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(54) **ELECTROMAGNETIC DEVICE AND METHOD FOR THE GEOMETRIC RECTIFICATION OF STAMPED METAL PARTS**

(57) The invention relates to an electromagnetic device and a method for the geometric rectification of stamped metal parts comprising at least one block (2) having a surface with a final geometry (10) which is intended to be obtained in one side of an area to be rectified of a part (1), which is positioned between said block (2) and a complementary electromagnetic coil (5) comprising

at least one winding (6) configured to generate a magnetic field configured to act on the part (1) and produce its impact against said block (2), there being a space between each electromagnetic coil (5) and each block (2) not greater than ten times a thickness of the part (1), with the aim of being able to move the part by the action of the magnetic field.

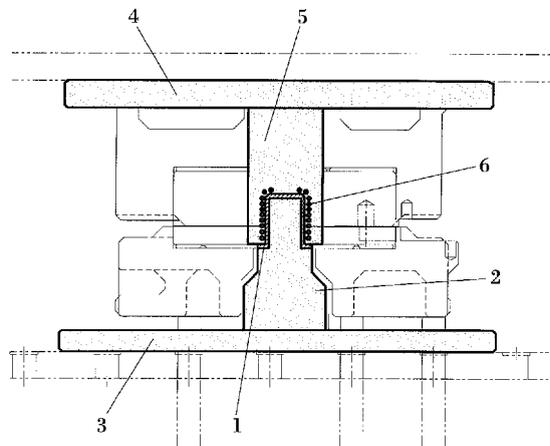


FIG. 6
B-B

EP 2 065 105 A1

Description

OBJECT OF THE INVENTION

[0001] The present invention relates to an electromagnetic device and a method for the geometric rectification of stamped metal parts having application in the iron and steel industry, allowing to rectify the deformation produced by elastic recovery as a result of the residual stress generated in this type of parts in the form of sheets after carrying out a mechanical forming process, for example after a flanging process.

BACKGROUND OF THE INVENCIÓN

[0002] The conventional stamping process of metal sheets requires the use of a press and at least two dies, a drawing die and a calibrating die, each of which is in turn formed by a complete hold-down plate, female element and male element having all the geometry, shape and dimensions desired in the sheet to be formed.

[0003] The drawback with mechanical stamping processes occurs after removing the parts from the press, due to the fact that they undergo an elastic recovery producing deformations, wall curls, and torsions as a result of the residual stress generated in the parts after the drawing process, with which the geometry of the part is different from the one that is desired.

[0004] The drawback mentioned in the previous paragraph is usually known as "springback" and it results in the obtained parts being out of the established tolerances, which are very strict especially in certain applications such as in the automotion field or on the aeronautical field, therefore, there is a need to rectify the geometry of the parts obtained after the drawing process.

[0005] With the aim of solving this drawback, after carrying out the mechanical drawing process it is necessary to carry out a reforming of the complete part in a calibrating die, in which the rectification of those areas of the part that are out of the admissible tolerances after the mechanical drawing process is achieved, which significantly increases the production costs of the parts.

[0006] On the other hand, with the aim of solving this same drawback, starting from 1960, alternative forming processes appeared comprising electromagnetic circuits and means capable of generating enough currents to produce a deformation in the material, in substitution of the traditional presses usually used to date, as set forth previously.

[0007] These electromagnetic forming processes are based on generating a magnetic field by means of electromagnetic coils inducing Foucault currents in the part or sheets to be formed, said Foucault currents having the opposite direction to the currents circulating in each electromagnetic coil, therefore, the coil and the metal part repel each other such that the part is driven against the wall of the dies, adopting the desired shape, i.e. the shape of the dies, which coincides with the final geometry of the

complete part which is intended to be obtained.

[0008] The aforementioned electromagnetic forming devices currently comprise a conductor, also denominated actuator, which is usually a copper solenoid coil connected in series with a capacitor, or usually a capacitor bank, and with a high voltage circuit and trigger start means.

[0009] The operation of these devices is explained below. When the capacitors are charged and switched on, i.e. the circuit switch connecting it to the electromagnetic coil is closed, a transient current is created in said electromagnetic coil, which generates a transient magnetic field inducing Foucault currents in the conducting material which is the metal part that is intended to be deformed.

[0010] A representation of the discharge current usually used has a damped sinusoidal shape, with frequencies that are usually in a range between 10 kHz and 100 kHz. The current generated in the electromagnetic coil and the currents generated in the part have opposite directions, therefore, the coil and the part repel each other such that the part acquires a high repulsion velocity and is driven against a male or female part adopting its shape. The electromagnetic pressure is converted into kinetic energy, the part being able to acquire velocities of an order of magnitude between 200 m/s and 300 m/s.

[0011] These electromagnetic forming processes have been the object of various studies by several authors which are gathered in different documents, such as for example in the following articles:

- Golovashchenko, Sergey F. 'springback calibration using pulsed electromagnetic field'; © 2005 American Institute of Physics.
- Moon, F. C. 'Magneto solid mechanics'; ASTM; High Velocity Forming of Metals; 1968.
- Plum, M.M. 'Electromagnetic forming. Metals handbook'; Maxwell Laboratories Inc. Pages 644-653.
- Belyy, I. V., Fertik, S. M. and Khimenko, L. T. 'Electromagnetic metal forming handbook Kharkov'; USSR; 1977.

[0012] There are also patent documents describing these electromagnetic forming processes since the start of their development, such as for example US Patent No. 2,976,907 for "*Device and method of metal forming*" corresponding to 1961, up to more recent documents which gather the latest means and applications, such as for example in US Patent No. 6,050,121 for "*Hybrid methods of metal forming using electromagnetic forming*" to the University of Ohio, in US Patent No. 5,730,016 for "*Method and apparatus for electromagnetic forming of thin walled metal*" to the company Elmag, Inc., in US patent application No. 2005/0097934 for "*Conjoining apparatus using electromagnetic forming*", US patent application No. 2005/0229376 for "*Electromagnetic trimming, flanging and hemming apparatus and method*" to the company General Motors, US patent application No. 2003/0182005 for "*Method for determining a die profile*"

for forming a metal part having a desired shape and associated methods" to Chu, E., Makosey, S. J. and Shoup, J. M. or in US patent No. 5,860,306 for "Electromagnetic actuator method of use and article made therefrom" to Daehn, to name some examples.

