On the Nature of Sources of Audio-Frequency Electromagnetic Interferences

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Abstract—It has been shown that metal elements of electronic equipment executing mechanical vibrations under exposure to the dc or low-frequency magnetic field could be sources of low-frequency electromagnetic interferences. The general solution of a boundary problem of electrodynamics was obtained that dealt with the electromagnetic field emission by a rod with circular cross-section made of metal of the non-ferromagnetic group under harmonic elastic oscillations in the dc magnetic field. A model example was considered for the situation where a source of low-frequency electromagnetic field was the rod with circular cross-section that executed longitudinal harmonic oscillations of compression–tension at the transverse dc magnetic field. An estimation of numerical values of the intensity of low-frequency magnetic field and the induced voltage of interference were also provided.

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INTRODUCTION

The urgency of ensuring the electromagnetic compatibility (EMC) is constantly growing under the current conditions of increasing sensitivity, improvement of other qualitative indicators and the extension of functionality of different kinds of electronic equipment.

This thesis is also valid for the modern multiple-hall digital cinema-and-concert complex equipped with diverse energy-intensive functional hardware facilities of high sensitivity operating in frequency ranges from audio to gigahertz frequencies [1–4].

The issues of the electromagnetic environment (EME) formed by conventional devices representing unintentional sources of electromagnetic interferences (EMI) (such as sound technology equipment, power supply sources, information and control instruments and others) were discussed in a number of papers prepared by national and foreign specialists [5–8].

However, insufficient attention has been paid to the sources (specific for cinema and concert complexes) of low-frequency EMI of sound and ultrasound ranges determined by electromechanical factors. Moreover, the low-frequency electromagnetic interferences of different levels exist also in hardware bays of aeronautical and space technology, equipment rooms of cinema and concert halls and music recording studios at computer centers and other premises. These electromagnetic interferences of kilohertz frequency band inadvertently form sources within the mechanical equipment of cinema and concert complex. The metal elements of electronic hardware vibrating (performing mechanical oscillations) during their operation could be sources of low-frequency electromagnetic interferences. One of the first papers analyzing the electroacoustic causes of EMI formation [9] was presented at the 19th International EMC symposium (Wroclaw, Poland).

Let us consider a metal non-ferromagnetic component of electronic equipment that vibrates in dc or low-frequency variable magnetic field.

Mechanical vibrations are accompanied by displacements of material particles of this component in relation to the equilibrium position. Let us designate these displacements by vector $\vec{u}(x_k, t)$, $x_k (k = 1, 2, 3)$ are the coordinates of point, at which the displacement is determined, $t$ is time. Displacements $\vec{u}(x_k, t)$ of material particles of the deformable metal are accompanied by the same (in terms of value) displacements of free carriers of electricity (conduction electrons).

In the presence of magnetic field from external sources with intensity $\vec{H}^0(x_k, t)$ generated in the non-ferromagnetic metal element, the moving conduction electrons are exposed to the Lorentz force. This

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