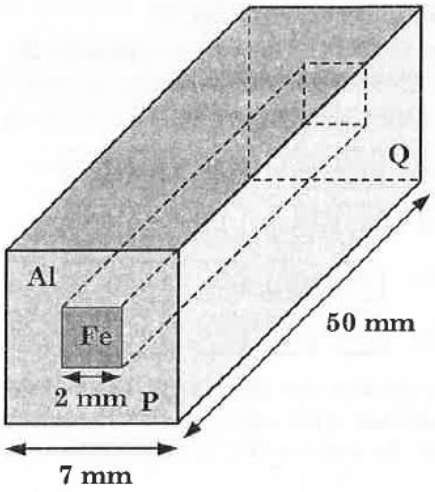
In an aluminum (Al) bar of square cross section, a square hole is drilled and is filled with iron (Fe) as shown in the figure. The electrical resistivities of Al and Fe are 2.7×10^{-8} Ω m and 1.0×10^{-7} Ω m, respectively. The electrical resistance between the two faces P and Q of the composite bar is



(A) $\frac{2475}{64}\mu\Omega$ (B) $\frac{1875}{64}\mu\Omega$ (C) $\frac{1875}{49}\mu\Omega$ (D) $\frac{2475}{132}\mu\Omega$

Solution

R_{Fe} & R_{Al} are in parallel. So, $\frac{1}{R}=\frac{1}{R_{Fe}}+\frac{1}{R_{Al}}$

$\therefore \frac{1}{R}=\frac{A_{Fe}}{\rho_{Fe}l}+\frac{A_{Al}}{\rho_{Al}l}$ (Where, $l=PQ$)

$\therefore \frac{1}{R}=\frac{1}{l}\left(\frac{A_{Fe}}{\rho_{Fe}}+\frac{A-A_{Fe}}{\rho_{Al}}\right)$ (Where, $A=7mm\times7mm$)

$\therefore \frac{1}{R}=\frac{1}{50\times10^{-3}}\left(\frac{2\times10^{-3}\times2\times10^{-3}}{1.0\times10^{-7}}+\frac{7\times10^{-3}\times7\times10^{-3}-2\times10^{-3}\times2\times10^{-3}}{2.7\times10^{-8}}\right)$

$\therefore \frac{1}{R}=20\left(40+\frac{4500}{2.7}\right)$

$\therefore \frac{1}{R}=200\left(4+\frac{500}{3}\right)=\frac{200\times512}{3}$

$\therefore R=\frac{3}{200\times512}\Omega=\frac{3\times10^{6}}{200\times512}\mu\Omega=\frac{3\times625}{64}\mu\Omega=\frac{1875}{64}\mu\Omega$

Hence, Option (B).

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