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(54) METHOD AND DEVICE FOR PRODUCING A FORMED HOLLOW PROFILE

VERFAHREN UND VORRICHTUNG ZUR HERSTELLUNG EINES GEFORMTEN HOHLPROFIL
PROCÉDÉ ET DISPOSITIF POUR FABRICATION D'UN PROFILE CREUX MIS EN FORME

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Description

FIELD OF THE INVENTION

5 **[0001]** The invention relates to a method for producing a formed hollow profile that is bent in a 2D strain, more preferably in 3D and consists of metal. Said bent hollow profile is preferably used as a formed hollow profile to be integrated in a motor vehicle, more preferably as a bumper. Furthermore, the invention relates to a device for carrying out the method according to the invention.

10 PRIOR ART

[0002] A method for producing a formed hollow profile hollow profile that is bent in a 2D strain, more preferably in 3D, i.e. curved in at least one axis or more preferably in at least two axis and consists of metal from a profile according to the preamble of Claim 1 is already known from practice.

15 **[0003]** For instance, US2011/0067473 discloses a method which includes, in combination, a roll former with rolls configured to form a structural beam from sheet material and a sweep unit for longitudinally sweeping a beam in any of vertical, horizontal, or combination directions. US2005/0046226 discloses a method which includes a metal blank to fluid pressure to form a bumper having a shape characterized by a curvature.

[0004] According to the book from Dorel Banabic, published by Springer, untitled "Advanced Methods in Materials forming" (pages 103 to 108), bending profiles in 3D have been disclosed in various embodiments.

20 **[0005]** For instance, multi roll bending permits the bending of profile curvatures in opposite directions as well as the production of three dimensionally bent profiles. Such 3D shapes can only be achieved however when bending tubes (circular symmetrical cross section). It is also substantial that between the individual forming or bending operations a feed movement of the profile takes place in each case.

25 **[0006]** In recent years, full flexible 3D freeform bending machined have been developed to permit to form in 3D non symmetrical cross section.

[0007] DE 10246977 discloses a device for the 3D free-form bending of profiles with arbitrary, but constant outside dimensions over the profile length, particularly hollow profiles, wherein the profile to be bent has a longitudinal axis and is moved through the through-opening of a guide element adjoining the profile surface and a bending sleeve that is arranged downstream of the guide element referred to the feed direction and held in a carrier element in a feed direction that extends parallel to the longitudinal axis, namely by means of a feed unit that contains a rotary drive. The bending sleeve can be pivoted about an axis that extends perpendicular to the feed direction and displaced perpendicular to the longitudinal axis of the profile. When turning the profile about its longitudinal axis by means of the feed unit, the guide element and the bending sleeve can be turned with the profile. DE102008006293 discloses a process for the three-dimensional bending of round tubes and/or profiles using the free-form bending process (also referred to as the multi roll bending process), in which the rear end of the profile to be bent is held, if appropriate such that said profile can rotate, in a feed carriage which can be moved in the longitudinal direction (X direction), and the front end of said profile is held in the bending zone, wherein the interior is supported by a mandrel shank concomitantly guided in the bending zone and the bending zone is formed by at least one central roll and a rolling roll arranged opposite said central roll (with respect to the Y plane), and is furthermore formed at least by two opposite further rolling rolls arranged in the Z plane and at least one bending roll arranged at a distance therefrom on the outlet side, characterized in that at least one or more central rolls are arranged on a common, rotatable driven tool changer, such that a specific central roll is optionally moved into engagement with the tube or profile to be bent, depending on the rotation of the tool changer.

45 DISCLOSURE OF THE INVENTION

[0008] Starting out from the shown prior art, the invention is based on the object of further developing a method enabling to bend a metallic hollow profile in a 2D strain, which means a deformation in one plane, for instance XY plane. However, the present invention also has the additional specific purpose, to allow bending also in 3D, which means a deformation in two planes, for instance XY and XZ planes. The term hollow profile here refers to metallic components having a symmetrical or a non-symmetrical closed cross section, with a circular, oval, rectangular or polygonal shape with one or multiple chambers. The hollow profile is preferably obtained by extruding billets, said hollow profile is then preferably an extruded hollow profile. In another embodiment, the hollow profile or the extruded hollow profile is preferably made from an aluminum alloy, preferably a 6xxx series.

55 **[0009]** The invention is referring to a method permitting to obtain different curvatures or forms with relatively minor device-related effort. In particular, the production of curvatures on a formed hollow profile having relative small radii is to be also made possible.

[0010] According to the invention, this object is solved with a method having the features of Claim 1.

[0011] The tool groups are fixed to the hollow metallic profile element on a given region of its cross section, in a forced based manner. It permits to hold the hollow metallic profile element in a sufficiently rigid manner to permit the subsequent forming but also permits a sufficient freedom of movement to insure the plastic deformation.

[0012] In contrast with the prior art initially mentioned at the outset, the deformation is obtained without the need of having an element, such as a bending roller, in contact with the area to be formed. According to the invention, any deformations or curvatures in the sections of the profile located between the tool groups can be achieved through a corresponding relative movement of the tool groups taking into account the material characteristics, such as the yield strength, the young modulus, the Poisson coefficient. It is also preferred that the profile is not formed in the region of the tool groups during the forming operation according to the invention described so far during the relative movement of the tool groups relative to one another. The tool groups are moved along at least one space axis (X,Y,Z) linearly and/or in a rotatively manner about at least one space axis (X,Y,Z). Preferentially, to obtain a 3D strain, the tool groups are moved along at least two space axis (X,Y,Z) linearly and/or in a rotatively manner about at least two space axis (X,Y,Z).

