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METHODOLOGY IMPROVMENT OF THE ELECTROMAGNETIC FIELD AMPLITUDE STUDY RELATED TO THE ANTENNA SYSTEM RISKRADIO-SOLID STATION OF LAND-DEVELOPMENT «CREDO-M1»

The article studies only the amplitudes of the electromagnetic field caused by the sound irradiator of the antenna system of the station «Credo-M1». A non-standard case of falling electromagnetic waves is considered, namely, provided that the wave coming back from the sounding object is normally polarized to the plane of its fall. It is found out that in this case, the fall will be excited only by waves. The field amplitude and their modeling are determined by the Huygens-Kirchhoff methods and by the application of the Lorenz lemma. Simulation is carried out for two types of (E-and H-plane) horns, one of which has parameters of the emitter of the antenna system of the station «Credo-M1».

Keywords: *rectangular horn irradiator, amplitude of the electromagnetic field, polarization characteristics, antenna system.*

Introduction

Problem solving. An analysis of research on the prospects for the development of electronic weapons of armaments and military equipment proves that their creation and improvement, to date, is carried out with the use of the latest technologies and involves an increase in the functionality of individual units, modules, antenna systems, etc. [1–6].

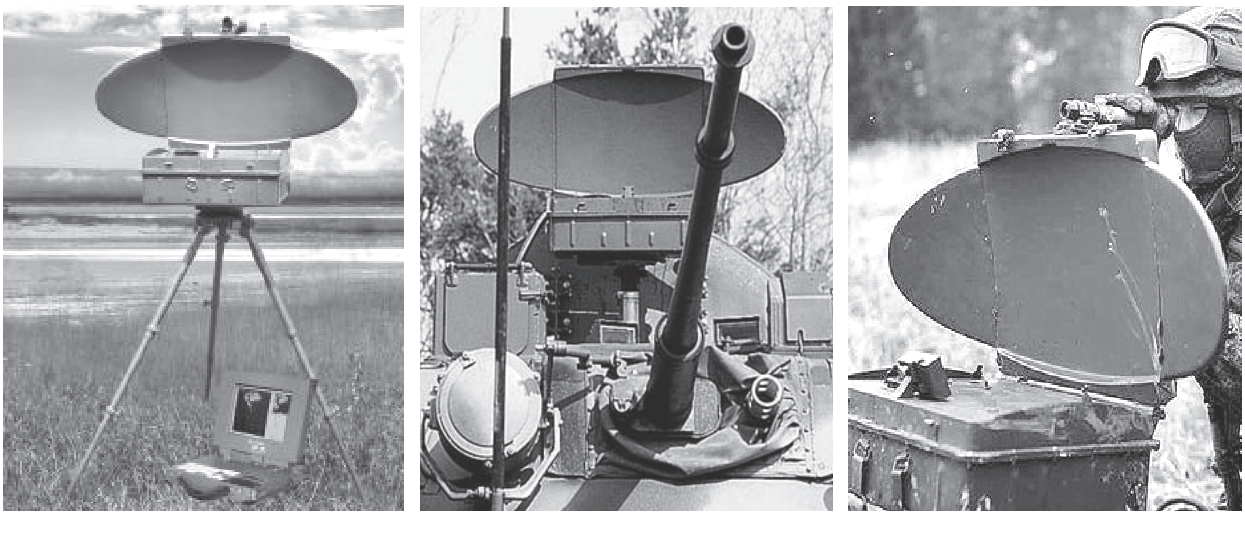
Improvement of antenna systems is carried out mainly not by creating fundamentally new ones but by improving the characteristics and parameters of existing ones [2]. Horn antennas are often used as illuminators of such systems. In today's conditions there is always a need to improve their characteristics, namely, the functional dependences of the amplitude, phases, and the coefficient of polarization of the electromagnetic field of the antennas from the angle of observation.

For example, a portable radar of ground intelligence PSNR-8 «Credo-M1» (1L120), depicted in fig. 1, a, modernized «Credo-M» in the BRM-3K (fig. 1, b), PSNR-5 «Credo» (fig. 1c), and its earlier modifications are refined models of weaponry. They were created on the basis of the antenna system ground-based intelligence station with the index 1RL133.

From fig. 1 it is evident that all samples have a comparable antenna system, which consists of a mirror paraboloid and a loud emitter with a rectangular opening. An antenna takes an electromagnetic wave of linear polarization in a two-centimeter wavelength range.

Station PSNR-8 «Credo-M1», in comparison with previous samples, has 1,5–2 times the greater range of operation and provides:

automatic detection of moving targets and subsequent tracking of them by forming lines on the screen;



a b c

Fig. 1. Ground intelligence stations:
a – portable radar station ground intelligence PSNR-8 «Credo-M1»;
b –modernized «Credo-M» in the BRM-3K; c – portable radar surveillance station PSNR-5 «Credo»

control of the accuracy of artillery bombs with the issuance of the coordinates of the projectile explosion point and the magnitude of the deviation from the point of rubbing in the polar and rectangular coordinate systems;

input, illumination and display of target coordinates on the display; Introduction and real-time transmission of information about identified user targets over digital channels [5].

