

УДК 621.318

PHYSICAL PROCESSES IN MAGNETIC-PULSE INFLUENCE ON THIN-WALLED METALS

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Abstract. The inductor system to apply the purposeful magnetic pulse force to the inner cavity of the flat angle in the crook of a metal sheet with a quite high specific electrical conductivity is considered in the paper.

Key words: inductor system, electrical conductivity, electrical magnetic treatment of metal.

ФІЗИЧНІ ПРОЦЕСИ ПРИ МАГНІТНО-ІМПУЛЬСНОМУ ВПЛИВІ НА ТОНКОСТІННІ МЕТАЛИ

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Анотація. Розглянуто магнітно-імпульсний силовий вплив індукторної системи на внутрішню порожнину плоского кута у вигині металевого листа з досить високою питомою електропровідністю.

Ключові слова: індукторна система, питома електропровідність, магнітно-імпульсна обробка металів.

ФИЗИЧЕСКИЕ ПРОЦЕССЫ ПРИ МАГНИТНО-ИМПУЛЬСНОМ ВОЗДЕЙСТВИИ НА ТОНКОСТЕННЫЕ МЕТАЛЛЫ

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Аннотация. Рассмотрено магнитно-импульсное силовое воздействие индукторной системы на внутреннюю полость плоского угла в изгибе металлического листа с достаточно высокой удельной электропроводностью.

Ключевые слова: индукторная система, удельная электропроводность, магнитно-импульсная обработка металлов.

Introduction

The practical usage of pulse electromagnetic fields energy opens exclusive perspectives for the development of new progressive technologies to treat the raw materials of any physical nature.

The basic feature of the field methods is the absence of direct contact with treated materials.

There is no need in any kind of contact. The energy transformation takes place in the work-piece.

One of the main problems in designing the tools of the magnetic pulse methods is the problem of the purposeful force acting on the work-piece that must be worked out in accordance with the production order. The electrical magnetic process analysis in the system “inductor – work-

piece” is necessary with the recommendations to design and arrange them [1, 2].

Analysis of publications

As it was shown in the science works by pressure working [1-4], high-speed pulse acting leads to appearance of some new property in behavior of the metal being worked. This new property was named as hyper-plasticity. Its practical usage allows deforming articles, which could not be produced by the methods known without destroying [4]. It should be noted that the problem of the creation of the magnetic field above the plane like that was solved by G.A. Shneerson in his monograph [2].

The aim and task

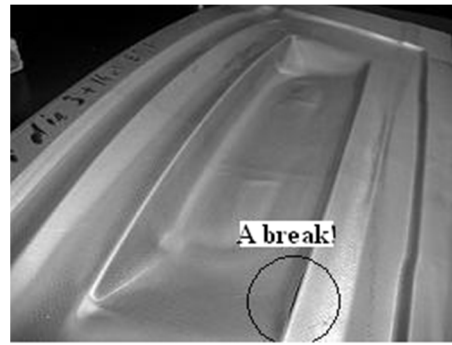
The aim of this work is the analysis of an inductor system for the marked aid-directed force acting on the inner cavity of the flat angle in the crook of a metal sheet with quite high specific electrical conductivity.

Magnetic-pulse influence

Realizing some technological operations in the sheet metals flat stamping demands concentrating the forces of pressure for “angles filling in” accordingly to ordered shape of a ready article, fig. 1 [5]. The term “angles filling in” is the special term from the forging stamping production. Practically it means preceding enough strict angles with the rounding off level that is ordered by the production operation conditions.

The magnetic pulse metalworking realizes practically the power force-acting regime in the time interval of the microseconds duration.

The main particularity of the methods working out like that is the indissoluble connection of the inductor-tool and the work-piece what is the subject for deforming. If during the mechanical stamping the puansone efficiency is not immediately connected with the inner processes in the metal being worked out, the magnetic pulse force acting is physically possible only when the electrical dynamic connection between the inductor-tool coil current and the current induced in the work-piece exists. Their interacting leads to the power ponder-motor forces appearance the value of which is proportional to multiplying these currents amplitudes [4; 5].



a)



b)

Fig. 3 The panel of an autocar body for model «Ford», the sharp angles of which is stamped by the electrohydraulic action: a) and magnetic pulse one; b) side

The inductor this is enough long single turn solenoid of a rectangular shape. One of its side it faces the “being filled in” angle.

In general, the calculations carried out show:

- the current of the parallel quite thin current-conductor of the rectangular turn what was placed in the inner cavity of the plane angle of the metal sheet bent with the high specific electrical conductivity is exciting on the coplanar plane the intensive magnetic fields with the same time shape and the pressure power forces. The intensity is achieving $\sim 10^7$ A/m for the current character value ~ 100 kA in the magnetic pulse metal working. The pressure maximums (till ~ 100 MPa) of the space distribution will be situated in points with coordinates according to arrangements of the current-conductors;
- the marked exceeding the value of the field and pressure being excited in the “farther” current-conductor zone above the according value in the “nearer” current-conductor zone may have a place on practice really. Should take in account, the really strict coplanar is impossible. Some distortion in the relative arrangement of the turn and planes will have a place always. In this case exceeding pointed out above may be explained by dissipating the current energy of the “nearer”

current-conductor for the field exciting as in the quasi-coplanar plane metal as in the orthogonal surface of the angle of the work-piece bent;

- increasing the slope angle of the turn plane to the according surface till $\sim 15^{\circ}$ leads to essential decreasing the excited field intensity amplitude (\sim one degree order) and the magnetic pressure value (\sim two degree orders) of the “farther” current-conductor side. Physically, the given fact can be explained by the electrical magnetic connection increasing between the current and the conductor because of the distance increasing between them;

- variation of the inter arrangement of the turn and one of the plane angle surfaces of the sheet work-piece bent allows realizing the essential concentration of the field and pressure in immediate nearness of the bend.

In the conducted consideration the current-conductors were being suggested by quite thin. But it is clear from some phenomenological statements the field sources cross dimensions must influent on the excitation processes of the inductor system. Obviously, the fields and pressure amplitudes must be changed; the distribution shapes must be changed etc. This everything demands some additional evaluating.

Conclusions

Thus, the optimum variant of the inductor system with two separate turns of the rectangular geometry, which are connected to the power source – the magnetic pulse apparatus, causes the aim-directed force directed to the centre of

the angle bend of the metal sheet with the amplitude of tens MPa.

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