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ELECTROMAGNETIC KEEPER OF ENERGY AND INFORMATION

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ABSTRACT

A well-known experiment demonstrates the preservation of the integrity of a certain structure in the absence of visible binding forces. Such an experiment was first described in 1842 but it still has not found a scientific explanation. However, an interest in it continues unabated that is reflected in Internet publications. Based on the solution of Maxwell's equations, this theoretical work shows that the experiment is explained by the conservation of electromagnetic energy inside the structure and the appearance of a standing electromagnetic wave. Based on this solution, it is shown that the structure can be made not only on the basis of ferromagnetics (known fact) but also in the form of a capacitor. It is also shown that the keeper may have a different shape. It is shown further that such designs can save not only energy but also information. This fact provides a basis for explaining such phenomena as the mirages of the past. These phenomena are astounding and await their rigorous scientific explanation. The article notes that mirages do not change their position on the ground. It is further shown that the stability of the position of the mirage can be explained by the fact that in the mirage area there are a standing electromagnetic wave, pulsating flow of electromagnetic energy, and pulsating electromagnetic mass. The center of mass does not change position. Therefore, the volume of the keeper can be considered as the volume of the pulsating mass with a constant center of gravity. This mass is held in place by gravity and does not interact with the material mass, i.e. cannot be shifted by air flow. This ensures a stable position of the keeper on the ground.

Keywords: electrodynamics; standing electromagnetic wave; Maxwell’s equations; electromagnetic keeper.

INTRODUCTION

A well-known experiment demonstrates the preservation of the integrity of a certain structure in the absence of visible binding forces. Such an experiment was first described in 1842 but still has not found a scientific explanation. However, an interest in the problem continues unabated, which is reflected in Internet publications. Based on the solution of Maxwell's equations, this article shows that the experiment is explained by the conservation of electromagnetic energy inside the structure and the appearance of a keeping electromagnetic wave.

Based on this solution, it is shown that the design can be made not only on the basis of ferromagnetics (known fact) but also in the form of a capacitor, and the keepers themselves can have various forms. Understanding of the "principle of action" of the keeper, the existence of both magnetic and electrical keepers, the diversity of its forms can be the basis of various technical inventions.

Further it is shown that such designs can save not only energy but also information. This fact provides a basis for explaining such phenomena as the mirages of the past (battles with the sounds of battle). These phenomena are astounding and await their rigorous scientific explanation. Observations show that mirages do not change their position on Earth. The stability of the position of the keeper is of particular interest. The article shows that the stability of the position of a mirage can be explained by the fact that there is a standing electromagnetic wave, a pulsating flow of electromagnetic energy and a pulsating electromagnetic mass in the mirage zone. The center of mass does not change position, which ensures a stable position of the guardian on the ground. Thus, mirages can be viewed as experimental evidence of the existence of an electromagnetic mass. The very fact of such evidence can be a stimulus for the development of new technical devices using electromagnetic mass.

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The description of the existing experiments

The following experiment is described in Internet (Leedskalnin's Perpetual Motion Holder, 2002, http://www.leedskalnin.com/LeedskalninsPerpetualMotionHolder.html; Beletsky, 2018, Magnetic Guardian surprises again, https://www.youtube.com/watch?time_continue=2617&v=J912WdC7Od4) and shown in figure 1. Take two bars of soft magnetic iron with a notch in the center of the bar along the entire length of the bar. These bars are folded so as to form a common channel. A wire is inserted into this channel, and a current pulse is passed through it. After this, the bars are held together by some kind of force. The force disappears when the wire passes a current pulse equal to the previous one in magnitude and duration but in opposite direction. A prerequisite for the occurrence of the effect is accurate processing of adjacent surfaces, preventing the appearance of an air gap between them.

Fig. 1. The simplest experiment.

Fig. 2. The experiments of Beletsky, https://www.youtube.com/watch?time_continue=2617&v=J912WdC7Od4.

