Arranging the heat sources in the fixed location with the regard for the restrictions on a temperature field.

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When the electronic equipment or various heating appliances are designed it is often arising the problem of arranging the heat sources in the device body or its component parts so as to answer some limitations on a temperature field that is generated by these sources. For example such a limitation can be the requirement that the temperature of chips does not exceed the critical value, which can cause the failure of a chip. According to the statement this problem is a geometrical inverse heat conduction problem as it is necessary to find geometrical parameters from known ones of temperature field.

Consider the particular steady-state problem in which the heat sources have the equal geometrical form and dimensions and can occupy only fixed locations. This problem can be formulated as following. There are \( n \) sources with output heat rating \( P_i \) (\( i = 1, 2, \ldots, n \)). In the considered domain there are \( m \) locations, which are described by regions \( S_k \) (\( k = 1, 2, \ldots, m \)). In each location it is possible to arrange one source. All regions \( S_k \) and heat sources have an equal geometrical form and dimensions. It is necessary to find such correspondence between serial numbers of sources and locations at which the temperature field described by a heat conduction equation

\[
\lambda_x \frac{\partial^2 T}{\partial x^2} + \lambda_y \frac{\partial^2 T}{\partial y^2} + \lambda_z \frac{\partial^2 T}{\partial z^2} - \alpha(T - T_f) + Q = 0 \tag{1}
\]

with boundary conditions

\[
B(T) = \varphi, \tag{2}
\]

satisfies the limitations

\[
R_l(T) \leq 0, \quad (3)
\]

where (\( l = 1, 2, \ldots, r \)); \( R_l \) – some functionals. For example \( R_l = T(x_l, y_l, z_l) - T^*_l \) describe the condition of non-exceeding the specified temperature \( T^*_l \) in check points \( (x_l, y_l, z_l) \).

Specific heat rating \( Q \) in regions \( S_k \) is equal \( Q_k = P_k/V \), where \( P_k \) – heat rating of the sources arranged in the \( k \)th location, \( V \) – the volume of region \( S_k \). outside of the locations \( Q = 0 \). When \( n > m \) some sources are not used, and when \( n < m \) some locations are free (for them \( Q_k = 0 \)).

The solution of problem (1)–(3) is the ordered set of numbers \((i_1, i_2, \ldots, i_m)\), where \( i_j \) – number of sources arranged in the \( j \)th location. This set is a permutation \((n = m)\) or an arrangement \((n \neq m)\). In general the problem (1)–(3) has several solutions as a few sets can satisfy limitations (3). If some extremum condition

\[
E(T) \to \text{extr} \tag{4}
\]

(for example requirement of minimizing the temperature in check points) is set in addition, it is possible to choose an optimal solution from the admissible (in the sense of (3)) ones. This solution is unique as a rule.

The procedure of solving the problem (1)–(3) is proposed in the paper. It is based on the successive narrowing of set of permutations (or arrangements). Note that the obtained solution is not optimal. If the problem contains condition (4), it is possible to find some admissible solutions using proposed procedure and then to choose an optimal one from them. This solution is an approximation of an exact one since not all admissible solutions are considered.

As an application the problem of arranging the radioelements (chips or micromodules) on a printed circuit board is examined.