The main functional feature of the radar is the ability to distinguish information about motor targets against a background of diverse landscapes (bushes, herbage, local objects), day and night, in difficult meteorological conditions (rain, snow, fog, dull, atmospheric pollution). That is, the station has rather high indicators of distinctive ability [5].

Such indicators are primarily dependent on the polarization characteristics of the antenna system. Their further improvement requires more detailed research on the determination of the amplitudes of the electromagnetic field that are excited by the irradiator overlap in the various polarization properties of the wave emitted through the antenna system and returns from the sounding object [5].

According to the level of characteristics analogue radar «Credo-1», there is a domestic radar 111L1 «Lys», developed by HC «Ukrspetstekhnika» [6–7]. However, the antenna system radar «Lys» for constructive execution is sharply different from those shown in fig. 1 antenna systems.

Antenna system radar «Credo-M1» (PSNR-8), as seen from fig. 1a, has no apparent structural differences in comparison with the basic ones: «Credo-M» (fig. 1, b), «Credo» (PSNR-5) (fig. 1, c) or other, earlier (to date, obsolete) samples. However, such radar systems are still in sufficiently large numbers today in almost all former post-Soviet countries and, accordingly, require modernization.

The possibility of further improvement of their polarization characteristics in open sources was not considered, but judging by the external invariability of the design of antenna systems (fig. 1) and not implemented.

Thus, in order to increase the efficiency of the use of the «Credo-M1» station and its earlier modifications, there is a need to improve the polarization characteristics of their antenna systems. This causes the need to find out the scattering properties of such systems by studying the diffraction of the electromagnetic field on its irradiators.

A large number of scientific papers [7–12] are devoted to the analysis of the phenomena of diffraction of electromagnetic waves on objects with horn antennas of various shapes. The papers [5–6] contain the results of investigations of the field, which is excited by the opening of the horn for the case of normal wave polarization to the plane of the fall. In [5], such studies were carried out using the Huygens-Kirchhoff method, where the disconnected electromagnetic field was replaced by equivalent currents. In [6], a Lorentz lemma was used to determine such a field. In [7] a mathematical device for studying the field amplitudes of the antenna excited by the radar system 1RL133 «Credo» is presented. The ultimate expression is the equation for determining the amplitudes of the field in the irradiator overlap for the case of normal wave polarization to the plane of its fall. In [8], such studies were continued for amplitudes of waves excited in the opening of the nth emitter of an equidistant linear lattice of horn irradiators. However, the final expressions need to be clarified in order to take into account additional factors that influence the diffraction phenomena on the opening of the antenna.

When constructing the antenna system of the «Credo-M1» station and earlier similar samples, the receiving and transmitting antenna system was designed, provided that the plane of the polarization of the falling wave and the plane of its fall coincide. Another case [5–8], namely, if the wave is normal (perpendicularly) polarized to the plane of its fall, is not taken into account. The superposition of both variants is the consideration of an arbitrary fall. Such a combination in the future will allow us to draw conclusions about the possibility of improving the polarization characteristics of antenna systems radar, which have in their composition retro-reflector illuminators.

The purpose of this article is to take into account and compare previous methods of investigations of the amplitudes of the electromagnetic field excited by the irradiator of its antenna system provided that the electromagnetic waves fall to the open, for the design of a new or upgraded existing antenna system of the radar «Credo-1M».

Formulation of the problem. Let the rectangular irradiator open (fig. 2, a), the primary electromagnetic wave (notnecessarily flat) falls $\vec{H}_{\Pi}$, $\vec{E}_{\Pi}$. The wave is normally polarized to the incident plane (i.e., the polarization plane of the wave and the fall plane are mutually perpendicular (fig. 2, b).

It is necessary to determine the amplitude of the electromagnetic field excited by the illuminator overlap, for the case of falling wave, which is shown in fig. 2, b The influence of the mirror (paraboloid) and the currents flowing over the open and reflected from the edges of the speaker, are not taken into account. The walls of the speaker will be considered perfectly conductive.

Presenting main material

1. Research the Huygens–Kirchhoff method. To determine the amplitudes of excited waves for opening, we use the expression for an electromagnetic field scattered by an illuminator of a mirror antenna, which is given in [7].