[0013] Since the method according to the invention comprises more than two tool groups which are spaced from one another, the case in which for example three or four tool groups which are spaced from one another are provided is obviously also included. By means of such an arrangement, a desired forming can be achieved in each case for example in the respective regions between the tool groups in one and the same method step. In contrast with the prior art mentioned at the outset, it is likewise not required during the forming operation to move the hollow metallic profile element into the region of the corresponding forming tools through a feed movement. The hollow profile, after being positioned is fixed in regions during the forming sequence.

[0014] Advantageous further developments of the method according to the invention for producing a formed hollow profile that is curved in at least one axis are mentioned in the subclaims. All combinations of at least two features disclosed in the claims, the description and/or the figures fall within the scope of the invention.

[0015] In a first embodiment of the method according to the invention, it can be provided that the spacing between the tool groups during the forming with respect to a neutral fibre or a neutral axis of the extruded profile changes in such a manner that the length of the neutral fibre or the neutral axis is enlarged or reduced or the position of the neutral fibre changed. In other words, in the region between the two tool groups, in which a forming of the hollow profile takes place, a tapering or enlargement of the profile cross section of the hollow profile (compressing or stretching) can take place. In the case of a change of position of the neutral fibre, it is made possible for example to avoid local material agglomerations which can lead to the forming of folds or local material shrinkage resulting in collapsed areas on the profile.

[0016] It is possible within the scope of the method according to the invention to not only curve the region of the hollow profile between two tool groups with respect to a space direction or to an axis, but to form almost any forms. These forms which are formed in multiple axes or space directions on the hollow profile can be obtained for example by moving the tool groups in different directions one after the other. For example, in a first method step a tool group is pivoted or rotated about a first axis with respect to another tool group in order to create a first curvature in the hollow profile. Following this, a parallel shift between the two part lengths of the hollow profile arranged in the respective tool groups can be formed through a linear movement of the respective tool group relative to another tool group along one space axis (X,Y,Z).

[0017] However, it is also possible, according to the invention, that such relatively complex deformations or deformations in multiple space axes are obtained by the movement of the tool groups, performed at least at times simultaneously, in multiple directions relative to one another. "Direction" is understood within the scope of the invention either as a linear movement along an axis, pivoting about or turning in an axis. In addition to this, the movements between the tool groups can be realised in principle in that either a first tool group is rigidly fixed while the other tool group is moved relative to the fixed tool group or in that all tool groups are moved relative to one another. The tool groups can move one after the other or simultaneously.

[0018] Almost all conceivable forms can be realised from the hollow metallic profile element relatively easily and quickly. However, the invention is to be expressly not limited to such cases in which forming of part sections of the hollow metallic profile element takes place exclusively in the regions between the individual tool groups which are moveably arranged relative to one another. Accordingly, it is provided in a preferred embodiment of the method according to the invention that, prior to the moving of the tool groups relative to one another, the hollow metallic profile element is additionally formed within a tool group, in particular for forming a curvature running in an axis of the extruded profile. This means that the tool elements of the tool group concerned have a shape or inner contour that is adapted to the form of the curved section of the hollow metallic profile element. Said additional forming is made possible by the displacement of the said shaped tool elements with respect to the tool group, said shaped tool elements displacing simultaneously or one after the other. Said displacement of shaped tool elements takes place along the initial straight part of the hollow metallic profile element to be formed. The part length of the hollow metallic profile element within the tool group concerned is provided with a curvature corresponding to the shape of the tool elements. Following the forming of the curvature, the relative movement of the tool groups relative to one another subsequently takes place in order to achieve the deformation between the tool groups, in the freely arranged region to obtain the formed hollow profile.

[0019] The invention also comprises a device as defined by claim 7.

[0020] For forming (almost) any forms of the extruded profile in the region between the tool groups, it is provided in a further development of the device that, at least the two tool groups are moveably arranged relative to one another and capable in moving in at least one linear direction and/or pivotable in or about at least one axis of rotation.

[0021] The tool groups are linearly movable by means of an adjusting drive along at least two space axis (X, Y, Z) and/or pivotable about at least two space axis (X, Y, Z). Advantageously, the formed hollow profile obtained by the method of the invention or produced by means of a device for carrying out the method according to the invention is used in an automotive structure, preferably as a bumper.

[0022] Further advantages, features and details of the invention are obtained from the following description of exemplary embodiments and with the help of the drawing.

[0023] The drawing shows in:

Fig. 1 a formed hollow profile that is curved in multiple directions, 3D, in a front view,

Fig. 2 the formed hollow profile according to Fig. 1 in a top view,

Fig. 3a to Fig. 3d different possible cross sections for the formed hollow profile according to Fig. 1 and 2,

Fig. 4 a highly simplified representation of a device for forming a formed hollow profile with multiple tool groups spaced from one another, wherein the tool elements of the tool groups are spaced from one another,

Fig. 5 and Fig. 6 the device according to Fig. 4 at different times during the forming sequences of the hollow metallic profile element.

Fig. 7 a section in the plane 15 of Fig. 5.

[0024] Same elements or elements with same function are marked with the same reference numbers in the figures.

