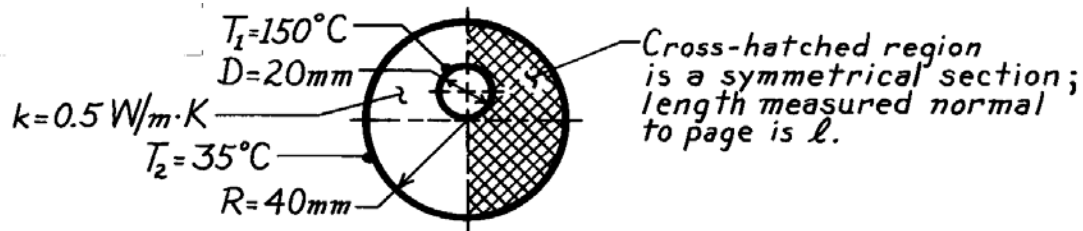


PROBLEM 4S.2

KNOWN: Hot pipe embedded eccentrically in a circular system having a prescribed thermal conductivity.

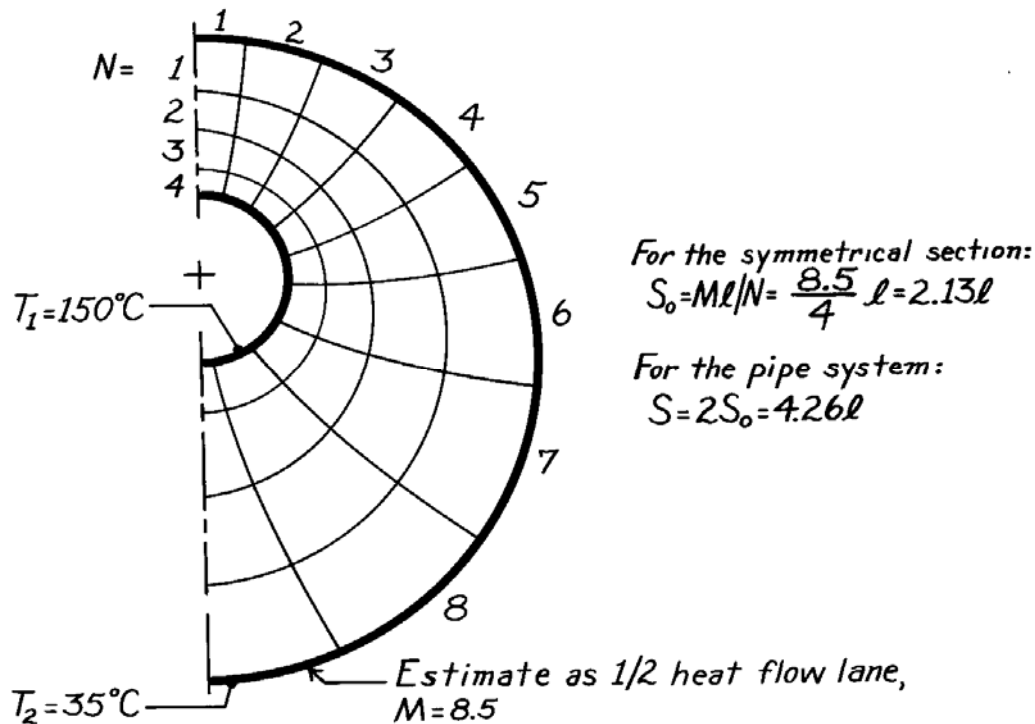
FIND: The shape factor and heat transfer per unit length for the prescribed surface temperatures.

SCHEMATIC:



ASSUMPTIONS: (1) Two-dimensional conduction, (2) Steady-state conditions, (3) Length $\ell \gg$ diametrical dimensions.

ANALYSIS: Considering the cross-sectional view of the pipe system, the symmetrical section shown above is readily identified. Selecting four temperature increments ($N = 4$), construct the flux plot shown below.



For the pipe system, the heat rate per unit length is

$$q' = \frac{q}{\ell} = kS(T_1 - T_2) = 0.5 \frac{\text{W}}{\text{m} \cdot \text{K}} \times 4.26(150 - 35)^\circ \text{C} = 245 \text{ W/m.}$$

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COMMENTS: Note that in the lower, right-hand quadrant of the flux plot, the curvilinear squares are irregular. Further work is required to obtain an improved plot and, hence, obtain a more accurate estimate of the shape factor.