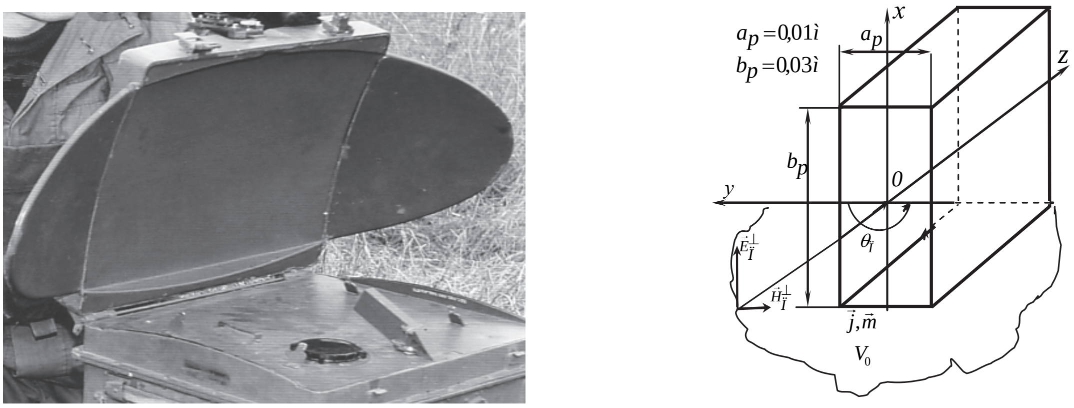


Fig. 2.
a – antenna station system PSNR-5 «Credo»;
b – to formulate a problem for the case of normal wave polarization to the plane of its fall

$$\begin{cases} \vec{E}_{\Pi}^{\perp} = \vec{e}_x E_0 e^{-ik(z\cos\theta_{\Pi} - y\sin\theta_{\Pi})}, \\ \vec{H}_{\Pi}^{\perp} = -\dfrac{E_0}{Z_0}\left(\vec{e}_y \cos\theta_{\Pi} + \vec{e}_z \sin\theta_{\Pi}\right) e^{-ik(z\cos\theta_{\Pi} - y\sin\theta_{\Pi})}, \end{cases} \quad (1)$$

where E_0 – the amplitude of the electrical component; $Z_0 = \sqrt{\mu_0/E_0}$ – wave resistance of free space; $k = 2\pi/\lambda$ the spread of the wave in the free space; θ_{Π} the angle of the fall of the plane wave.

By the Huygens-Kirchhoff method [7], the field from expression (1) is replaced by equivalent currents:

for the component and - for the component (fig. 2, c):

$$\begin{cases} \vec{j}_{екв} = -\left[\vec{n};\vec{H}_{\Pi}\right] = -\vec{e}_x \dfrac{E_0}{Z_0}\cos\theta_{\Pi} e^{iky\sin\theta_{\Pi}}; \\ \vec{m}_{екв} = \left[\vec{n};\vec{E}_{\Pi}\right] = \vec{e}_y E_0 e^{iky\sin\theta_{\Pi}}, \end{cases} \quad (2)$$

where $\vec{n}$ – the outer normal to the opening;

The amplitudes of waves in the horn $AR(\theta_{\Pi})$, excited by currents from the system of equations (2) can be found using the expression [11–12]

$$AR(\theta_{\Pi}) = \frac{1}{N_S}\int_{S_p}\left[\left(\vec{j}_{екв};\vec{E}_{\mp S}\right) - \left(\vec{m}_{екв};\vec{H}_{\mp S}\right)\right] dS, \quad (3)$$

where S_p – open area; $\vec{E}_{\pm S}$, $\vec{H}_{\pm S}$ – personal waves of a rectangular waveguide with dimensions equal to the size of the opening of the speake; N_S – the wavelength of the electric and magnetic type.

$$N_S = \int_S \left(\left\{\left[\vec{E}_{+S};\vec{H}_{-S}\right] - \left[\vec{E}_{-S};\vec{H}_{+S}\right]\right\}, \vec{e}_z\right) dS. \quad (4)$$

Substituting in expression (3) expressions for personal waves [11] and equivalent currents from the system of equations (2), and also taking integrals, we determine their amplitude. In this case, it will appear that only waves of type with amplitudes will be excited in the horn [7].

$$AR_{0n}(\theta_{\Pi}) = \frac{-2E_0 a_p\left(\cos\theta_{\Pi} + \sqrt{1-\left(\dfrac{n\lambda}{2a_p}\right)^2}\left[\sin^2\left(\dfrac{n\pi}{2}\right)\cos\left(\dfrac{\pi a_p}{\lambda}\sin\theta_{\Pi}\right) - i\cos^2\left(\dfrac{n\pi}{2}\right)\sin\left(\dfrac{\pi a_p}{\lambda}\sin\theta_{\Pi}\right)\right]\right)}{(n\pi)^2\sqrt{1-\left(\dfrac{n\lambda}{2a_p}\right)^2}\left(1-\left(\dfrac{2a_p}{\lambda}\sin\theta_{\Pi}\right)^2\right)}, \quad (5)$$

where n – integers.

Further research on the Huygens-Kirchhoff method will consist in determining the general field scattered from the opening of the horn or the lattice of the horns, and the field scattered from the system (illuminator, mirror).

It can be found by the method of equivalent currents and the late-potential theorem after the application of boundary conditions on the surface of the antenna overturning.

Another method can be used to determine the scattered field when it is presented in the form of a decomposition in a continuous spectrum of plane waves, whose amplitudes are provided under the condition of continuity of the tangent components in the opening of the antenna.

