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ELECTRODYNAMIC PROPERTIES OF DISCRETE SURFACES. PART 2 — SYMMETRIC MULTILAYER DISCRETE-PLANE SURFACES

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The paper considers peculiarities of multilayer discrete surfaces used as antenna elements and focusing devices. Relationships for calculation of geometric parameters of such surfaces are derived. The concept of generalized Fresnel zones is introduced. Based on numerical treatment of the integral equation, the characteristics of scattered fields of these surfaces and the radiation patterns of symmetric multilayer discrete- planar surfaces are analyzed.

The geometry of planar multilayer discrete surfaces. This paper is an extension of inquiries devoted to creation and characteristics of discrete surfaces commenced in [1]. As before, by the discrete surface is meant a set of domains (zones) selected on some imaginary surface. If the surface is planar, the structure thus formed is called discrete-planar. We limit ourselves by considering the parabolic technique of discretization, when the fragmentation of a plane surface into zones is performed so that the zones' boundaries correspond to lines of intersection of this surface with the family of confocal paraboloids of revolution [1].

Symmetric discretization of plane surfaces. Below are presented some relationships describing the geometry of symmetric multilayer discrete surfaces used, for example, as reflectors in mirror antennas, focusing devices and probably in collimators. To gain a better understanding, consider M parallel planes $S_1, S_2,..., S_m,..., S_M$ (we call them layers) located as shown in Fig. 1.

Select some point $F(x_0, 0)$, set the dimension of opening d, and the focal distances f_m for each layer in conformity to the rule

$$f_{m+1} = f_m - \lambda / 2M. \tag{1}$$

The integer $M \geq 2$ will be called the discretion parameter, and $m = 1, 2, 3,..., M$ denotes the number of the layer. We perform fragmentation of each plane S_m into zones, and enumerate these zones so that the distances from the point x_0 to marginal points of each nth zone (focal radii r_{nm}), belonging to the mth plane, satisfy the condition $r_{nm} = f_m + n\lambda/M$. The radii of these zones ρ_{nm} can be determined from the expression

$$\rho_{nm} = \sqrt{2 f_m \lambda / M + (n\lambda / M)^2} \tag{2}$$

where n is the ordinal number of the zone ($n = 1, 2,... N_m$), and N_m is the total number of zones on the mth plane in the discretization area ($\rho_{nm} \leq d$). It can be determined from formula (2) by taking the integral part of the expression

$$\frac{M}{\lambda}\sqrt{d^2 - \frac{2 f_m \lambda}{M}}.$$

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