[0013] Additionally, Japanese patents No. JP 2004-122177 and JP 2001-252788 describe processes with presses for forming by stamping, incorporating a magnetic forming device which allows avoiding the springback effect. Japanese patent No. JP 2004-122177 describes a line of presses or equipment comprising a plurality of presses, commonly called "transfer", containing at least an electromagnetic forming device in the press itself with the aim of obtaining an aluminium part without elastic recovery with a certain final geometry.

[0014] The main drawback of this type of equipment is that they are highly complex and expensive due to the need to incorporate electromagnetic forming means in the stamping equipment itself, i.e., in the presses themselves.

[0015] The electromagnetic forming process is carried out simultaneously with the stamping process, and this requires the use of expensive equipment or the adaptation of existing stamping equipment, combining the electromagnetic means with the stamping process itself, which significantly increases the production costs of the parts.

[0016] Furthermore, although the sheets formed by means of the aforementioned electromagnetic processes do not have the unwanted elastic recovery or springback effect, these processes have another series of drawbacks, amongst other causes as a result of the high temperature that the generated magnetic field produces in the electromagnetic coil, needing to incorporate cooling means with the aim that the temperature of the electromagnetic coil during the process is not too excessive and thus extending its working life, which is not necessary in mechanical stamping processes.

DESCRIPTION OF THE INVENTION

[0017] The electromagnetic device and the method for the geometric rectification of stamped metal parts proposed by the invention allows correcting the deformation produced by the springback effect after a conventional forming process in an equipment independent of the mechanical stamping equipment by means of applying electromagnetic charges only in those areas or parts of the part which require to be rectified to obtain a part with a desired final geometry and in accordance with established dimensional tolerances.

[0018] A first aspect of the invention relates to an electromagnetic device for the geometric rectification of stamped metal parts which allows rectifying the deformation produced by the elastic recovery as a result of the residual stress generated in the parts after carrying out a mechanical stamping process.

[0019] The electromagnetic device proposed by the in-

vention comprises at least one block configured to receive the impact and contact a side of a certain area to be rectified of a part, i.e., a sheet which has been previously mechanically stamped in a press.

[0020] The geometry of a surface of said at least one block configured to contact the part to be rectified corresponds exactly to a final geometry, i.e., shape and dimensions, which is desired in said side of the area to be rectified of the part.

[0021] Although, in the field of stamping, an element penetrating in a plane defined by the sheet is usually called male element, and a complementary element configured to house the deformed sheet by the action of said male element is usually called female element, in the description of the present invention, a block is considered to be any element such as a male element, a female element or an insert having the suitable geometry and being configured to receive the impact and contact the part to be rectified.

[0022] In a complementary manner to each at least one block, the device comprises an electromagnetic coil which is configured to be located on a side opposite to said at least one block of a certain area to be rectified of the part.

[0023] In the event that a block is located on a first side of the part, then the complementary electromagnetic coil is located on a second side opposite to the first side, and vice versa, i.e., in the event that the block is located on the second side of the part, then the electromagnetic coil is located on the first side.

[0024] Each at least one electromagnetic coil comprises at least one winding of a copper wire embedded in a part, preferably a synthetic body of glass fiber for example. Said electromagnetic coil has an outer surface opposite to a side of the part to be rectified having a geometry approximate to the desired final geometry in the part, i.e., it has a geometry complementary to that of the at least one corresponding block, there being a space or clearance between each at least one electromagnetic coil and each at least one block that is less than ten times the thickness of the part, with the aim that the action of the magnetic field drives the part for its impact against the block.

[0025] As mentioned previously, each at least one, electromagnetic coil comprises at least one winding connected to a power supply source configured to generate a magnetic field.

[0026] Each at least one electromagnetic coil is operatively located such that the magnetic field it generates acts in a certain area to be rectified of the part, acting thereupon and producing an impact of the part against the corresponding block.

[0027] Each at least one electromagnetic coil is configured to act both on the planar areas of the part and in the curved areas or folding lines, i.e., in the areas in which the sheet has a change in direction between planes.

[0028] In a stamped part, the joints between two sides thereof that are contained in different planes have a cer-

tain radius, it being preferably in these areas, at which the part is folded, in which the unwanted springback effect occurs, an unwanted deformation being observed. With the aim of removing this deformation each at least one winding and electromagnetic coil have a geometry approximate to the final geometry to be obtained, including a curved geometry.

[0029] With the aim of being able to generate the electromagnetic field each at least one winding is connected to a discharge circuit comprising a capacitor, preferably a capacitor bank, and to a high voltage circuit comprising a power supply source and trigger start means, i.e., electrical switches, such that when the capacitors are charged and are activated by means of the trigger start means, a transient current is created in each at least one winding generating the transient magnetic field.

[0030] Said magnetic field induces Foucault currents in the part to be rectified due to the fact that the part is a sheet of electrical conducting material, the current generated in each at least one winding and the Foucault currents generated in the part having opposite directions, therefore, the part is driven in the direction opposite to that of each at least one electromagnetic coil, being pushed against said at least one block such that the side of the areas to be rectified of the part in contact with said at least one block is formed acquiring the geometry of said at least one block.

[0031] The possibility is considered that said at least one block and electromagnetic coil are linked both at a first base and a second base, with the aim of serving as a support. Likewise, the possibility is also considered that said first base and said second base comprise moveable closure means, the bases being able to be arranged in both a horizontal and a vertical position.

[0032] Finally, the possibility is contemplated that the device comprises at least one driver located between said at least one electromagnetic coil and the part to be rectified, with the aim of reducing the energy demands of the device to obtain a certain geometry in a part to be rectified.