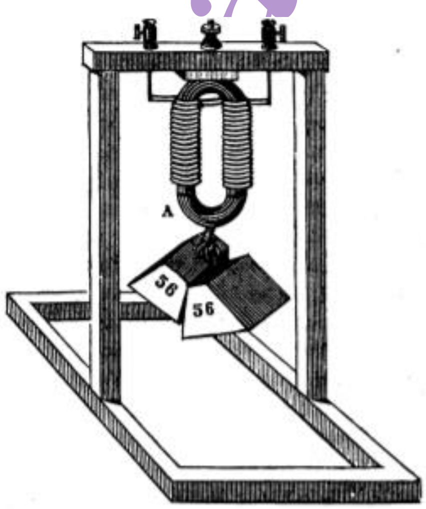

Fig. 3. The experiments by Davis (1842).

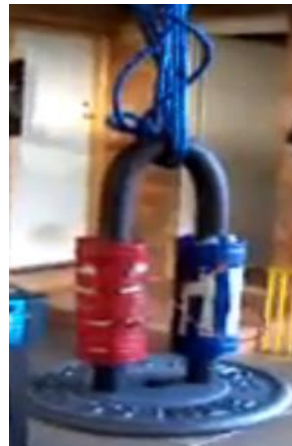

Fig. 4. The electromagnet.

Fig. 5. The electromagnet of Ed Leedskalnin (Leedskalnin, 2002).

Khmelnik (2013) has already addressed this problem. Here it is described a more rigorous justification of this phenomenon. Now an interest in this problem has returned, thanks to the experiments (figure 2) carried out by Beletsky in 2018: Magnetic Guardian surprises again, https://www.youtube.com/watch?time_continue=2617&v=J912WdC7Od4. However, this topic is not discussed in the scientific literature (and therefore this article has few references to published works). But in fact, this topic has a long history: in the book by Davis *et al*. (1842) a similar design was considered. Figure 3 (Davis *et al*., 1842) shows a detachable electromagnet. The loads are suspended to it after switching on the electrical current. However, after turning off the electrical current, the electromagnet does not disintegrate.

The effect cannot be explained by diffusion because the bars in figures 1 and 2 are applied to each other without pressure and “stick out” when the reverse impulse is turned on. Also, the effect cannot be explained by magnetic attraction because the material of the bars is magnetically soft and does not preserve magnetization.

There are other experiments that demonstrate the same effect. Figure 4 shows an electromagnet that retains the force of attraction after the current is turned off. It is assumed that Ed Leedskalnin used such electromagnets during the construction of the famous Coral Castle that is shown in figure 5 (Leedskalnin's Perpetual Motion Holder, 2002, http://www.leedskalnin.com/LeedskalninsPerpetualMotionHolder.html).

In all these structures, at the time of current shutdown, electromagnetic energy has some significance. This energy can be dissipated by radiation and heat loss. However, if these factors are not significant (at least in the initial period) the electromagnetic energy must be conserved. Next, we consider the conditions, under which the electromagnetic energy is stored for an arbitrarily long time, and the corresponding construction can be considered as an electromagnetic energy keeper.

Mathematical model

Consider a cube consisting of a soft magnetic material with a certain absolute magnetic permeability μ and absolute dielectric constant ε. Let an electromagnetic wave with energy W_o arise as a result of some impact in a cube. There are no heat losses in the cube, and the radiation of the cube (including thermal ones) is negligible. After some time, the wave parameters μ, ε, W_o will take stationary values determined by the size of the cube. These parameters are the electric field strength and the magnetic field intensity as functions of the Cartesian coordinates (x, y, z) and time (t), i.e. $E(x,y,z,t)$ and $H(x,y,z,t)$, respectively. Naturally, they satisfy the following set of the Maxwell homogenious equations:

$$\begin{cases} \frac{\partial H_z}{\partial y} - \frac{\partial H_y}{\partial z} - \varepsilon \frac{\partial E_x}{\partial t} = 0 \\ \frac{\partial H_x}{\partial z} - \frac{\partial H_z}{\partial x} - \varepsilon \frac{\partial E_y}{\partial t} = 0 \\ \frac{\partial H_y}{\partial x} - \frac{\partial H_x}{\partial y} - \varepsilon \frac{\partial E_z}{\partial t} = 0 \\ \frac{\partial E_z}{\partial y} - \frac{\partial E_y}{\partial z} + \mu \frac{\partial H_x}{\partial t} = 0 \\ \frac{\partial E_x}{\partial z} - \frac{\partial E_z}{\partial x} + \mu \frac{\partial H_y}{\partial t} = 0 \\ \frac{\partial E_y}{\partial x} - \frac{\partial E_x}{\partial y} + \mu \frac{\partial H_z}{\partial t} = 0 \\ \frac{\partial E_x}{\partial x} + \frac{\partial E_y}{\partial y} + \frac{\partial E_z}{\partial z} = 0 \\ \frac{\partial H_x}{\partial x} + \frac{\partial H_y}{\partial y} + \frac{\partial H_z}{\partial z} = 0 \end{cases} \tag{1}$$

where there are the partial first derivatives of components (E_x, E_y, E_z) and (H_x, H_y, H_z) with respect to time t and the real space components (x, y, z), respectively.

Consider the following functions proposed in (Khmelnik, 2008):

$$E_x(x,y,z,t) = e_x \cos(\alpha x)\sin(\beta y)\sin(\gamma z)\sin(\omega t) \tag{2}$$
$$E_y(x,y,z,t) = e_y \sin(\alpha x)\cos(\beta y)\sin(\gamma z)\sin(\omega t) \tag{3}$$
$$E_z(x,y,z,t) = e_z \sin(\alpha x)\sin(\beta y)\cos(\gamma z)\sin(\omega t) \tag{4}$$
$$H_x(x,y,z,t) = h_x \sin(\alpha x)\cos(\beta y)\cos(\gamma z)\cos(\omega t) \tag{5}$$
$$H_y(x,y,z,t) = h_y \cos(\alpha x)\sin(\beta y)\cos(\gamma z)\cos(\omega t) \tag{6}$$
$$H_z(x,y,z,t) = h_z \cos(\alpha x)\cos(\beta y)\sin(\gamma z)\cos(\omega t) \tag{7}$$

where $e_x, e_y, e_z, h_x, h_y, h_z$ are the constant amplitudes of functions; $\alpha, \beta, \lambda, \omega$ are the constants.

Differentiating equations from (2) to (7) and substituting the obtained result in equations' set (1), and after reducing by common factors, one can obtain the following form:

$$\begin{cases} h_z\beta - h_y\gamma + e_x\varepsilon\omega = 0 \\ h_x\gamma - h_z\alpha + e_y\varepsilon\omega = 0 \\ h_y\alpha - h_x\beta + e_z\varepsilon\omega = 0 \\ e_z\beta - e_y\gamma - h_x\mu\omega = 0 \\ e_x\gamma - e_z\alpha - h_y\mu\omega = 0 \\ e_y\alpha - e_x\beta - h_z\mu\omega = 0 \\ e_x\alpha + e_y\beta + e_z\gamma = 0 \\ h_x\alpha + h_y\beta + h_z\gamma = 0 \end{cases} \tag{8}$$

The considered system is symmetric and therefore, it is possible to apply the following equalities:

$$\alpha = \beta = \lambda \tag{9}$$

Then equations' set (8) takes the following form:

$$\begin{cases} h_z - h_y + \frac{e_x\varepsilon\omega}{\alpha} = 0 \\ h_x - h_z + \frac{e_y\varepsilon\omega}{\alpha} = 0 \\ h_y - h_x + \frac{e_z\varepsilon\omega}{\alpha} = 0 \\ e_z - e_y - \frac{h_x\mu\omega}{\alpha} = 0 \\ e_x - e_z - \frac{h_y\mu\omega}{\alpha} = 0 \\ e_y - e_x - \frac{h_z\mu\omega}{\alpha} = 0 \\ e_x + e_y + e_z = 0 \\ h_x + h_y + h_z = 0 \end{cases} \tag{10}$$

