ЕКСПЕРИМЕНТАЛЬНІ ДОСЛІДЖЕННЯ ІМПУЛЬСНИХ ПРОЦЕСІВ В РІЗНИХ ГАЛУЗЯХ ПРАКТИЧНОГО ЗАСТОСУВАННЯ

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DOUBLE INDUCTOR SYSTEM AS TOOL TO FLAT STAMPING OF THIN-WALLED METALS

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Abstract. *The effective application of magnetic-pulse technologies in motor industry is proved. The analysis of a double inductor system as a tool of the flat stamping of thin-walled metals is made, its efficiency and effectiveness are proved.*

Key words: *magnetic-pulse metal treatment, magnetic field, inductor system, workpiece, intensity, flat stamping.*

СПАРЕНА ІНДУКТОРНА СИСТЕМА – ІНСТРУМЕНТ ДЛЯ ПЛОСКОГО ШТАМПУВАННЯ ТОНКОСТІННИХ МЕТАЛІВ

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Анотація. *Обгрунтована актуальність застосування магнітно-імпульсних технологій в автомобілебудуванні. Проведений аналіз спареної індукторної системи – інструмента плоскої штамповки тонкостінних металів, обгрунтована її ефективність та дієвість.*

Ключові слова: *магнітно-імпульсна обробка металів, магнітне поле, індукторна система, заготовка, напруженість, плоске штампування.*

СПАРЕННАЯ ИНДУКТОРНАЯ СИСТЕМА – ИНСТРУМЕНТ ДЛЯ ПЛОСКОЙ ШТАМПОВКИ ТОНКОСТЕННЫХ МЕТАЛЛОВ

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Аннотация. *Обоснована актуальность применения магнитно-импульсных технологий в автомобилестроении. Проведенный анализ спаренной индукторной системы - инструмента плоской штамповки тонкостенных металлов, обоснована ее эффективность и действенность.*

Ключевые слова: *магнитно-импульсная обработка металлов, магнитное поле, индукторная система, заготовка, напряженность, плоское штамповки.*

Introduction

The practical use of the energy of impulsive electromagnetic fields opens exceptional prospects for creation of progressive technologies to treat materials of any physical nature in any kind of industry.

The absence of direct contact with the material under treatment is a distinctive feature of field methods. Therefore, a given production operation is noncontact that substantially simplifies a technological process, promotes its efficiency and considerably lowers the time of metal treatment. It is true in terms of the flat stamping of thin-walled metals. It is used as a technological operation at production and repair of vehicles [1].

The purpose of paper is to analyze a double inductor system as a tool for the flat stamping of thin-walled metals, the research object is a double inductor system. The article deals with electrodynamics processes in a double inductor system.

The limitation of magnetic-pulse influence on thin-walled conductors is conditioned by substantial diffusion of fields through workpiece [3]. It lowers pressure forces which are proportional to the difference of squared intensity on its boundary surfaces.

Negative consequences of diffusion are removed and the increase of magnetic pressure forces on thin-walled metals is achieved due to some solutions to create certain inductor systems (IS) which are the tools of the magnetic-pulse method. Yu.V. Batygin, V.I. Lavinsky, L.T. Khimenko proposed the device with the effect of the penetration of a plain parallel field through a thin conductor sheet into a free semispace [1, 2]. Practically such a system consists of a thin inductor and a dielectric matrix which has a workpiece on its surface.

A structure with a double current wires is a simple variant of IS. The maximum possible degree of adequacy is an advantage of the given suggestion in the design of effect of penetration of package of flat hertzian waves through the thin conducting a screen in free semispace. Low efficiency of transformation of magnetic energy in mechanical one and the increase of the given parameter is impossible in ferms of structure design.

Nevertheless, the IS having double current wires is a variant of the tool which is quite acceptable for experimental research of magnetic-pulse influence on thin-walled conductors. A structure with a flat single-turn inductor over a thin metallic sheet is schematically shown on fig. 1 a.