[0025] In Fig. 1 and 2, a formed hollow profile 1 is shown in front view and top view respectively. This type of shape can be employed in the region of a vehicle front of a motor vehicle, as a bumper. The formed hollow profile 1 consists of metal, in particular of an aluminium alloy and is obtained from an extruded profile.

[0026] The formed hollow profile 1 is arranged symmetrically to a centre plane 2 and in front view has a middle region 3 and two edge regions 4, which are each formed linearly. The middle region 3 is equipped with a height offset h , which can typically amount up to 100 mm, relative to the edge regions 4. Between the middle region 3 and the edge regions 4, at least two sections 5, 6, each with a same or different curvature radii r_1 and r_2 , exemplarily with a curvature radius r_1 and r_2 of 50 mm each, are provided in each case. In addition to this, the two edge regions 4, such as in particular evident by the representation of Fig. 2, are arranged inclined by an angle α with respect to the middle region 3. Furthermore, the middle region 3 is set back with a depth offset t , which can amount up to 100 mm, relative to the two front face sections 7, 8 of the formed hollow profile formed hollow profile 1.

[0027] In Fig. 3a to 3d typical cross sections through a formed hollow profile 1 described so far are shown. Here, the profile height H of the formed hollow profile 1 typically amounts to between 40 mm and 200 mm. The profile thickness T of the formed hollow profile 1 typically amounts to approximately between 20 mm and 60 mm. Within the cross section of the formed hollow profile 1, the cross section can be subdivided into profile chambers by at least one profile web 9. Accordingly, in Fig. 3b, the formed hollow profile 1 is subdivided into two chambers by a profile web 9, while in Fig. 3c by using two profile webs 9 the cross section of the formed hollow profile 1 is subdivided into three profile chambers. In Fig. 3d, a total of six profile chambers are provided wherein the number of the profile chambers is merely restricted by the number of profile webs 9 or by the production technology.

[0028] In Fig. 4 to 6, a device 10 for producing a formed hollow profile (1) is shown, wherein for the sake of simplicity the formed hollow profile (1) produced by means of the device 10 differs in its geometry or its cross section from the formed hollow profile (1) corresponding to Fig. 1 and 2.

[0029] The device 10 exemplarily comprises three tool groups 11 to 13, which likewise merely exemplarily are arranged symmetrically to a symmetry plane 15. Here, the two tool groups 12 and 13 are arranged symmetrically or on opposite sides of the (central) tool group 11. The tool group 11 comprises a lower tool element 16 and an upper tool element 17, which are exemplarily attached to a lower mounting unit 18 or an upper mounting unit 19. The device 10 is easily modifiable with little tool changing effort to permit to obtain different forms of formed hollow profile (1).

[0030] The two tool elements 16, 17 of the tool group 11 are exemplarily arranged moveably relative to one another in each case in the direction of the double arrows 21, 22 between an opened position and a closed position. Furthermore, the two tool elements 16, 17 seen in longitudinal direction are each equipped with a curved or bent contour 26, 27 viewed

on sides facing one another. From the representation of Fig. 7, the cross section of the hollow metallic profile element 25, initially used to obtain the formed hollow profile (1) is positioned within a lower mounting 28 or an upper mounting 29 of the two tool elements 16, 17 with tool elements 16, 17 which are together located in the closed position. Said positioning can be done in such way that either profile 25 is completely embedded within the lower or upper mounting or it can be embedded partially, i.e. some wall region of the cross section of the profile are not in contact with the mounting system (28 and/or 29). The hollow metallic profile element 25 exemplarily has a rectangular cross section without profile webs 9. The hollow metallic profile element is fixed in a forced based manner a part of the cross section of the hollow metallic profile element (25), on a given length.

[0031] The two tool groups 12, 13 are exemplarily identically constituted and each has a lower tool element 31 and an upper tool element 32, which are likewise moveably arranged in the direction of the double arrows 33, 34 relative to one another between an opened position shown in Fig. 4 and a closed position shown in Fig. 5. Exemplarily, it is provided according to Fig. 4 with tool elements 31, 32 spaced from one another that the two tool groups 12, 13 are arranged about an angle β relative to a vertical. Furthermore, the tool elements 31, 32 are each preferentially replaceably arranged on a lower mounting unit 35 or an upper mounting unit 36 analogously to the tool group 11. The tool elements 31, 32 each also have a contour which is not shown in detail, which with closed tool elements 31, 32 makes possible, to embed at least partly, preferentially completely, the cross section of the hollow metallic profile element 25.

[0032] A part of the cross section of the hollow metallic profile element 25 is fixed by the tool elements 31, 32 of the tool groups 12, 13 in a forced based manner, on a given length of the hollow metallic profile element 25.

[0033] In the shown exemplary embodiment, the tool elements 31, 32 or their mounting for the hollow metallic profile element 25 which are not shown in detail are designed linearly or without curvature, which means that the hollow metallic profile element 25 arranged between the tool elements 31, 32 is not formed within the tool elements 31, 32.

[0034] It is preferred for the invention that the tool groups 12, 13, which are arranged on both sides of the middle tool groups 11, are adjustably arranged relative to the tool group 11. To this end, the tool elements 31, 32 and the mounting elements 35, 36 respectively are each coupled to an adjusting drive 40 which is merely shown symbolically. The adjusting drive 40 can for example be designed as a hydraulic, electric or pneumatic adjusting drive 40 and is activated by means of a control device 41. In addition to this, the control device 41 preferentially also controls the movement of the tool elements 16, 17 of the tool group 11 and of the tool elements 31, 32 of the tool groups 12, 13.