[0033] Said driver consists of a sheet of material with a high copper content, so that, due to its high electrical conductivity, it makes it possible for the driver to generate induced currents of a greater intensity than those generated in the part, which is a sheet of material with a lower electrical conductivity. For this reason, the repulsion force between the driver and the electromagnetic coil is greater with respect to the case of not having said driver, allowing to obtain the same results with a lower energy demand.

[0034] On the other hand, a second aspect of the invention relates to a method for the geometric rectification of stamped metal parts with an electromagnetic device like the one described previously.

[0035] The method of the invention is carried out starting from a metal part to be rectified, i.e., a sheet which has already been mechanically stamped in a traditional press, with the aim of rectifying the geometry of the part

on those areas in which the part is out of the established tolerances. Unlike the methods of the state of the art, it is not intended to avoid the negative spring back effect of the part when the part is stamped, but to correct it afterwards.

[0036] Therefore, the method for the geometric rectification of stamped metal parts object of the invention comprises the steps described below.

[0037] A first step comprises to place a stamped part with each area to be rectified operatively located between a block and an electromagnetic coil, said part being conveniently separated from the block which is separated from the complementary electromagnetic coil by a distance not greater than ten times the thickness of the part, with the aim that the said part can impact against said block by the action of a magnetic field generated by said electromagnetic coil.

[0038] Then, the method comprises a second step comprising to generate a magnetic field configured to act in the areas to be rectified of the part such that they adopt a required final geometry when the part impacts against each block.

[0039] Finally, the method comprises a third step comprising to remove the already rectified part.

[0040] The possibility is considered that the method comprises an intermediate step which would be carried out before the second step of generation a magnetic field and comprising to place at least one driver, i.e. a sheet of material with a high copper content between said at least one electromagnetic coil and the part to be rectified, with the aim of reducing the energy demands of the method.

[0041] The deformation of the metal part to be rectified is achieved by means of the discharge of an electric current through said at least one winding which is near the area to be rectified of the part. Due to the currents induced in the part, a quick movement of the area of the part near the coil occurs. The kinetic energy associated with the movement originates the physical change in the part.

[0042] Therefore, according to the described invention, the electromagnetic device and method for the geometric rectification of stamped metal parts proposed by the invention constitute a breakthrough in the forming devices and methods used to date, and they fully and easily solve the aforementioned drawbacks in that they allow its use in any type of sheets, whichever their forming process has been, allowing the regular exploitation and use of available stamping equipment such as for example traditional presses in a certain factory, i.e., without the need of having to carry out any modification thereof, in order to later rectify the parts in the device of the invention outside the press line only in the cases in which it is necessary.

[0043] Therefore, the user can manufacture a part by means of a conventional stamping process and in view of the result, can decide if it is necessary to use the electromagnetic forming device of the invention for its rectification.

[0044] The device proposed by the invention is different from the electromagnetic forming devices of the state of the art because it does not require an upper female element and a lower female element accurately reproducing the final geometry, both the shape and the dimensions, of the entire part to be obtained due to the fact that the magnetic field acts only in those areas in which the part is out of the admissible tolerances, with the subsequent cost reduction.

[0045] It is extremely simple and cheap to manufacture the electromagnetic device proposed by the invention because it uses at least one block and at least one electromagnetic coil as tools allowing its adaptation to each type of geometry.

[0046] Said at least one block and said at least one electromagnetic coil can be exchanged, being adapted to each area to be rectified, therefore, if their design is taken care of, a same pair formed by a block and an electromagnetic coil can serve to rectify different parts, being located in areas having the same final geometry to be obtained.

[0047] Therefore, the cost is much lower than in the case of having to arrange a complete hold-down plate, female element and male element having exactly the complete final geometry of the entire sheet to be obtained.

[0048] This device eliminates the need of having to carry out successive corrections in the geometry of conventional stamping dies in order to eliminate the springback effect in the part. These corrections are generally carried out by means of an iterative correction, trial and error process with the great cost increase that this entails.

[0049] The device of the invention substitutes the mechanical calibrating die which can be omitted, with the subsequent saving of space in a factory, the reduction of initial costs due to the removal of a die and the possibility of use in press lines with one less station.

[0050] Furthermore, compared to the device and processes described in Japanese patents No. JP 2004-122177 and JP 2001-252788, the device of the invention allows rectifying any type of parts, preferably sheets, of conducting metallic materials such as steel, in addition to the aforementioned advantages.

DESCRIPTION OF THE DRAWINGS

[0051] In order to complement the description being made and with the aim of aiding in better understanding the features of the invention, according to a preferred embodiment thereof, a set of drawings is attached as an integral part of said description, in which the following has been represented with an illustrative and non-limiting character:

Figure 1 shows an electric scheme of the discharge circuit comprising the device of the invention and allowing the generation of a magnetic field for the rectification of metal parts.

Figure 2 shows a section of a final geometry to be obtained for a part and a geometry obtained after a conventional stamping process, the springback effect being observed in the latter, in comparison to the final geometry to be obtained.

Figure 3 shows a section of an elevational view of a schematic representation of the electromagnetic device proposed by the invention in which the situation of the part to be rectified can be observed.

Figure 4 shows a section according to a plan view of an embodiment of the device of the invention in which three blocks and three electromagnetic coils in three areas to be rectified of the part can be observed on a conventional stamping die base design, in which the simplicity of the device object of the invention compared with the complexity of a conventional stamping die can be verified.

Figure 5 shows an elevational view of the electromagnetic device of the invention according to the direction A-A of the previous figure.

Figure 6 shows a section of an elevational view according to section line B-B shown in Figure 4, in which a block and an electromagnetic coil located in correspondence, between which is a part to be rectified, can be observed.

Figure 7 shows another section of an elevational view like that of the previous figure according to section line C-C shown in Figure 4.

Figure 8 shows a flow diagram in which the main steps comprising the method for the geometric rectification of stamped metal parts proposed by the invention can be observed.

