 W, and (*b*) at 1.0 W when the volume is turned down?

APPROACH We assume that the loudspeaker can be treated as a simple resistance (not quite true—see Chapter 21) with $R = 8.0\ \Omega$. We are given the power P, so we can determine V_{rms} and I_{rms} using the power equations, Eqs. 18–9.

SOLUTION (*a*) We solve Eq. 18–9c for V_{rms} and set $\overline{P} = 100\ \text{W}$ (at the maximum):

$$V_{\text{rms}} = \sqrt{\overline{P}R} = \sqrt{(100\ \text{W})(8.0\ \Omega)} = 28\ \text{V}.$$

Next we solve Eq. 18–9b for I_{rms} and obtain

$$I_{\text{rms}} = \sqrt{\frac{\overline{P}}{R}} = \sqrt{\frac{100\ \text{W}}{8.0\ \Omega}} = 3.5\ \text{A}.$$

Or we could use Ohm's law ($V = IR$):

$$I_{\text{rms}} = \frac{V_{\text{rms}}}{R} = \frac{28\ \text{V}}{8.0\ \Omega} = 3.5\ \text{A}.$$

(*b*) At $\overline{P} = 1.0\ \text{W}$,

$$V_{\text{rms}} = \sqrt{(1.0\ \text{W})(8.0\ \Omega)} = 2.8\ \text{V}$$

$$I_{\text{rms}} = \frac{2.8\ \text{V}}{8.0\ \Omega} = 0.35\ \text{A}.$$

EXERCISE F What would be the rms voltage and rms current of the stereo in Example 18–13 if the 100 W was connected to a loudspeaker rated at 4 Ω?

This Section has given a brief introduction to the simpler aspects of alternating currents. We will discuss ac circuits in more detail in Chapter 21. In Chapter 19 we will deal with the details of dc circuits only.