[0035] In particular it can be provided that the adjusting drive 40 makes possible a movement or adjustability of the tool groups 12, 13 relative to the tool group 11 in and about the three space axes X, Y, Z, i.e. a linear or pivot or turning movement of the tool groups 12, 13. In other words, this means that the adjusting drive 40 as six-axis adjusting drive 40 makes possible any spatial movement of the tool groups 12, 13 to the tool group 11.

[0036] As is evident furthermore with the help of the representation of Fig. 4 to 6, the tool groups 12, 13 and their tool elements 31, 32 respectively are arranged spaced from the tool group 11 in such a manner that between the tool groups 11 to 13 in each case a section 42, 43 of the hollow metallic profile element (25) is provided which in each case is freely arranged, i.e. not in contact with one of the tool groups 11 to 13.

[0037] For obtaining the formed hollow profile (1), from the hollow metallic profile element 25, arranged between the tool element 16, 17 and 31, 32, it is initially provided according to Fig. 4 that the profile element 25 which is initially straight is positioned between the opened tool elements 16, 17 and 31, 32. This can be effected both manually and also by means of a handling robot which is not shown. Following this, the two tool elements 16, 17 of the tool group 11 are moved against one another. In the process, the tool elements 16, 17 come into contact or into operational connection with the profile element 25 and the same is provided through the mountings 28, 29 with a curvature corresponding to the contour 26, 27. Because of the forming of the curvature the sections of the profile element 25 which are congruent with the lower tool elements 31 of the tool groups 12, 13 come to be aligned in parallel with the tool elements 31, 32 which are consequently placed against the cross section of the profile element 25 (Fig. 5). Following this, a movement of the two tool groups 12, 13 relative to the tool group 11, in the shown exemplary embodiment turning about the space axis Z arranged perpendicularly to the drawing plane of Fig. 4 to 6 takes place according to the representation of Fig. 6 by means of the adjusting drive 40, wherein the sections 42, 43 of the profile element (25) which are freely arranged between the tool groups 11 to 13 are formed at least in regions and exemplarily provided with a curvature 45, 46.

[0038] Following the forming of the curvatures 45, 46 shown in Fig. 6 or at the same time as the forming of the curvatures 45, 46, the two tool groups 12, 13 can move in the direction of the two other space axes X, Y or to turn about said space axes X, Y, or perform a movement of the middle tool group 11 (for the purpose of which the same is coupled to the adjusting drive 40), in order to be able for example to obtain a formed hollow profile (1), formed in multiple space axes for example corresponding to the representation of Fig. 1 and 2.

[0039] During the sequence of forming, the hollow metallic profile element 25 initially positioned within the tool elements is kept fixed; no movement of it is needed to insure the forming.

[0040] The device 10 described so far can be variously modified without deviating from the inventive idea. In particular it can be provided to perform further mechanical process steps such as punching, attaching connecting elements or similar on the formed hollow profile 1 before or after the forming. It is also possible that the formed hollow profile 1 is

not formed symmetrically to the centre plane 2. The asymmetry in this case is to comprise different bending courses and/or different bending angles on the formed hollow profile 1.

LIST OF REFERENCE CHARACTERS

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[0041]

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- 1 Formed hollow profile
- 2 Centre plane
- 3 Region
- 4 Edge region
- 5 Section
- 6 Section
- 7 Face section
- 8 Face section
- 9 Profile web
- 10 Device
- 11 Tool group
- 12 Tool group
- 13 Tool group
- 15 Symmetry plane
- 16 Lower tool element
- 17 Upper tool element
- 18 Lower mounting unit
- 19 Upper mounting unit
- 21 Double arrow
- 22 Double arrow
- 25 Profile element
- 26 Contour
- 27 Contour
- 28 Lower mounting
- 29 Upper mounting
- 31 Lower tool element
- 32 Upper tool element
- 33 Double arrow
- 34 Double arrow
- 35 Lower mounting unit
- 36 Upper mounting unit
- 40 Adjusting drive
- 41 Control device
- 42 Section
- 43 Section
- 45 Curvature
- 46 Curvature
- T Profile thickness
- H Profile height
- h Height offset
- t Depth offset
- r₁ Curvature radius
- r₂ Curvature radius
- α Angle
- β Angle
- X Axis
- Y Axis
- Z Axis

Claims

1. A method for producing a metallic formed hollow profile (1) which is curved in three axis (X, Y, Z), in which a hollow metallic profile element with multiple chambers (25) is formed by means of at least two tool elements (16, 17, 31, 32) of a tool group (11 to 13) which hold a cross section part of the hollow metallic profile element (25), on a given length of said hollow metallic profile element (25)

characterized in that

more than two tool groups (11 to 13) each comprising two tool elements (16, 17, 31, 32) which are spaced from one another are provided, **in that** each of the tool groups (11 to 13) is fixed to the hollow metallic profile element with multiple chambers (25) at least in regions in a forced based manner, wherein a region (42, 43) of the hollow metallic profile element with multiple chambers (25) to be formed is freely arranged between the tool groups (11 to 13), and **in that** by moving the tool groups (11 to 13) along at least two space axis (X, Y, Z) linearly and/or in a rotatively manner about at least two space axis (X, Y, Z), the hollow metallic profile element with multiple chambers (25) in the freely arranged region (42, 43) located between the tool groups (11 to 13) is formed at least partially.