PREFERRED EMBODIMENT OF THE INVENTION

[0052] In view of the described figures, it can be observed that in one of the possible embodiments of the invention, the electromagnetic device for the geometric rectification of stamped metal parts comprises at least one block (2) configured to receive the impact and contact a side of a certain area to be rectified of a part (1).

[0053] The geometry of a surface of said at least one block (2) configured to contact the part (1) to be rectified exactly corresponds to a desired final geometry (10) in said side of the area to be rectified of the part (1).

[0054] In a complementary manner to each at least one block (2), the device comprises an electromagnetic coil (5) which is configured to be located on a side opposite to said at least one block (2) of a certain area to be rectified of the part (1).

[0055] In the event that a block (2) is located on a first side (12) of the part (1), then the complementary electromagnetic coil (5) is located on a second side (11) opposite to the first side (12), and vice versa, i.e., in the event that a block (2) is located on the second side (11) of the part (1), then the electromagnetic coil (5) is located on the first side (12).

[0056] Each at least one electromagnetic coil (5) com-

prises at least one winding (6) embedded in a part, preferably a synthetic body of fiberglass for example. Said electromagnetic coil (5) has an outer surface opposite to a side of the part (1), having a geometry approximate to the desired final geometry (10) in the part (1), there being a space or clearance between each at least one electromagnetic coil (5) and each at least one block (2) that is less than ten times the thickness of the part (1), with the aim that the action of the magnetic field drives the part (1) for its impact against the block (2).

[0057] As depicted in figures 1 and 3, each at least one electromagnetic coil (5) comprises at least one winding (6) connected to a power supply source (7) configured to generate a magnetic field.

[0058] Each at least one electromagnetic coil (5) is operatively located such that the magnetic field it generates acts in a certain area to be rectified of the part (1), acting thereupon and producing an impact of the part (1) against the corresponding block (2).

[0059] Each at least one winding (6) is connected to a discharge circuit comprising a capacitor (8), preferably a capacitor bank and a high voltage circuit comprising a power supply source (7) and trigger start means (9), such that when the capacitors (8) are charged and are activated by means of the trigger start means (9), a transient current is created in each at least one winding (6) generating the transient magnetic field.

[0060] Said magnetic field induces Foucault currents in the part (1) to be rectified, therefore the part (1) is driven in a direction opposite to that of each at least one electromagnetic coil (5), being pushed against said at least one block (2) such that the side of the areas to be rectified of the part (1) in contact with said at least one block (2) is formed acquiring the geometry of said at least one block (2).

[0061] As shown in figures 3 to 7, the possibility is considered that said at least one block (2) and electromagnetic coil (5) are linked both at a first base (3) and a second base (4), with the aim of serving as a support.

[0062] Likewise, the possibility is considered that said first base (3) and said second base (4) comprise moveable closure means to facilitate the removal of the part (1), the bases being able to be arranged in both a horizontal and a vertical position.

[0063] In the embodiment shown in figures 4 to 7, the device comprises a first block (2) located in a complementary manner to a first electromagnetic coil (5) comprising a first winding (6). On the other hand, the device comprises a second block (2') located in a complementary manner to a second electromagnetic coil (5') comprising a second winding (6'). Finally, the device comprises a third block (2'') located in a complementary manner to a third electromagnetic coil (5'') comprising a third winding (6'') arranged perpendicular to the first winding (6) and to the second winding (6').

[0064] As can be seen in figure 6, the first winding (6) has a geometry adapted to the curved area of the final geometry (10) to be obtained in the part.

[0065] In this embodiment, the first block (2), the third block (2'') and the second electromagnetic coil (5') are linked to the first base (3) whereas the second block (2'), the first electromagnetic coil (5) and the third electromagnetic coil (5'') are linked to the second base (4).

[0066] Finally, the possibility is contemplated that the device comprises at least one driver (13) consisting of a sheet of material with a high copper content, as can be seen in figure 3, located between said at least one electromagnetic coil (5) and the part (1) to be rectified, with the aim of reducing the energy demands of the device to obtain a certain geometry in a part (1) to be rectified.

[0067] A second aspect of the invention relates to a method for the geometric rectification of stamped metal parts with an electromagnetic device like the one previously described.

[0068] The method of the invention is carried out starting from the metal part to be rectified, i.e., a sheet which has already been mechanically stamped in a traditional press, with the aim of rectifying the geometry of the part in those areas in which the part is out of the established tolerances.

[0069] As can be observed in figure 8, the method for the geometric rectification of stamped metal parts object of the invention comprises the following steps:

A first step (A) comprising to place a stamped part (1) with each area to be rectified operatively located between a block (2) and an electromagnetic coil (5), said part (1) being conveniently separated from the block (2) which is separated from the complementary electromagnetic coil (5) by a distance not greater than ten times the thickness of the part (1).

A second step (B) comprising to generate a magnetic field configured to act in the areas to be rectified of the part (1) such that they adopt a required final geometry (10) when the part (1) impacts against each block (2).

A third step (C) comprising to remove the already rectified part.

[0070] The possibility is considered that the method comprises an intermediate step which would be carried out before the second step (B) and comprising to place at least one driver (13), i.e. a sheet of material with a high copper content, between said at least one electromagnetic coil (5) and the part (1) to be rectified, with the aim of reducing the energy demands of the method.

[0071] In view of this description and set of drawings, a person skilled in the art will understand that the embodiments of the invention which have been described can be combined in many ways within the object of the invention. The invention has been described according to some preferred embodiments thereof, but for a person skilled in the art it will be evident that many variations can be introduced in said preferred embodiments without surpassing the object of the claimed invention.

