N_1, the secondary emf is less than that of the primary, and the transformer is called a *step-down transformer.*

It may seem that a transformer provides something for nothing. For example, a step-up transformer can change an applied emf from 10 V to 100 V. However, the power output at the secondary is, at best, equal to the power input at the primary. In reality, energy is lost to heating and radiation, so the output power will be *less* than the input power. Thus, an increase in induced emf at the secondary means that there must be a proportional decrease in current.

SAMPLE PROBLEM C

Transformers

PROBLEM

A step-up transformer is used on a 120 V line to provide a potential difference of 2400 V. If the primary has 75 turns, how many turns must the secondary have?

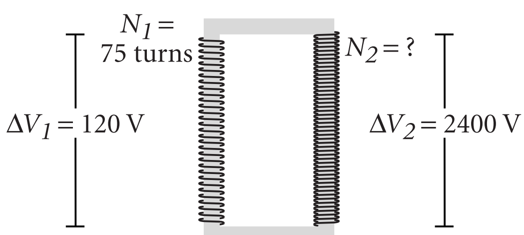
SOLUTION

1. DEFINE

Given: $\Delta V_1 = 120$ V $\quad \Delta V_2 = 2400$ V $\quad N_1 = 75$ turns

Unknown: $N_2 = ?$

Diagram:



2. PLAN

Choose an equation or situation: Use the transformer equation.

$$\Delta V_2 = \frac{N_2}{N_1} \Delta V_1$$

Rearrange the equation to isolate the unknown:

$$N_2 = \frac{\Delta V_2}{\Delta V_1} N_1$$

3. CALCULATE

Substitute the values into the equation and solve:

$$N_2 = \left(\frac{2400 \text{ V}}{120 \text{ V}}\right) 75 \text{ turns} = 1500 \text{ turns}$$

$$\boxed{N_2 = 1500 \text{ turns}}$$

4. EVALUATE

The greater number of turns in the secondary accounts for the increase in the emf in the secondary. The step-up factor for the transformer is 20:1.