Let's simulate the amplitudes of the electromagnetic field, which can be obtained from expression (5) using the Huygens-Kirchhoff method for a wave of type H_{01} ($n = 1$).

In the first study, we use the dimensions of the rectangular waveguide, $a_p = 0{,}03$ м, $б_p = 0{,}01$ м (fig. 3, a, b), and in the second (fig. 4a, b), the parameters of the irradiator of the antenna system of the station 1RL-133 «Credo» (fig. 3. c), $a_p = 0{,}01$ м, $б_p = 0{,}03$ м.

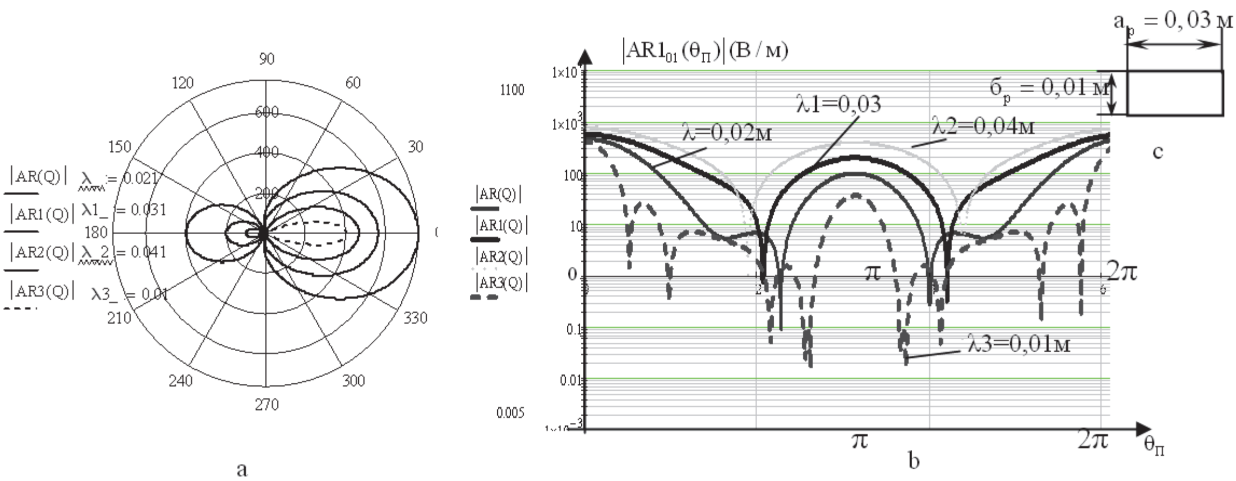


Fig. 3. Electromagnetic field amplitude diagrams excited to open the horn illuminator using the Huygens-Kirchhoff method for the wave: a – in pola; b – a rectangular coordinate system in logarithmic scale with: c – parameters of opening $a_p = 0,03$ м, $б_p = 0,01$ м

From fig. 3 it can be seen that in the case of a fall of a wave H_{01} that is normally polarized to the incident plane, the amplitudes of not only a two-centimeter, but also a three-, four-and one-centimeter range, which can come from other random sources, will be excited on the illuminator. In this case, the greatest amplitude will be for the case of falling on the four-cm waveguide. The smallest is the amplitude for a one-centimeter wavelength incident.

Fig. 4 shows the simulation results that are different from those shown in fig. 3 that the waveguide is rotated 90 degrees. Now the study is subject to the E-plane horn, spikes $a_p = 0,01$ м, $б_p = 0,03$ м. It is these geometric parameters that have an illuminator radar «Credo».

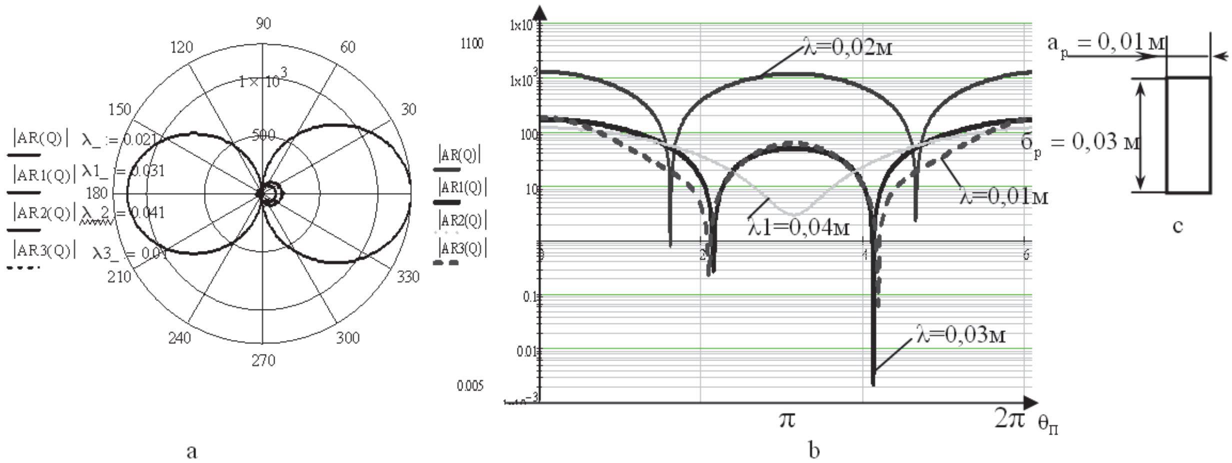


Fig. 4. Electromagnetic field amplitude diagrams excited to open the horn illuminator using the Huygens-Kirchhoff method for the wave: a – in the polar coordinate system; b – in a rectangular coordinate system on a logarithmic scale with: c – parameters of opening $a_p = 0,01$ м, $б_p = 0,03$ м