Claims

1. An electromagnetic device for the geometric rectification of stamped metal parts **characterized in that** it comprises:
- at least one block (2) configured to contact one side of an area to be rectified of a stamped metal part (1), the geometry of a surface of said at least one block (2) configured to contact the part (1) coinciding with a desired final geometry (10) in said side of the area to be rectified of the part (1),
 - at least one electromagnetic coil (5) configured to be located on a side opposite to said at least one block (2) of said area to be rectified of the part (1),
 - at least one embedded winding (6) that comprises each at least one electromagnetic coil (5), said winding (6) being configured to generate a magnetic field operatively configured to act on the part (1) and produce its impact against the corresponding block (2),
 - a space between each at least one electromagnetic coil (5) and each at least one block (2) not greater than ten times the thickness of the part (1).
2. An electromagnetic device for the geometric rectification of stamped metal parts according to claim 1, **characterized in that** each at least one block (2) and each at least one electromagnetic coil (5) are linked to a first base (3) and to a second base (4).
3. An electromagnetic device for the geometric rectification of stamped metal parts according to claim 2, **characterized in that** the first base (3) and the second base (4) comprise moveable closure means.
4. An electromagnetic device for the geometric rectification of stamped metal parts according to any of claims 2 and 3, **characterized in that** it comprises:
- a first block (2) located in a complementary manner to a first electromagnetic coil (5) comprising a first winding (6),
 - a second block (2') located in a complementary manner to a second electromagnetic coil (5') comprising a second winding (6'),
 - a third block (2'') located in a complementary manner to a third electromagnetic coil (5'') comprising a third winding (6'') arranged perpendicular to the first winding (6) and to the second winding (6').
5. An electromagnetic device for the geometric rectification of stamped metal parts according to claim 4, **characterized in that** the first block (2), the third block (2'') and the second electromagnetic coil (5')
- are linked to the first base (3) whereas the second block (2'), the first electromagnetic coil (5) and the third electromagnetic coil (5'') are linked to the second base (4).
6. An electromagnetic device for the geometric rectification of stamped metal parts according to any of claims 1 to 3, **characterized in that** the area to be rectified of the part (1) corresponds to virtually the entire surface of said part (1).
7. An electromagnetic device for the geometric rectification of stamped metal parts according to any of the previous claims, **characterized in that** it comprises at least one driver (13) consisting of a sheet of a material with a high copper content, located between said at least one electromagnetic coil (5) and the part (1) to be rectified, in order to reduce the energy demands of the device for obtaining a certain geometry in a part (1) to be rectified.
8. An electromagnetic device for the geometric rectification of stamped metal parts according to any of the previous claims, **characterized in that** at least one electromagnetic coil (5) comprises a body of synthetic material, said body having at least one surface configured to be located opposite to a side of the part (1) with a geometry corresponding substantially to the desired final geometry (10) in said side of the mentioned area to be rectified of the part (1).
9. A method for the geometric rectification of stamped metal parts with a device according to any of the previous claims, **characterized in that** it comprises the following steps:
- a first step (A) comprising to place a stamped part (1) with each area to be rectified operatively located between a block (2) and an electromagnetic coil (5), said part (1) being conveniently separated from the block (2) which is separated from the complementary electromagnetic coil (5) by a distance not greater than ten times the thickness of the part (1),
 - a second step (B) comprising to generate a magnetic field configured to act in the areas to be rectified of the part (1) such that they adopt a required final geometry (10) when the part (1) impacts against each block (2),
 - a third step (C) comprising to remove the already rectified part.
10. A method for the geometric rectification of stamped metal parts according to claim 9, **characterized in that** it comprises an intermediate step, prior to the second step (B), comprising to place at least one driver (13), i.e. a sheet of a material with a high copper content, between said at least one electromag-

netic coil (5) and the part (1) to be rectified, with the aim of reducing the energy demands of the method.

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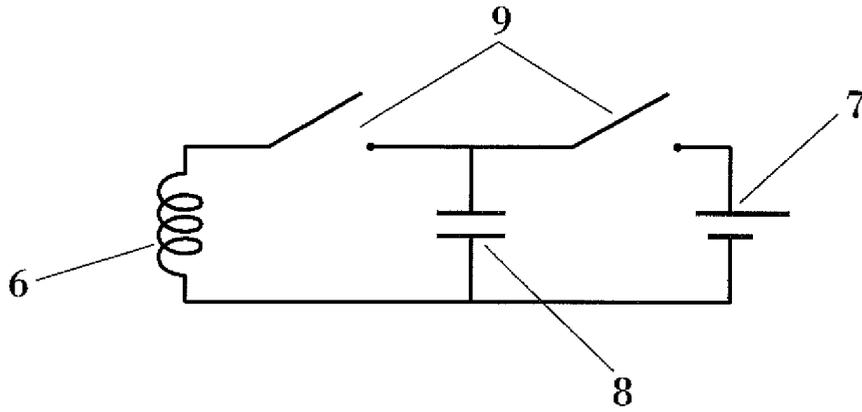