2. The method according to Claim 1,

characterized in that

the spacing between the tool groups (11 to 13) during the forming of the hollow metallic profile element with multiple chambers (25) is changed in such a manner that the hollow metallic profile element with multiple chambers (25) between the tool groups (11 to 13) is stretched or compressed or the position of a neutral fibre changed.

3. The method according to Claim 1 or 2,

characterized in that

during a forming of the hollow metallic profile element with multiple chambers (25) in multiple space axes (X, Y, Z) the tool groups (11 to 13) are moved one after the other.

4. The method according to Claim 1 or 2,

characterized in that

for forming the hollow metallic profile element with multiple chambers (25) in multiple space axes (X, Y, Z) the tool groups (11 to 13) are moved simultaneously at least at times.

5. The method according to any one of Claims 1 to 4,

characterized in that

prior to the moving of the tool groups (11 to 13) towards one another the hollow metallic profile element with multiple chambers (25) is additionally formed within a tool group (11) with shaped tool elements, in particular for forming a curvature.

6. The method according to any one of Claims 1 to 5,

characterized in that

said hollow metallic profile element with multiple chambers (25) is an extrusion profile, preferably made from an aluminium alloy.

7. A device (10) for carrying out a method according to any one of the Claims 1 to 6, wherein the device (10) has more than two tool groups (11 to 13) which are moveably arranged relative to one another, and which are linearly movable by means of an adjusting drive (40) along at least two space axis (X, Y, Z) and/or pivotable about at least two space axis (X, Y, Z) wherein the tool groups (11 to 13) each comprises two tool elements (16, 17, 31, 32) which are moveable against one another and against a cross section part of a hollow metallic profile element with multiple chambers (25), said tools elements (16, 17, 31, 32) of a tool groups (11 to 13) are capable of holding a cross section part of the hollow metallic profile element with multiple chambers (25), on a given length in a forced based manner, and wherein between the tool groups (11 to 13) a spacing is provided, in which the hollow metallic profile element with multiple chambers (25) with the section (42, 43) to be formed can be formed without direct contact with the tool groups (11 to 13).

8. The device according to claim 7,

characterized in that

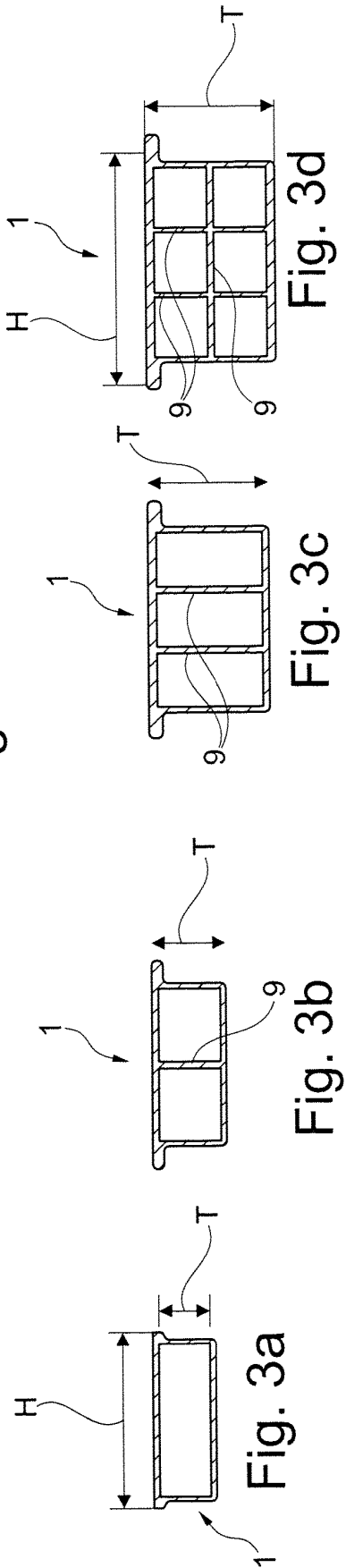
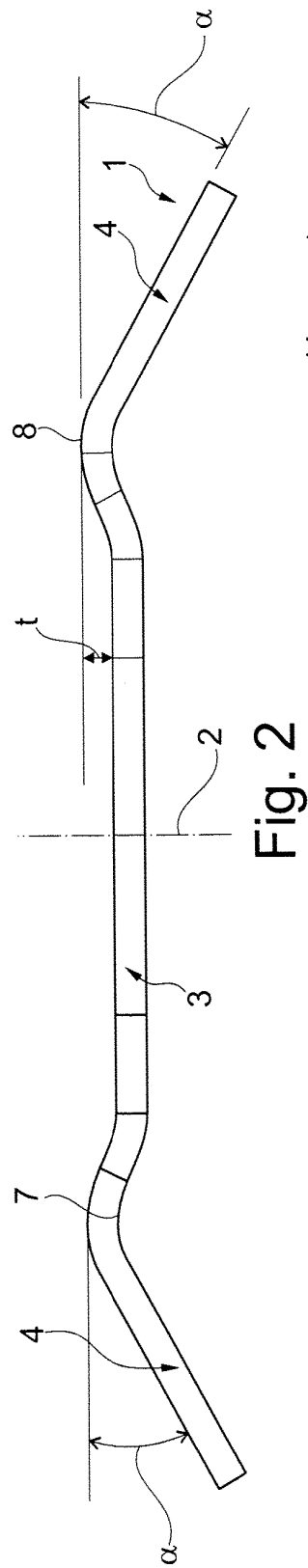
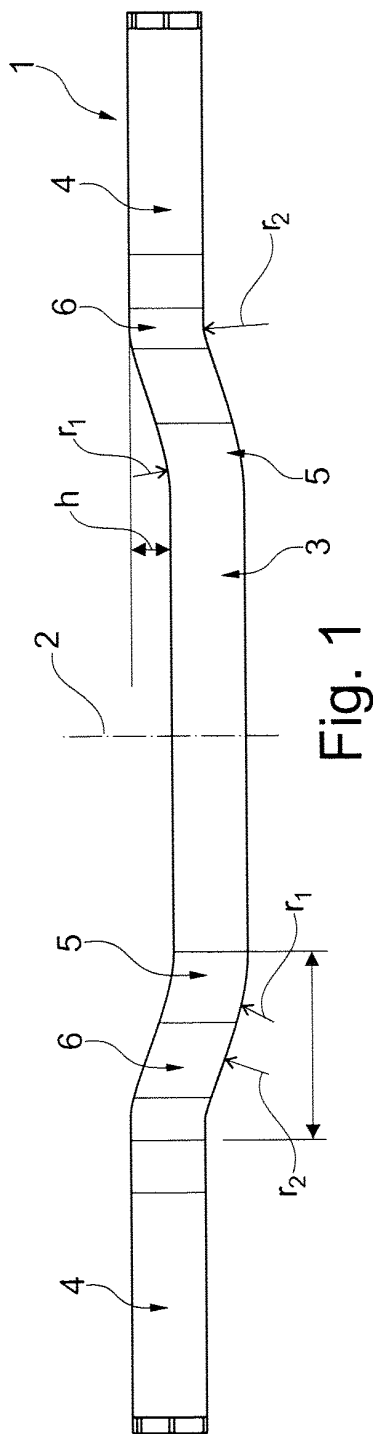
at least one tool group (11) is designed in order to form the profile element with multiple chambers (25) within the tool group (11).