Fig. 4 it can be seen that for an active two-centimeter wavelength range at which such a station operates, its maximum amplitude $AR_{0n}(\theta_П)$ will be 1100 V/m, which is 10 times greater than the fall of other wavelengths.

It should be noted that in the diagrams given in fig. 3 and rice 4, there is a sufficiently substantial rear petal pattern of direction. This phenomenon can be explained by the fact that the reflection coefficient was not taken into account in Equation (5) obtained by the Huygens-Kirchhoff method.

2. Investigation of the amplitudes by the decay method in a continuous spectrum of plane waves with the application of the Lorentz lemma.

Let the transmission of an independent source of radiation be inside the antenna (fig. 2, c). There, it forms a field that can be designated as $\vec{E}_B$, $\vec{H}_B$ both externally and internally.

Inside the horn, we will denote such a field with a personal function ν.

$\vec{E}_{\mp\nu}$ та $\vec{H}_{\mp\nu}$ are single wave amplitudes, which is reflected from the overlap with the reflection coefficient $\rho_{+\nu}$.

It is necessary to determine the amplitudes of waves that are excited in the opening.

Solution. Expression for $\vec{E}_B$, $\vec{H}_B$, with reflection coefficient $\rho_{+\nu}$ has the form:

$$\begin{cases}\vec{E}_B=\left(\vec{E}_{-\nu}+\rho_{+\nu}\vec{E}_{+\nu}\right);\\ \vec{H}_B=\left(\vec{H}_{-\nu}+\rho_{+\nu}\vec{H}_{+\nu}\right),\end{cases} \quad (6)$$

where $\pm\nu$ is the number of its own function.

On the surface of the antenna S_p open on the inside, that is, in the horn, the full field can also be represented next to its own functions of the speaker:

$$\begin{cases}\vec{E}=\sum_{\mu=1}^{\infty}AR_{+\mu}\left(\vec{E}_{+\mu}+\rho_{-\mu}\vec{E}_{-\mu}\right);\\ \vec{H}=\sum_{\mu=1}^{\infty}AR_{+\mu}\left(\vec{H}_{+\mu}+\rho_{-\mu}\vec{H}_{-\mu}\right),\end{cases} \quad (7)$$

where μ – the number of its own function; $AR_{\pm\mu}$ amplitude of eigenfunctions; $\vec{E}_{+\mu}$, $\vec{H}_{+\mu}$ – its own functions, extending from the opening to the mouth of the speaker; $\vec{E}_{-\mu}$, $\vec{H}_{-\mu}$ – their own functions, which extend in the opposite direction – from the neck to the opening; $\rho_{-\mu}$ – coefficient of reflection of its own function from internal inhomogeneities.

We write the Lorentz lemma for the fields $\vec{E}$, $\vec{H}$, i $\vec{E}_B$, $\vec{H}_B$, for a volume V that is bounded by two surfaces: on the one hand, infinitely distant from the antenna, and on the other, with a closed surface of the overlap S_p (fig. 2b)

$$\int_V\left\{\left(\vec{j},\vec{E}_B\right)-\left(\vec{m},\vec{H}_B\right)\right\}dV = \\ =\int_{S_p}\left\{\left(\left[\vec{E},\vec{H}_B\right]-\left[\vec{E}_B,\vec{H}\right]\right),d\vec{S}\right\}. \quad (8)$$

Substituting in (8) the functions for $\vec{E}_B$, $\vec{H}_B$ (6) i $\vec{E}$, $\vec{H}$ (7) and applying the condition of the orthogonality of eigenfunctions [11], we can obtain an expression for the amplitudes of waves in the opening of the speaker:

$$AR_{+\nu}=\frac{\int_V\left\{\left(\vec{j},\vec{E}_B\right)-\left(\vec{m},\vec{H}_B\right)\right\},dV}{N_\nu\left(1-\rho_{-\nu}\rho_{+\nu}\right)}, \quad (9)$$

where N_ν – the norm of its own functions, which is determined similarly (4).