The seventh and eighth equations in equations' set (10) are satisfied only if $\omega > 0$, see in Appendix 1. In addition, the seventh and eighth equations in set (10) follow directly from the previous equations in the set. Indeed, adding the fourth and fifth to the sixth, we obtain the eighth, and adding the first and second equations to the third, we obtain the seventh. The first six equations in set (10) with six unknowns are independent and the amplitudes of functions $(e_x, e_y, e_z, h_x, h_y, h_z)$ can be found from them.

It is possible to obtain a solution for the set of the first six equations in (10) with the following condition:

$$h_z = 0 \qquad (11)$$

Then this set of six homogenious equations will have the following form:

$$\begin{cases} \frac{e_x \varepsilon\omega}{\alpha} - h_y = 0 \\ \frac{e_y \varepsilon\omega}{\alpha} + h_x = 0 \\ \frac{e_z \varepsilon\omega}{\alpha} - h_x + h_y = 0 \\ -e_y + e_z - \frac{h_x \mu\omega}{\alpha} = 0 \\ e_x - e_z - \frac{h_y \mu\omega}{\alpha} = 0 \\ -e_x + e_y = 0 \end{cases} \qquad (12)$$

The solution of equations' set (12) is:

$$h_y = -h_x \qquad (13)$$
$$e_x = -\frac{h_x \alpha}{\varepsilon\omega} \qquad (14)$$
$$e_y = e_x \qquad (15)$$
$$e_z = -2e_x \qquad (16)$$

It is possible to write intensities (2) in the following form:

$$E_x(x,y,z,t) = e_x \sin(\omega t) E_x^T(x,y,z) \qquad (17)$$

where the trigonometric function $E_x^T(x,y,z)$ is

$$E_x^T(x,y,z) = \cos(\alpha x)\sin(\beta y)\sin(\gamma z) \qquad (18)$$

Similarly, we can rewrite the functions from (3) to (7), taking into account formulas (11), (13) to (16)

$$E_y(x,y,z,t) = e_x \sin(\omega t) E_y^T(x,y,z) \qquad (19)$$
$$E_z(x,y,z,t) = -2e_x \sin(\omega t) E_z^T(x,y,z) \qquad (20)$$
$$H_x(x,y,z,t) = -\frac{\varepsilon\omega}{\alpha} e_x \cos(\omega t) H_x^T(x,y,z) \qquad (21)$$
$$H_y(x,y,z,t) = \frac{\varepsilon\omega}{\alpha} e_x \cos(\omega t) H_y^T(x,y,z) \qquad (22)$$
$$H_z(x,y,z,t) = 0 \qquad (23)$$

Let us now find the square of the module of total intensities. They read as follows:

$$E^2 = \left(E_x^2 + E_y^2 + E_z^2\right) = 6e_x^2 \sin^2(\omega t) E_T^2(x,y,z) \qquad (24)$$
$$H^2 = \left(H_x^2 + H_y^2\right) = 2\left(\frac{\varepsilon\omega}{\alpha}\right)^2 e_x^2 \cos^2(\omega t) H_T^2(x,y,z) \qquad (25)$$

where

$$E_T^2(x,y,z) = \left(E_x^T(x,y,z)\right)^2 + \left(E_y^T(x,y,z)\right)^2 + \left(E_z^T(x,y,z)\right)^2 \qquad (26)$$
$$H_T^2(x,y,z) = \left(H_x^T(x,y,z)\right)^2 + \left(H_y^T(x,y,z)\right)^2 \qquad (27)$$