Patentansprüche

1. Verfahren zur Herstellung eines geformten Hohlprofils (1) aus Metall, das in drei Achsen (X, Y, Z) gekrümmt ist, wobei ein metallenes Hohlprofilelement mit mehreren Kammern (25) mittels mindestens zwei Werkzeugelementen (16, 17, 31, 32) einer Werkzeuggruppe (11 bis 13), die einen Querschnittsteil des metallenen Hohlprofilelements (25) halten, auf einer gegebenen Länge des metallenen Hohlprofilelements (25) geformt wird, **dadurch gekennzeichnet, dass** mehr als zwei Werkzeuggruppen (11 bis 13), die jeweils zwei voneinander beabstandete Werkzeugelemente (16, 17, 31, 32) umfassen, bereitgestellt werden, dadurch, dass jede der Werkzeuggruppen (11 bis 13) mindestens bereichsweise kraftbasiert an dem metallenen Hohlprofilelement mit mehreren Kammern (25) befestigt wird, wobei ein Bereich (42, 43) des metallenen Hohlprofilelements mit mehreren Kammern (25), das geformt werden soll, frei zwischen den Werkzeuggruppen (11 bis 13) angeordnet ist, und dadurch, dass durch Bewegen der Werkzeuggruppen (11 bis 13) linear entlang mindestens zwei Raumachsen (X, Y, Z) und/oder drehend um mindestens zwei Raumachsen (X, Y, Z) das metallene Hohlprofilelement mit mehreren Kammern (25) in dem frei angeordneten Bereich (42, 43), der sich zwischen den Werkzeuggruppen (11 bis 13) befindet, mindestens teilweise geformt wird.
2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** der Abstand zwischen den Werkzeuggruppen (11 bis 13) während des Formens des metallenen Hohlprofilelements mit mehreren Kammern (25) so verändert wird, dass das metallene Hohlprofilelement mit mehreren Kammern (25) zwischen den Werkzeuggruppen (11 bis 13) gestreckt oder gestaucht oder die Position einer neutralen Faser verändert wird.
3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** während eines Formens des metallenen Hohlprofilelements mit mehreren Kammern (25) in mehreren Raumachsen (X, Y, Z) die Werkzeuggruppen (11 bis 13) nacheinander bewegt werden.
4. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** um das metallene Hohlprofilelement mit mehreren Kammern (25) in mehreren Raumachsen (X, Y, Z) zu formen, die Werkzeuggruppen (11 bis 13) mindestens zweitweise gleichzeitig bewegt werden.
5. Verfahren nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** vor dem Aufeinanderzubewegen der Werkzeuggruppen (11 bis 13) das metallene Hohlprofilelement mit mehreren Kammern (25) zusätzlich innerhalb einer Werkzeuggruppe (11) mit geformten Werkzeugelementen geformt wird, insbesondere, um eine Krümmung zu formen.
6. Verfahren nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** das metallene Hohlprofilelement mit mehreren Kammern (25) ein Strangpressprofil ist, das vorzugsweise aus einer Aluminiumlegierung besteht.
7. Vorrichtung (10) zum Ausführen eines Verfahrens nach einem der Ansprüche 1 bis 6, wobei die Vorrichtung (10) mehr als zwei Werkzeuggruppen (11 bis 13) aufweist, die relativ zueinander beweglich angeordnet sind, und die mittels eines Stellantriebs (40) linear entlang mindestens zwei Raumachsen (X, Y, Z) und/oder schwenkend um mindestens zwei Raumachsen (X, Y, Z) bewegt werden können, wobei die Werkzeuggruppen (11 bis 13) jeweils zwei Werkzeugelemente (16, 17, 31, 32) umfassen, die gegeneinander und gegen einen Querschnittsteil eines metallenen Hohlprofilelements mit mehreren Kammern (25) bewegt werden können, wobei die Werkzeugelemente (16, 17, 31, 32) einer Werkzeuggruppe (11 bis 13) in der Lage sind, einen Querschnittsteil des metallenen Hohlprofilelements mit mehreren Kammern (25) auf einer gegebenen Länge kraftbasiert zu halten, und wobei zwischen den Werkzeuggruppen (11 bis 13) ein Abstand bereitgestellt ist, in dem das metallene Hohlprofilelement mit mehreren Kammern (25) mit dem zu formenden Abschnitt (42, 43) ohne direkten Kontakt mit den Werkzeuggruppen (11 bis 13) geformt werden kann.
8. Vorrichtung nach Anspruch 7, **dadurch gekennzeichnet, dass** mindestens eine Werkzeuggruppe (11) konzipiert ist, um das Profilelement mit mehreren Kammern (25) innerhalb der Werkzeuggruppe (11) zu formen.