FIG. 1

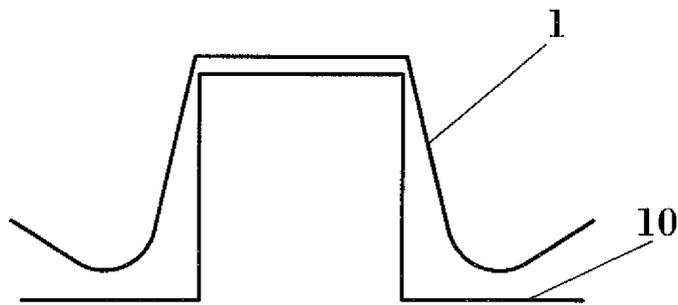


FIG. 2

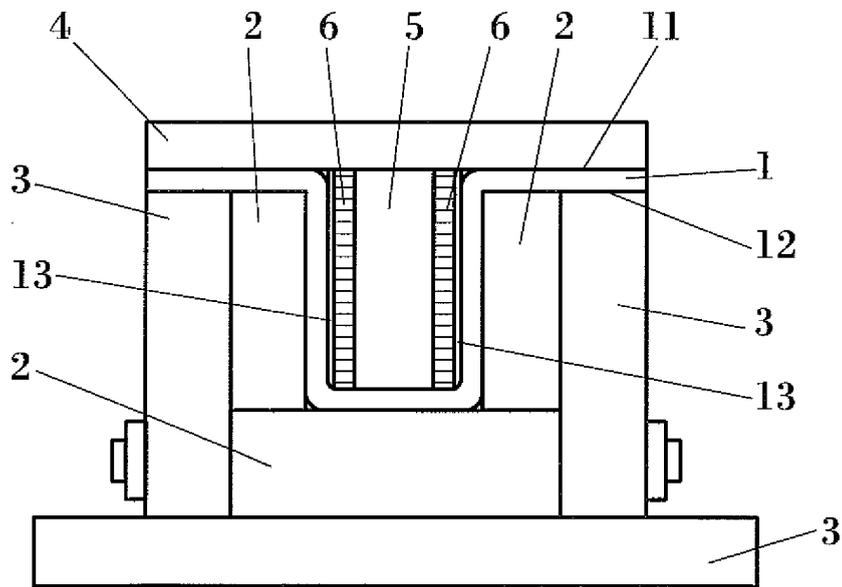


FIG. 3

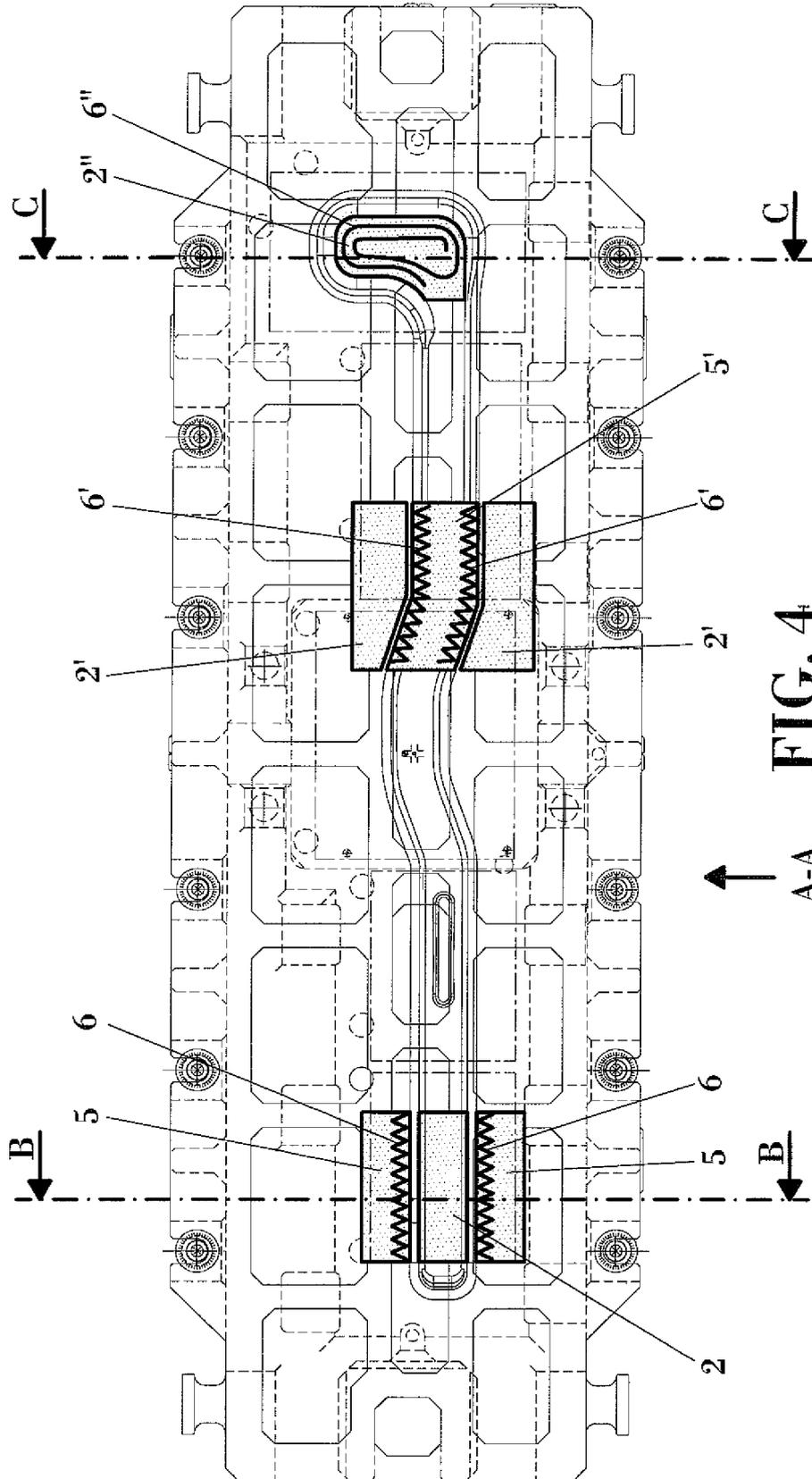


FIG. 4

A-A

B

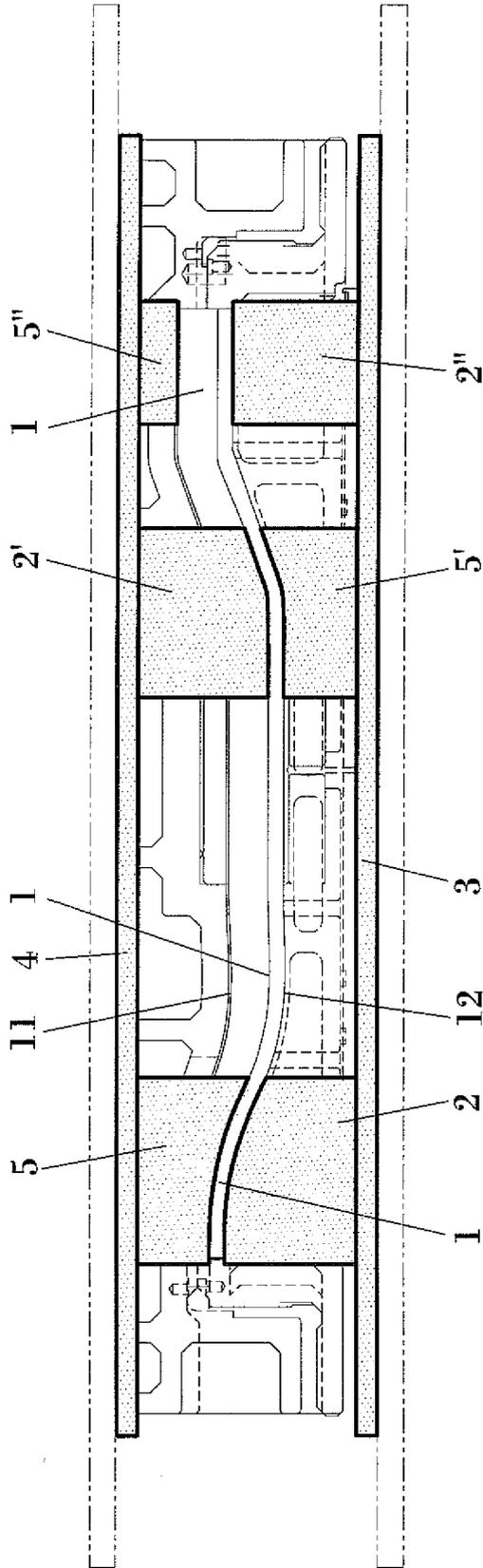


FIG. 5
VIEWED FROM A-A

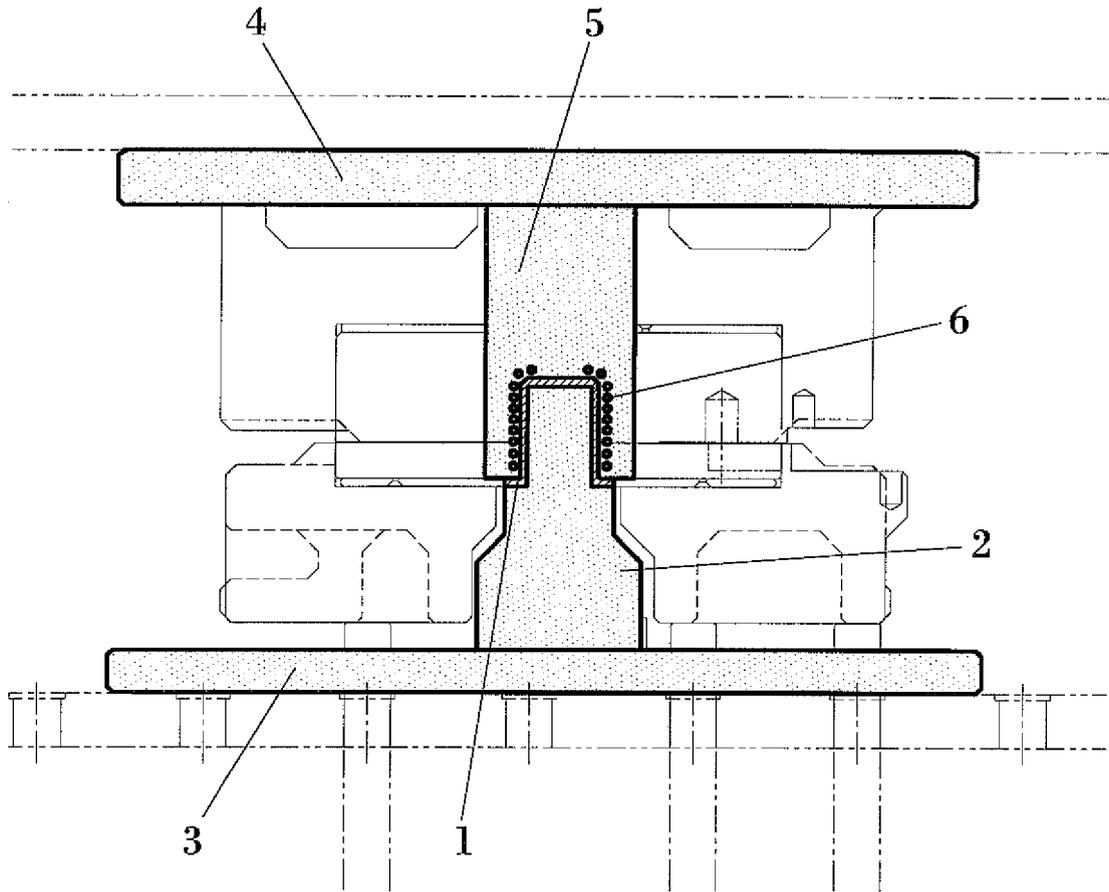


FIG. 6
B-B

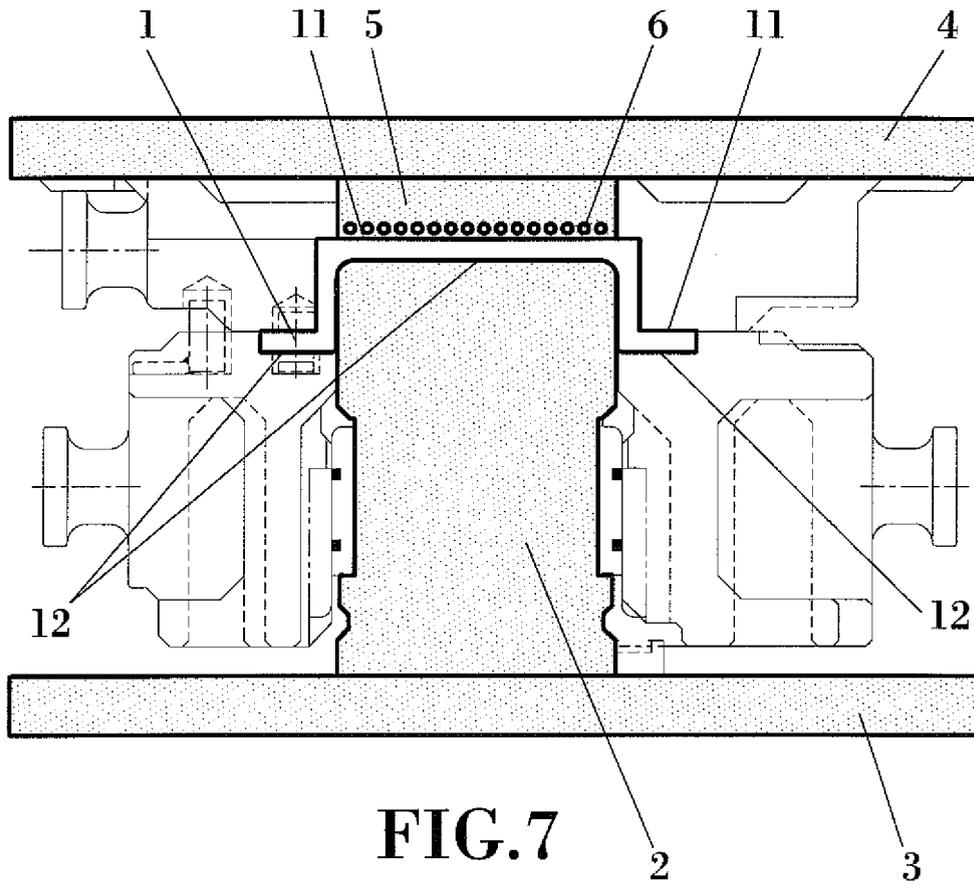


FIG. 7
C-C

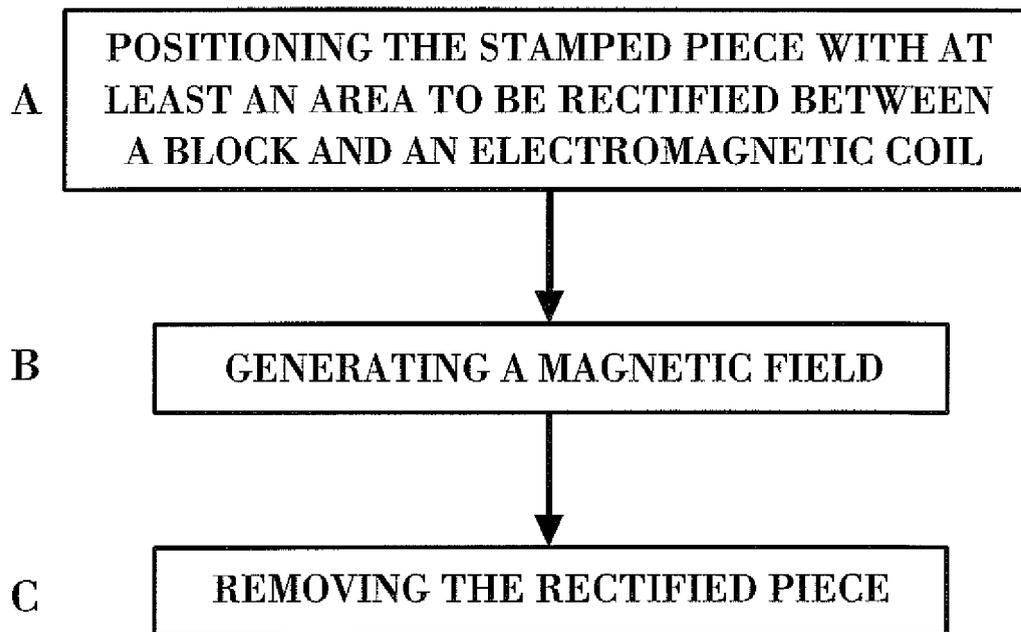


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/ES2006/000511

A. CLASSIFICATION OF SUBJECT MATTER INV. B21D26/14		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) B21D		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 050 121 A (DAEHN GLENN S [US] ET AL) 18 April 2000 (2000-04-18) cited in the application column 21, lines 55-67; figure 9 column 44, lines 53-57	1-6,8-10
Y	-----	7
X	JP 2004 209486 A (KOBE STEEL LTD) 29 July 2004 (2004-07-29) abstract; figures	1-6,8-10