The recording of the Lorentz lemma for the incident wavelength, and transmitted by the speaker $\vec{E}_B$, $\vec{H}_B$, for the same volume as in the previous case (fig. 2,c), yields the result [7]

$$\int_V\left\{\left(\vec{j},\vec{E}_B\right)-\left(\vec{m},\vec{H}_B\right)\right\}dV = \\ =\int_{S_p}\left(\left\{\left[\vec{E}_\Pi,\vec{H}_B\right]-\left[\vec{E}_B,\vec{H}_\Pi\right]\right\},d\vec{S}\right). \quad (10)$$

Substituting expression (9) into formula (8), we obtain

$$AR_{+\nu}=\frac{\int_{S_p}\left(\left\{\left[\vec{E}_\Pi,\vec{H}_B\right]-\left[\vec{E}_B,\vec{H}_\Pi\right]\right\},d\vec{S}\right)}{N_\nu\left(1-\rho_{-\nu}\rho_{+\nu}\right)}. \quad (11)$$

Which, taking into account formula (6), will take the form of:

$$AR_{+\nu}= \\ =\frac{\int_{S_p}\left(\left\{\left[\vec{E}_\Pi,\vec{H}_{-\nu}\right](1+\rho_{+\nu})-\left[\vec{E}_{-\nu},\vec{H}_\Pi\right](1+\rho_{+\nu})\right\},d\vec{S}\right)}{N_\nu\left(1-\rho_{-\nu}\rho_{+\nu}\right)}. \quad (12)$$

Expression (11) can be used to determine the amplitudes of waves excited in the opening of the horn antenna for the case if the wave of any form falls, not necessarily flat.

For the case of the normal polarization of the wave to the fall plane after substitution, the expressions (11) of the eigenfunctions of the fields E and H of the types for the incident field from formula (1) and the coefficients of reflection from the opening [5] $\rho_{\pm\nu}$

$$\rho_{+mn}^{H_\perp}=\frac{\sqrt{1-\left(\frac{m\lambda}{2b_p}\right)^2-\left(\frac{n\lambda}{2a_p}\right)^2}-1}{\left(1+\sqrt{1-\left(\frac{m\lambda}{2b_p}\right)^2-\left(\frac{n\lambda}{2a_p}\right)^2}\right)}, \quad (13)$$

where λ – the wavelength excited in the horn of the field; m,n – the number of standing half-waves, which are enclosed along the sides x and y of the cross-section; a_p, b_p – the lengths of the sides of the rectangular opening of the speaker.

We obtain an expression for the magnitudes of the magnetic-type waves excited in the opening of the horn when a flat electromagnetic wave falls on it, which is normally polarized to the plane of incidence

$$AR_{+mn}^{H_\perp}=2E_0\Psi\frac{n\pi}{N_{mn}^H Z_0 a_p}\times \\ \times\frac{\left(1+\cos\theta_\Pi\right)\sqrt{1-\left(\frac{m\lambda}{2b_p}\right)^2-\left(\frac{n\lambda}{2a_p}\right)^2}}{\left(1-\rho_{-mn}^H\rho_{+mn}^H\right)\left(1+\sqrt{1-\left(\frac{m\lambda}{2b_p}\right)^2-\left(\frac{n\lambda}{2a_p}\right)^2}\right)}, \quad (14)$$

where is the expression Ψ for having an expression

$$\int_{-\frac{a_p}{2}}^{\frac{a_p}{2}} \sin\left(\frac{n\pi}{a_p}\left(y+\frac{a_p}{2}\right)\right)\exp\left(-iky\sin\theta_\Pi\right)dy \int_{-\frac{b_p}{2}}^{\frac{b_p}{2}} \cos\left(\frac{m\pi}{b_p}\left(x+\frac{b_p}{2}\right)\right)dx,$$

which after integration will equal

$$\Psi = \frac{a_p\left(\sin\frac{(n\pi)}{2}\right)^2\cos\left(\frac{ka_p}{2}\sin\theta_\Pi\right)+j\left(\cos\left(\frac{(n\pi)}{2}\right)\right)^2\sin\left(\frac{ka_p}{2}\sin\theta_\Pi\right)}{1-\left(\frac{ka_p}{n\pi}\sin\theta_\Pi\right)^2}\frac{2b_p\sin m\pi}{(m\pi)}, \qquad (15)$$

N^H_{mn} – the norm of the waves of the magnetic type, which is determined similarly to the expression (4) [13].

For a case of falling wave (fig. 2, b) N^H_{mn} will be equal

$$N^H_{mn} = -\frac{a_p b}{2Z_0}\sqrt{1-\left(\frac{m\lambda}{2b_p}\right)^2-\left(\frac{n\lambda}{2a_p}\right)^2}\left(\frac{m\pi}{b_p}\right)^2\left(1-\frac{\sin 2m\pi}{2m\pi}\right)\left(1+\frac{\sin 2n\pi}{2n\pi}+\left(\frac{n\pi}{a_p}\right)^2\left(1+\frac{\sin 2m\pi}{2m\pi}\right)\left(1-\frac{\sin 2m\pi}{2m\pi}\right)\right). \qquad (16)$$