The solution of the problem to design the IS, which has a rather homogeneous field in its working area, can be found if we analyze the dependency between the single-turn solenoid (a flat ring) and an ideal conductor surface in terms of the intensity in the space. Formula (1) of the intensity of the magnetic field in space between an inductor and a workpiece is suitable for the certain conclusions.

$$H = \frac{\Phi}{\mu_0 2\pi \cdot h \cdot r} \quad (1)$$

where Φ – magnetic flow in the system;
μ_0 – the vacuum magnetic permeability;
h – the least distance from an inductor to the surfase of workpiece;
r – radius of field in which this flow is considered.

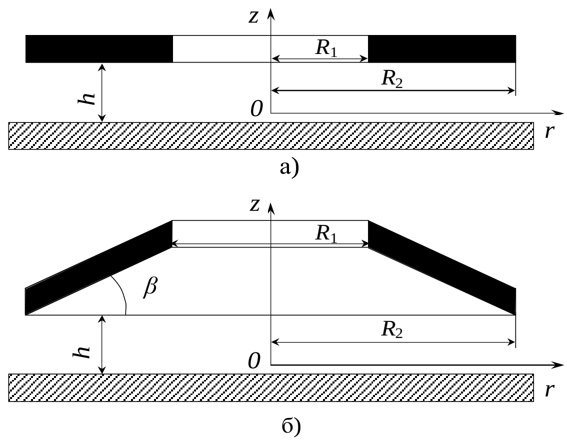

Fig. 1. The single-turn inductor above a thin metallic sheet: а) – flat coil of inductor; б) – conical coil of inductor

In the case of a thin-walled workpiece which is deformed on a dielectric matrix, a tangent component of the intensity of a magnetic field through does not almost penetrate a workpiece. Obviously the processes of the formation of magnetic fields in the systems with an ideally conducting sheet and a flat workpiece of metal, wich separates the source of field (inductor) from free half-space (dielectric matrix), take place practically identically.

The transversal distribution of the field in a working area is irregular, because intensity and a radial coordinate are inversely proportional. However, the distance between the surfaces of both inductor and workpiece is not constant so that the product h·r ≈ const, than the transversal distribution of intensity becomes uniform, and the field is homogeneous.
It practically means, that the internal surface of a ring inductor must have the form of toroid (fig. 1 b), the cross-section of it from the side of workpiece will be limited by a line $h(r) = \text{const} / r$.

The more concrete dependence between variable height and a radial coordinate can be received on the condition: $h \cdot R_2 = \text{const}$, where h – the least distance from an inductor to the surface of workpiece at $r = R_2$. Taking into account the fixed const, we have $h(r) = h(R_2 / r)$.

An inductor with the profile (in a working area) which is limited by a hyperbolical curve must excite the magnetic field with the uniform distribution of intensity along the surfaces of the workpiece under treatment.

Conclusions

In addition, the structure of the IS gives a possibility to make the size of a working area almost as large as the size of the all inductor surface that provides a pretty high degree of the transformation of the magnetic field energy into mechanical one. This feature makes the structure quite promising to create effective tools for a magnetic-pulse method which can work on industrial programs.

The application of magnetic-pulse technologies in motor industry makes it possible to effectively make flat stamping of thin-walled metals.

References

1. Batygin Yu.V. Direction Change of the Force Action upon Conductor under Frequency Variation of the Acting magnetic Field / Yu.V. Batygin, V.I. Lavinsky, L.T. Khimenko // Proceedings of the 1-st International Conference on High Speed Metal Forming. – Germany, 2004. – P.132–150.
2. Батыгин Ю.В. Магнитно-импульсная обработка тонкостенных металлов / Ю.В. Батыгин, В.И. Лавинский. – Харьков : МОСТ – Торнадо, 2002. –288 с.
3. Шнеерсон Г.А. Поля и переходные процессы в аппаратуре сверхсильных токов. СССР, Ленинград: Энергоиздат, 1981.– 199 с.