Revendications

1. Procédé de fabrication d'un profil métallique creux mis en forme (1) qui est incurvé dans trois axes (X, Y, Z), dans lequel un élément de profil métallique creux avec de multiples chambres (25) est mis en forme au moyen d'au moins deux éléments d'outil (16, 17, 31, 32) d'un groupe d'outils (11 à 13) qui maintiennent une partie en coupe transversale de l'élément de profil métallique creux (25), sur une longueur donnée dudit élément de profil métallique creux (25), **caractérisé en ce que** plus de deux groupes d'outils (11 à 13) comprenant chacun deux éléments d'outil (16, 17, 31, 32) qui sont espacés l'un de l'autre sont prévus, **en ce que** chacun des groupes d'outils (11 à 13) est fixé à l'élément de profil métallique creux avec de multiples chambres (25) au moins dans des régions d'une manière basée sur la force, dans lequel une région (42, 43) de l'élément de profil métallique creux avec de multiples chambres (25) à mettre en forme est agencée librement entre les groupes d'outils (11 à 13), et **en ce que**, en déplaçant les groupes d'outils (11 à 13) le long d'au moins deux axes spatiaux (X, Y, Z) linéairement et/ou de manière rotative autour d'au moins deux axes spatiaux (X, Y, Z), l'élément de profil métallique creux avec de multiples chambres (25) dans la région agencée librement (42, 43) située entre les groupes d'outils (11 à 13) est au moins partiellement mis en forme.
2. Procédé selon la revendication 1, **caractérisé en ce que** l'espacement entre les groupes d'outils (11 à 13) au cours de la mise en forme de l'élément de profil métallique creux avec de multiples chambres (25) est changé de telle manière que l'élément de profil métallique creux avec de multiples chambres (25) entre les groupes d'outils (11 à 13) soit étiré ou compressé ou que la position d'une fibre neutre soit changée.
3. Procédé selon la revendication 1 ou 2, **caractérisé en ce que** au cours d'une mise en forme de l'élément de profil métallique creux avec de multiples chambres (25) dans de multiples axes spatiaux (X, Y, Z), les groupes d'outils (11 à 13) sont déplacés l'un après l'autre.
4. Procédé selon la revendication 1 ou 2, **caractérisé en ce que** pour la mise en forme de l'élément de profil métallique creux avec de multiples chambres (25) dans de multiples axes spatiaux (X, Y, Z), les groupes d'outils (11 à 13) sont déplacés simultanément au moins par intermittence.
5. Procédé selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** avant le déplacement des groupes d'outils (11 à 13) l'un vers l'autre, l'élément de profil métallique creux avec de multiples chambres (25) est en outre mis en forme à l'intérieur d'un groupe d'outils (11) avec des éléments d'outil façonnés, en particulier pour la mise en forme d'une courbure.
6. Procédé selon l'une quelconque des revendications 1 à 5, **caractérisé en ce que** ledit élément de profil métallique creux avec de multiples chambres (25) est un profil extrudé, de préférence constitué d'un alliage d'aluminium.
7. Dispositif (10) pour réaliser un procédé selon l'une quelconque des revendications 1 à 6, dans lequel le dispositif (10) comporte plus de deux groupes d'outils (11 à 13) qui sont agencés de façon à pouvoir se déplacer l'un par rapport à l'autre, et qui peuvent se déplacer linéairement au moyen d'un mécanisme de réglage (40) le long d'au moins deux axes spatiaux (X, Y, Z) et/ou qui peuvent pivoter autour d'au moins deux axes spatiaux (X, Y, Z), dans lequel les groupes d'outils (11 à 13) comprennent chacun deux éléments d'outil (16, 17, 31, 32) qui peuvent se déplacer l'un contre l'autre et contre une partie en coupe transversale d'un élément de profil métallique creux avec de multiples chambres (25), lesdits éléments d'outil (16, 17, 31, 32) d'un groupe d'outils (11 à 13) sont capables de maintenir une partie en coupe transversale de l'élément de profil métallique creux avec de multiples chambres (25), sur une longueur donnée d'une manière basée sur la force, et dans lequel, entre les groupes d'outils (11 à 13), il est prévu un espacement dans lequel l'élément de profil métallique creux avec de multiples chambres (25) avec la section (42, 43) à mettre en forme peut être mis en forme sans contact direct avec les groupes d'outils (11 à 13).
8. Dispositif selon la revendication 7, **caractérisée en ce que** au moins un groupe d'outils (11) est conçu pour mettre en forme l'élément de profil avec de multiples chambres (25) à l'intérieur du groupe d'outils (11).