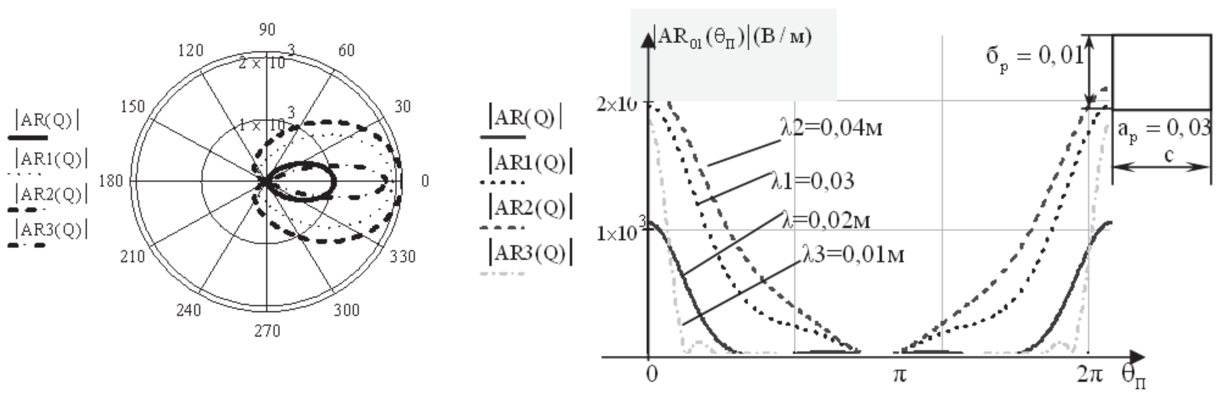
After substituting (14) expressions (15) and (16) and taking into account that in the given case of falling electromagnetic waves [13] $m=0$ we obtain the finite equation

$$AR^{H\perp}_{0n} = -\frac{4E_0 a_p\left(1+\cos(\theta_\Pi)\right)}{(n\pi)^2}\frac{\left(\sin\frac{(n\pi)}{2}\right)^2\cos\left(\frac{ka_p}{2}\sin\theta_\Pi\right)+j\left(\cos\left(\frac{(n\pi)}{2}\right)\right)^2\sin\left(\frac{ka_p}{2}\sin\theta_\Pi\right)}{\left(1+\sqrt{1-\left(\frac{n\lambda}{2a_p}\right)^2}\right)\left(1-\rho^2_{mn}\right)\left(1-\left(\frac{2a_p}{n\lambda}\sin\theta_\Pi\right)^2\right)}. \qquad (17)$$

Let's simulate the amplitudes of the field determined by the method using the Lorenz lemma, by the expression (17).

In fig. 5, a and 5, b the results are presented in a polar and rectangular coordinate system for a horn with a size of the horizontal edge of the openingsm.

In fig. 6, a and 6, b show similar results for the horn (fig. 2, b) with the parameters (fig. 5, c) corresponding to the opening of the irradiator of the antenna system of the station 1RL-133 «Credo» $a_p = 0{,}01$ м, $б_p = 0{,}03$ м.



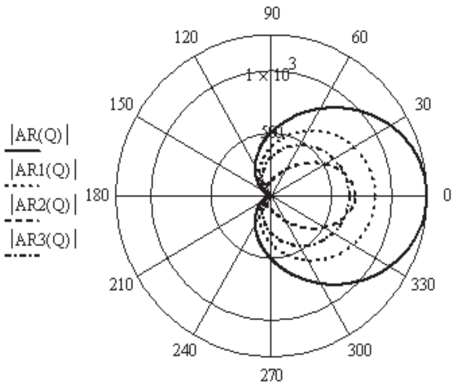
a b

Fig. 5. The diagrams of the amplitudes of the electromagnetic field that are excited to reveal the illuminator using the Lorentz lemma: a – in polar coordinate systems; b – in a rectangular coordinate system with: c – open parameters $a_p = 0{,}03$ м, $б_p = 0{,}01$ м

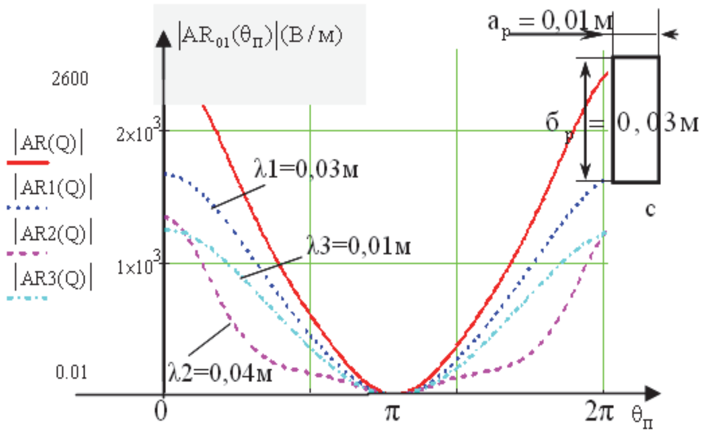
Diagrams constructed on the expression (17) obtained by the Lorenz method are proved that the antenna can function well in the wavelength range from one to four centimeters (fig. 5–6).

