KNOWN: Heat generation and thermal boundary conditions of bus bar. Finite-difference grid.
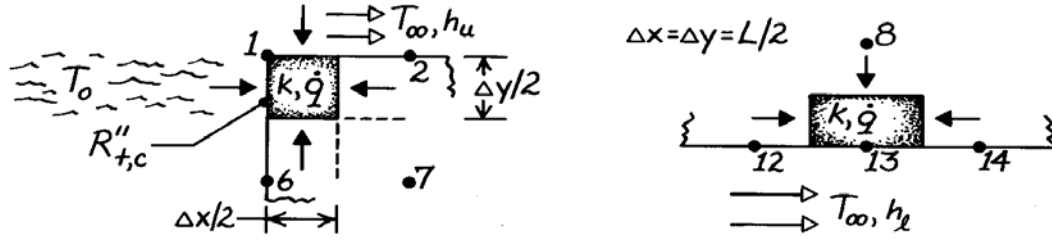
FIND: Finite-difference equations for selected nodes.

SCHEMATIC:

ASSUMPTIONS: (1) Steady-state conditions, (2) Two-dimensional conduction, (3) Constant properties.

ANALYSIS: (a) Performing an energy balance on the control volume, $(\Delta x/2)(\Delta y/2)\cdot 1$, find the FDE for node 1,

$$\frac{T_0 - T_1}{R''_{t,c}/(\Delta y/2)1} + h_u\left(\frac{\Delta x}{2}\cdot 1\right)(T_\infty - T_1) + \frac{k(\Delta y/2 \cdot 1)}{\Delta x}(T_2 - T_1)$$

$$+ \frac{k(\Delta x/2 \cdot 1)}{\Delta y}(T_6 - T_1) + \dot{q}\left[(\Delta x/2)(\Delta y/2)1\right] = 0$$

$$\left(\Delta x/kR''_{t,c}\right)T_0 + \left(h_u\Delta x/k\right)T_\infty + T_2 + T_6$$

$$+ \dot{q}(\Delta x)^2/2k - \left[\left(\Delta x/kR''_{t,c}\right) + \left(h_u\Delta x/k\right) + 2\right]T_1 = 0. \qquad <$$

(b) Performing an energy balance on the control volume, $(\Delta x)(\Delta y/2)\cdot 1$, find the FDE for node 13,

$$h_l(\Delta x \cdot 1)(T_\infty - T_{13}) + (k/\Delta x)(\Delta y/2 \cdot 1)(T_{12} - T_{13})$$
$$+ (k/\Delta y)(\Delta x \cdot 1)(T_8 - T_{13}) + (k/\Delta x)(\Delta y/2 \cdot 1)(T_{14} - T_{13}) + \dot{q}(\Delta x \cdot \Delta y/2 \cdot 1) = 0$$

$$\left(h_l\Delta x/k\right)T_\infty + 1/2(T_{12} + 2T_8 + T_{14}) + \dot{q}(\Delta x)^2/2k - \left(h_l\Delta x/k + 2\right)T_{13} = 0. \qquad <$$

COMMENTS: For fixed T_0 and T_∞, the relative amounts of heat transfer to the air and heat sink are determined by the values of h and $R''_{t,c}$.