Consider now the following relationship

$$q = \frac{E_T^2(x,y,z)}{H_T^2(x,y,z)} \qquad (28)$$

It can be shown that under condition (9) the ratio does not depend on the size of the cube and the value of α. This means that the amplitudes of the total strengths are referred to as

$$\frac{E^2}{H^2} = \frac{6e_x^2 q}{2\left(\frac{\varepsilon\omega}{\alpha}\right)^2} \qquad (29)$$

or

$$\frac{|E|}{|H|} = \frac{\sqrt{6q}}{\frac{\varepsilon\omega}{\alpha}\sqrt{2}} = \frac{\alpha\sqrt{3q}}{\varepsilon\omega} \qquad (30)$$

or

$$|H| = \frac{\varepsilon\omega}{\alpha\sqrt{3q}}|E| \qquad (31)$$

For a cube, one has to use the following value:

$$q = 3 \qquad (32)$$

As a result, one can obtain the following equality:

$$|H| = \frac{\varepsilon\omega}{3\alpha}|E| \qquad (33)$$

Energy
Energy density is equal to

$$W = \varepsilon E^2 + \mu H^2 \qquad (34)$$

or, taking into account the previous formulas, one can get

$$W = 6\varepsilon e_x^2 \sin^2(\omega t) E_T^2(x,y,z) + 2\mu\left(\frac{\varepsilon\omega}{\alpha}\right)^2 e_x^2 \cos^2(\omega t) H_T^2(x,y,z) \qquad (35)$$

Given (28), we write

$$W = E_T^2(x,y,z) e_x^2 \left(6\varepsilon\cdot\sin^2(\omega t) + \frac{2\mu}{q}\left(\frac{\varepsilon\omega}{\alpha}\right)^2 \cos^2(\omega t)\right) \qquad (36)$$

If the frequency satisfies the condition

$$6\varepsilon = \frac{2\mu}{q}\left(\frac{\varepsilon\omega}{\alpha}\right)^2 \quad (37)$$

or, subject to (29), the condition

$$\omega = \frac{3\alpha}{\sqrt{\mu\varepsilon}} \quad (38)$$

then the reader can get

$$W = 6\varepsilon E_T^2(x,y,z)e_x^2\left(\sin^2(\omega t) + \cos^2(\omega t)\right) \quad (39)$$

or

$$W = 6\varepsilon E_T^2(x,y,z)e_x^2 \quad (40)$$

Therefore, if the frequency satisfies condition (32), then the energy of the electromagnetic wave does not depend on time. The total energy in the cube volume is as follows:

$$\bar{\bar{W}} = \iiint_{x,y,z} W dxdydz =$$
$$6\varepsilon e_x^2 \iiint_{x,y,z} E_T^2(x,y,z)dxdydz \quad (41)$$

So, there is such a frequency of an electromagnetic wave, in which the energy of an electromagnetic wave in construction is kept constant.

With (33) and (38), it follows that in this case there is the following:

$$|H| = \frac{\varepsilon}{3\alpha}\frac{3\alpha}{\sqrt{\mu\varepsilon}}|E| = |E|\sqrt{\frac{\varepsilon}{\mu}} \quad (42)$$

With (18) and (23), it follows that

$$E = |E|\sin(\omega t) \quad (43)$$
$$H = |H|\cos(\omega t) \quad (44)$$

This means that under these conditions there is a standing electromagnetic wave in the cube. The standing wave does not radiate through the cube edges.

The other forms of the keeper

A keeper in the form of a cube under the condition (9) was considered above. For the existence of another form of a keeper, it is sufficient to make sure that for this form the value of relationship (28) does not depend on the body size and the value of α. The author has checked the fulfillment of this condition for a cylinder with a height equal to the diameter and for a sphere. The value of $q = 3$ was used for the cylinder, sphere, and cube. For bodies with a central point of symmetry (parallelepiped, cylinder of arbitrary height, cylinder with an elliptical base, ellipsoid) this condition is also satisfied. However, $q \neq 3$ for them.

The capacitor keeper

From the foregoing, it follows that the values of the parameters ε and μ do not affect the mere existence of the phenomenon under consideration. Therefore, there may exist a capacitor keeper in addition to the magnetic keeper. This can actualy exist.