X	JP 2001 252788 A (ISHIKAWAJIMA HARIMA HEAVY IND) 18 September 2001 (2001-09-18) cited in the application page 4, paragraph 21; figure 3 ----- -/--	1-6,8-10
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents :		
A document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed		*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. *&* document member of the same patent family
Date of the actual completion of the international search 18 April 2007		Date of mailing of the international search report 24/04/2007
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer Knecht, Frank

INTERNATIONAL SEARCH REPORT

International application No PCT/ES2006/000511

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	BE 714 249 A (CENTRE NATIONAL DE RECHERCHES METALLURGIQUES [BE]) 25 October 1968 (1968-10-25) page 2, lines 13-18 -----	7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/ES2006/000511

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6050121	A	18-04-2000	NONE	
JP 2004209486	A	29-07-2004	NONE	
JP 2001252788	A	18-09-2001	NONE	
BE 714249	A	25-10-1968	LU 53726 A	10-02-1969

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2976907 A [0012]
- US 6050121 A [0012]
- US 5730016 A [0012]
- US 20050097934 A [0012]
- US 20050229376 A [0012]
- US 20030182005 A [0012]
- US 5860306 A [0012]
- JP 2004122177 A [0013] [0013] [0050]
- JP 2001252788 A [0013] [0050]

Non-patent literature cited in the description

- **Golovashchenko, Sergey F.** springback calibration using pulsed electromagnetic field. American Institute of Physics, 2005 [0011]
- **Moon, F. C.** Magneto solid mechanics. *ASTME; High Velocity Forming of Metals*, 1968 [0011]
- **Plum, M.M.** Electromagnetic forming. Metals handbook. Maxwell Laboratories Inc, 644-653 [0011]
- **Belyy, I. V. ; Fertik, S. M. ; Khimenko, L. T.** Electromagnetic metal forming handbook Kharkov. 1977 [0011]