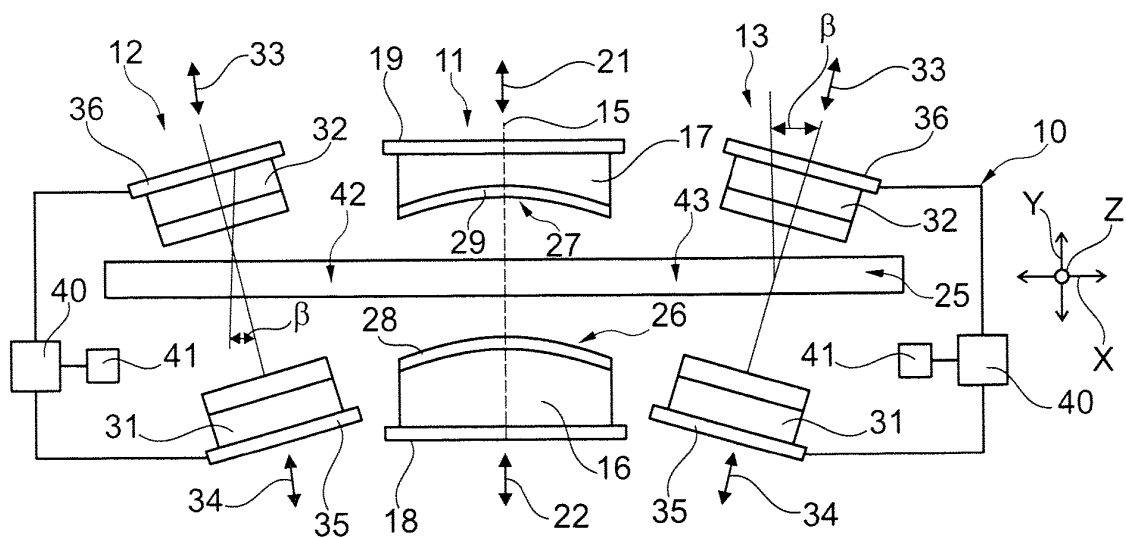


Fig. 4

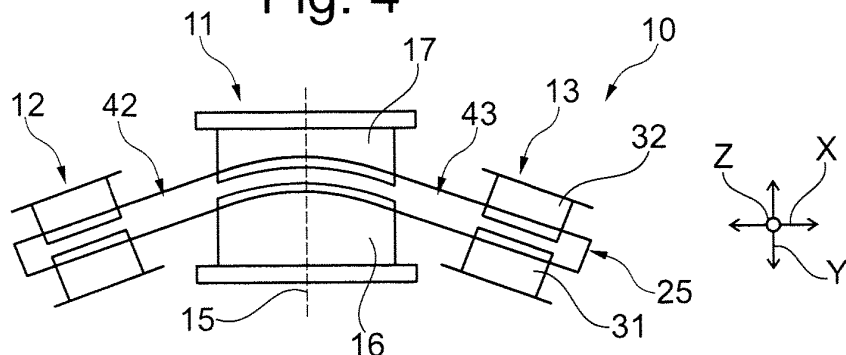


Fig. 5

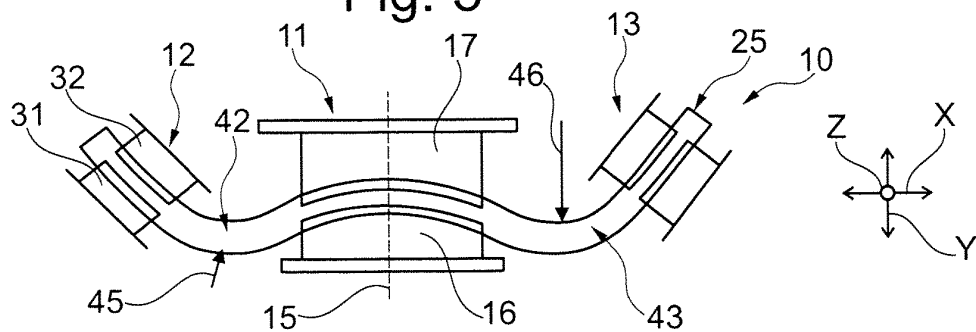


Fig. 6

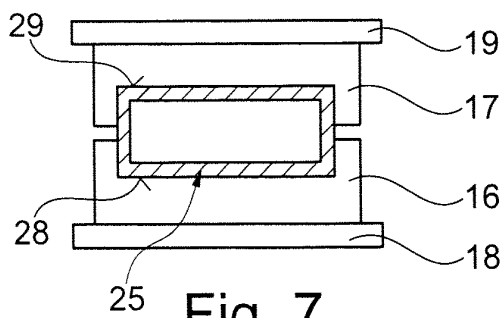


Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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