The experiment is known, which is (in our opinion) the indisputable proof that the energy of a capacitor is stored in a dielectric (Revyakin, 2018). For experiments, the installation was made of two capacitors, between which the dielectric moves. As a result, in one capacitor the dielectric is charged with energy from a high-voltage source, and from the other capacitor this energy is extracted. The capacitor discharges through the discharger. The author of the experiment explains this phenomenon by charge transfer in a dielectric. This is not surprising: the question of where the charge is stored is still being debated. Similar, but much less spectacular experiments, have so far been explained by the fact that a film of moisture retains charge on the surface of the dielectric after the removal of the metal plate (Semikov, 2004). However, the following issues are not considered: how this film manages to arise and how water manages to charge. Thus, electromagnetic energy, which is stored in a charged capacitor as a stationary stream of electromagnetic energy, when removing the plates, is converted into standing wave energy (Khmelnik, 2016).

Let the capacitor dielectric consist of two loose parts. We charge it and remove the charged plates. Both parts of the dielectric will be held by some force. The author did not perform such an experiment that can be performed in the future.

About preserving force

The density of electromagnetic energy is equal, as is known, to the internal pressure in the body where this energy is located. The pressure force is directed towards the inside of the body (also, for instance, as in a charged capacitor). When a body is stretched, its energy increases, since its volume increases at a constant energy density. Therefore, to stretch the body you need to do the work. The tensile force is equal to the force of the internal pressure in the direction of the force. This means that the "destroyer" needs to overcome such a force. This is what is demonstrated in these experiments.

The vacuum keeper

We emphasize once again that the value of the parameters ε and μ does not affect the mere existence of the phenomenon under consideration. Therefore, in addition to the magnetic and capacitor keeper, there may be a vacuum keeper.

Concerning the vacuum keeper, it is difficult to imagine the keeper in a clearly limited volume, for instance, in the form of a vacuum cube with clear walls. The vacuum keeper may be, for example, in a volume that gradually decreases with distance from the center. Such a volume can be represented in the form of a rather flat ellipsoid. Another variant of the vacuum volume can be described by the following formula:

$$z = 2N - \frac{4}{N}\left(\left(x - \frac{N}{2}\right)^2 - \left(y - \frac{N}{2}\right)^2\right) \quad (45)$$

where N is a constant, N = 200 in figure 6. It is interesting to note that in this case q = 3.

The electromagnetic wave in the vacuum energy saver can be modulated. In this case, this energy keeper becomes the information keeper. When such a keeper is destroyed, electromagnetic energy is emitted in the form of a modulated wave.

There have been cases of radio programs of the 1930s (songs, speech), mirages of the past (battles with the sounds of battle). These phenomena are striking and inexplicable (http://paranormal-news.ru/news/prizrachnye_bitvy/2013-02-12-6246). It is important to note that they are tightly linked to the terrain. For example, in (http://othereal.ru/mirazhi-velikoj-bitvy/) we read: "Every year, only in the Sahara, there are 160,000 all kinds of mirages. Moreover, the emerging paintings are immediately applied to Bedouin cards ... This is a necessary measure, as there have been cases when whole caravans died because of mirages."

Considering the previous conclusions, these phenomena can be explained by the fact that the modulated electromagnetic wave is memorized in a certain amount. This volume can be destroyed and then this wave is emitted from it in the form of radio transmission or in the form of video transmission. It is possible that this volume may be partially destroyed and then such transfers will be repeated. It is also possible that this volume can expand with increasing energy (due to incoming energy from the outside) without changing the frequency of the wave. Then the recoverable information keeper is formed.

In this case, a question arises, to which my attention drew: how is the keeper volume held in place? If the keeper is implemented in an air dielectric, then the keeper should be moved by air flows. If it is realized in the vacuum volume, then the Earth must leave this volume in its motion.