From fig. 5, a, b, it follows that the geometrical parameters of the waveguide ($a_p = 0{,}03$ м , $б_p = 0{,}01$ м). Will be the greatest amplitude for the case of falling on the waveguide $\lambda = 0{,}04$м , see the smallest $\lambda = 0{,}02$м , if see.

Fig. 6, a, b indicate that in the case of rotation of the 90 degree horn, it will correspond to the irradiator antenna system station 1RL133 «Credo». Now $a_p = 0{,}01$ м , $б_p = 0{,}03$ м Under these conditions, the amplitude will be greatest on the horn, which will be activated in the case of irradiation of its wave $\lambda = 0{,}02$м , that is, for the current two-centimeter wavelength range, on which the 1RL133 operates, the amplitude $AR_{0n}(\theta_П)$ will be the largest.



a



b

Fig. 6. Diagrams of the amplitudes of the electromagnetic field excited by the irradiator overlap using the Lorentz lemma: a – in the polar coordinate system; b – a rectangular coordinate system on a logarithmic scale with; c – parameters of opening $a_p = 0{,}01$ м , $б_p = 0{,}03$ м

Conclusions

The simulation results show that, in contrast to the diagrams obtained with expression using the Huygens-Kirchhoff method (fig. 3–4), further increase or decrease of the length of the incident wave will lead to a decrease in the amplitude. Thus, the expression obtained using the Lorenz lemma is more precise

Diagrams of field amplitudes in fig. 5–6 (unlike 3, 4) do not have back and side petals. This suggests that taking into account the reflection coefficient in expression (17) will allow for more qualitative simulation compared with the expression (4).

Expressions (4) and (17) have not only a calculation-practical but also a methodological value. Their use will contribute to further research of the scattered (redistributed field) not only from a single irradiator, but also from the system «mirror + irradiator», antenna arrays and other similar systems having pyramidal shaped horns as radiators.

Improvement of the methodology of investigations of amplitudes of an electromagnetic field consists in comparing two methods of finding the amplitude for a non-standard case of falling wave from an object of sounding. Such calculations will be further implemented for the design of the new antenna system of the «Credo-M1» station in order to improve its polarization characteristics.

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УДОСКОНАЛЕННЯ МЕТОДОЛОГІЇ ДОСЛІДЖЕННЯ АМПЛІТУД ЕЛЕКТРОМАГНІТНОГО ПОЛЯ, ЩО ЗБУДЖУЄТЬСЯ ОПРОМІНЮВАЧЕМ АНТЕННОЇ СИСТЕМИ РАДІОЛОКАЦІЙНОЇ СТАНЦІЇ НАЗЕМНОЇ РОЗВІДКИ «КРЕДО-М1»

О Л. Сидорчук, О.Ю. Тофанчук, О.В. Критенко, Ю.В. Каленчук

Досліджено амплітуди електромагнітного поля, що збуджуються рупорним опромінювачем антенної системи станції «Кредо-М1». Розглянуто нестандартний випадок падіння електромагнітної хвилі, а саме за умови, що хвиля, яка повертається від об'єкта зондування, є нормально поляризованою до площини свого падіння. Визначення амплітуд поля та їх моделювання здійснено двома методами – Гюйгенса-Кірхгофа та із застосуванням леми Лоренца. Моделювання полягало у порівнянні двох (E- і H- площинних) рупорів, один з яких має параметри опромінювача антенної системи станції «Кредо-М1».

Ключові слова: *прямокутний рупорний опромінювач, амплітуда електромагнітного поля, поляризаційні характеристики, антенна система.*

УСОВЕРШЕНСТВОВАНИЕ МЕТОДОЛОГИИ ИССЛЕДОВАНИЯ АМПЛИТУД ЭЛЕКТРОМАГНИТНОГО ПОЛЯ, ВОЗБУЖДЕННОГО ОБЛУЧАТЕЛЕМ АНТЕННОЙ СИСТЕМЫ РАДИОЛОКАЦИОННОЙ СТАНЦИИ НАЗЕМНОЙ РАЗВЕДКИ «КРЕДО-М1»

О Л. Сидорчук, А.Ю. Тофанчук, О.В. Критенко, Ю.В. Каленчук

Исследовано амплитуды электромагнитного поля, возбуждаемого рупорным облучателем антенной системы станции «Кредо-М1». Рассмотрен нестандартный случай падения электромагнитной волны, а именно, если волна, которая возвращается от объекта зондирования, поляризована перпендикулярно к площади своего падения. Исследование амплитуд поля и их моделирование проведено двумя методами – Гюйгенса-Кирхгофа и с использованием леммы Лоренца. Моделирование состояло в сравнении двух (Е-и Н-плоскостных) рупоров, один из которых имеет параметры облучателя антенной системы станции «Кредо-М1».

Ключевые слова: *прямоугольный рупорный облучатель, амплитуда электромагнитного поля, поляризационные характеристики, антенная система.*