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INVESTIGATION OF DIPOLE ANTENNA ARRAYS OVER A GRID REFLECTOR

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The paper is devoted to research in characteristics of small-size axially symmetric radial and azimuthal dipole antenna arrays placed above a small-size grid reflector. To diminish the dipole dimensions and to lower the level of backward radiation of the antenna arrays, it is suggested to use lumped inductive elements connected between the radiating arms of the dipoles.

The dipole axially symmetric antenna arrays (AA) with all-round vision of space in azimuthal plane [1] are used in the systems of radio communication, radiolocation and radio navigation. The prospects of further reduction of antenna dimensions and mass, and improvement of their wind-resistance, are related to connection, to the radiating branches of the dipoles, of shortening lumped inductive elements [1, 2], when the reflectors are made as grid structures [4].

Consider the results of investigation of AA characteristics with inductive elements in the radiating branches, for two AA configurations — radial and azimuthal, presented in Figs. 1*a* and 1*b*, respectively. In Fig. 1 the symmetric vibrators (dipoles) *1* of AA with lumped inductive elements *L* are located above grid reflector *2*.

Let vibrators *1* in both modifications of AA be shortened by a half, for example, up to $d = 0.12\lambda_0$ (where d is the length of an arm in dipole *1*) as compared to traditional resonant dimensions of dipoles whose arm's length $d = 0.23–0.24\lambda_0$. The inductive elements are connected in series with both arms of each dipole, symmetrically about the excitation node U at distances $h_L = 0.0366\lambda_0$, and the radius of the dipole wire $r_a = 0.0024\lambda_0$. All the radiating system is arranged at a height of $H = 0.25\lambda_0$ above a conducting grid screen having the shape of a square with dimensions $D = 0.9\times0.9\lambda_0$, and dimensions of square cells $\Delta_1 = 0.05\lambda_0$ and $\Delta_1 = 0.112\lambda_0$, where λ_0 is the central wavelength of the operation range.

With regard for the above initial data, determine the optimal values of the inductive elements $L^{(1)}$, whose connection to an individual dipole results in the first series resonance of the current. In other words, perform the structural optimization of the truncated dipole with inductive elements in free space (as a first approximation) based on the theory of equivalent long line (ELL) [2, 3], using the formula

$$L^{(1)} = \frac{W}{4\pi f}\left\{\cot\left[\eta_1 k\left(d - h_L\right)\right] - \tan\left(\eta_2 k h_L\right)\right\} \tag{1}$$

where $W = 120[\ln(d/r_a)]^{-1}$ is the dipole wave resistance; f is the working frequency; $k = 2\pi/\lambda$ is the wave number; η_1 and η_2 are the coefficients of shortening of the current flow wave on the dipoles in free space, i.e.,

$$\eta_1 = 1 + \left[2.3\cdot\ln\left((d - h_L)/r_a\right)\right]^{-1}; \quad \eta_2 = 1 + \left[2.3\cdot\ln\left(h_L / r_a\right)\right]^{-1}. \tag{2}$$

Now, with the use of these initial values of inductances $L^{(1)}$ for prescribed points of their connection h_L, perform analysis and parametric optimization of the inductance elements. The procedure includes two steps:

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