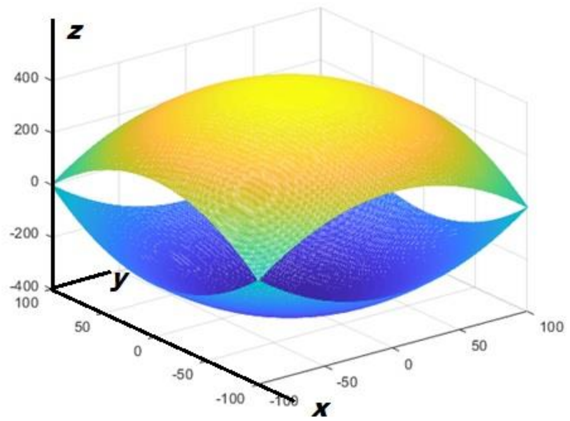

Fig. 6. The possible volume of the vacuum keeper, N = 200.

The answer appears to be as follows. As mentioned, the electromagnetic energy W is stored in the custodian's volume and there is a standing electromagnetic wave. Consequently, in this volume the flow of electromagnetic energy S pulses. Together with this flow there is an electromagnetic impulse p and an electromagnetic mass m. These values are related to each other and with the speed c of propagation of electromagnetic energy (Feynman *et al*., 1977; Beloded, 2011):

$$S = Wc \quad (46)$$

$$p = \frac{W}{c} \quad (47)$$

$$m = \frac{p}{c} \quad (48)$$

Therefore,

$$m = \frac{W^3}{S^2} \quad (49)$$

This electromagnetic mass pulsates along with the flow of electromagnetic energy. However, the center of mass does not change position. Consequently, the volume of the custodian can be considered as the volume of the pulsating mass with a constant center of gravity. This mass is held in place by gravity and does not interact with the material mass, i.e. cannot be shifted by air flow. This ensures a stable position of the keeper on the ground.

Another question arises, to which my attention also drew: why are there no mirages of events that took place on Earth hundreds or thousands of years ago? The answer, apparently, is that the keeper is partially destroyed by the radiation of electric energy in the form of a modulated wave, and the recovery of energy may be incomplete. These factors limit the life of the custodian.

CONCLUSION

It follows from the written above that an electromagnetic wave can exist in a cube such that the cube faces do not radiate and there are no heat losses: there are no electric currents even in an iron cube. Under these conditions, an electromagnetic wave can exist for an arbitrarily long time. This cube saves

- magnitude of electromagnetic energy,
- structural integrity.

Such a keeper may have a different, noncubic form and is made of various materials. It can be implemented as a body or as a certain amount of a vacuum.

Together with energy the keeper can store information.

The keeper can have not only man-made but also natural origin. A vivid example is the keepers of information about events on Earth, manifesting themselves as mirages of past battles. Such guardians prove, moreover, the existence of an electromagnetic mass.

Appendix 1.

Let use $\omega = 0$ in (9). Then from (9) one can get the following equalities:

$$e_z\beta - e_y\gamma = 0 \quad (A1)$$
$$e_x\gamma - e_z\alpha = 0 \quad (A2)$$
$$e_y\alpha - e_x\beta = 0 \quad (A3)$$
$$e_x\alpha + e_y\beta + e_z\gamma = 0 \quad (A4)$$

From (A4) we find:

$$e_y = e_x \frac{\beta}{\alpha} \quad (A5)$$

From (A2) we find:

$$e_z = e_x \frac{\gamma}{\alpha} \quad (A6)$$

From (A1), (A5), (A6) we find:

$$e_x \frac{\gamma}{\alpha}\beta - e_x \frac{\beta}{\alpha}\gamma \equiv 0 \quad (A7)$$

From (A4), (A5), and (A6) we find:

$$e_x\alpha + e_x \frac{\beta}{\alpha}\beta + e_x \frac{\gamma}{\alpha}\gamma = 0 \quad (A8)$$

or

$$\alpha^2 + \beta^2 + \gamma^2 = 0 \quad (A9)$$

This means that $\alpha = \beta = \gamma = 0$, i.e. the electromagnetic field at $\omega = 0$ is absent.

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