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(54) **Metal plate bending assembly and method**

Einrichtung und Verfahren zum Biegen eines Bleches

Dispositif et méthode de pliage d'une tôle

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## Description

**[0001]** The present invention relates to a metal plate bending method according to the preamble of claim 9 and to a bending assembly according to the preamble of claim 1.

**[0002]** US-A-4 043 165 discloses a bending assembly and a bending method according to the preamble of claim 1 and claim 9 respectively, except the features that the rotation axis of the bending tool is essentially coinciding with a common segment between the region to be bent and an adjacent region which cooperates on both sides with an edge of said bending tool and with an edge of said reference tool.

**[0003]** In the metal plate machining sector, bending of metal plate according to a predetermined angle is known, i.e. comprising a first and a second reciprocally bent portions at a respective common end edge and reciprocally forming aforesaid angle.

**[0004]** In order to bend metal plates back on themselves, a first bending operation is performed in which the first portion is partially bent on the second portion, defining the aforesaid end edge, and a second beating operation of the first portion, adapted to overlap the first and the second portion themselves so as to define the predetermined deformation angle.

**[0005]** It is known in the sector to perform the first operation using bending machines essentially comprising a pair of constraint devices reciprocally defining a crossing compartment of the metal plate and an open configuration, in which they allow the advancement of metal plate through the aforesaid compartment, and a closed configuration, in which they clamp the metal plate so that it overhangingly protrudes with respect to the constraint devices themselves; in particular, one of the regions protruding laterally from the compartment defined by the constraint devices is maintained in fixed position during the bending operation, while the other region is subjected to bending.

**[0006]** More in detail, the constraint devices comprise respective acute angle inclined peripheral surfaces with respect to a laying plane of the non-deformed metal plate.

**[0007]** The bending assemblies also comprise, on both sides of the compartment, a pair of tools arranged on opposite sides of the metal plate and presenting respective edges cooperating with respective opposite sides of the metal plate.

**[0008]** More in detail, the tools are arranged in two different configurations, in each of which a region of the metal plate to be bent cooperates, on one side only, with the edge of a tool acting as bender, while an adjacent region of the metal plate cooperates, on both its sides, with the edge of the other tool acting as reference and with the respective walls of the constraint devices.

**[0009]** More precisely, in each of the aforesaid configurations, the edges are parallelly arranged in a direction of advancement and reciprocally staggered.

**[0010]** In particular, the edge of the tool acting as bend-

er is advanced with respect to the edge of the reference tool with respect to the aforesaid direction of advancement.

**[0011]** The tool acting a bender, therefore, in both said configurations, may be rotationally carried about an axis essentially coinciding with a common segment between the aforesaid regions so that the respective edge bends the region to be bent against the tool acting as reference.

**[0012]** The bending assemblies of the type described above are particularly versatile because according to the tool acting as bender, the region to be bent of the metal plate may be bent with respect to the remaining region towards both opposite sides of the laying plane of the non-deformed metal plate.

**[0013]** Indeed, to bend the region of the metal plate towards one or the other of its sides, it is sufficient to arrange the tools in one of the respective aforesaid configurations and to move the tool acting as bender with respect to the other tool acting as reference.

**[0014]** After bending, the tool acting as bender previously turned is moved away from the deformed metal plate, the constraint devices are taken to open configuration and the bent metal plate is extracted and sent to the next operation.

**[0015]** The bending assemblies of the type described above present the following drawbacks.

**[0016]** In order to reduce costs and time required to complete manufacturing of the bent metal plate, it is felt in the sector the need to perform most of the deformation angle by means of the bending assembly, and therefore, to minimise the acute angle comprised between the laying plane of the non-deformed metal plate and the common contact surface between the peripheral surface of each constraint device and the tool acting as reference.

**[0017]** The reduction of such angle is disadvantageous because it increases the bending stress acting on each tool following the presence of forces deriving from the bending directed orthogonally to the non-deformed metal plate plane.

**[0018]** If the bending tool is arranged underneath the metal plate, its own weight determines a further increase of said bending stress.

**[0019]** The tools and constraint devices are also either connected together by levers fitted on bearings to allow correct reciprocal actuation, or if the length of the machine is not excessive, the levers are replaced by two bearings on the ends.

**[0020]** Such connections present inevitable play, which in time varies due to wear.

**[0021]** Due to the presence and variability of such play, the edge of the tool acting as reference and the walls of the constraint device clamping the metal plate are not maintained parallel, causing inevitable errors in the region to be bent of the metal plate itself.

**[0022]** It results that the bending angle existing between the first and the second portion of the metal plate is not maximised and especially not obtainable with repeatable precision constant in time.

**[0023]** It is the object of the present invention to create a metal plate bending assembly, which allows to simply and cost-effectively solve the drawbacks related to the bending assemblies of the known type specified above.

**[0024]** The aforesaid object is achieved by the bending assembly of claim 1 and by the metal plate bending method of claim 9.

**[0025]** For a better understanding of the present invention, embodiments will now be described only by way of non-limitative example, and with reference to the accompanying drawings, in which:

- figures 1 and 2 show a side view of an embodiment of the bending assembly according to the present invention to two different operating modes;
- figures 3 and 4 show a cross-sectional view of the bending assembly shown respectively in figure 1 and 2; and
- figures 5 and 6 show a cross-sectional view of a further embodiment of the bending assembly in figure 3 and 4.

**[0026]** With reference to figures from 1 to 4, number 1 indicates a metal plate 2 bending assembly adapted to bend an end portion 3 of the metal plate 2 with respect to a main portion 4 according to a predetermined bending angle.

**[0027]** In greater detail, non-deformed metal plate 2 presents a laying plane P; after deformation, the main portion 4 still lays on plane P while the end portion 3 is bent with respect to plane P according to said bending angle.

**[0028]** Assembly 1 essentially comprises a pair of constraint devices 5, 6 adapted to maintain metal plate 2 in a predetermined position, and first and second bending tool 8, 9 arranged on opposite sides with respect to plane P and each comprising a respective portion 10, 11 adapted to cooperate with a respective device 5, 6 and a respective edge 14a, 14b adapted to cooperate with opposite sides 15a, 15b of the end portion 3 during a bending operation.

**[0029]** Constraint devices 5, 6 (only partially shown in the attached figures) are arranged on opposite sides of the plane P and reciprocally define an advancement plane 17 of the metal plate 2, which presents an open end to allow feeding of the metal plate 2.

**[0030]** The constraint devices 5, 6 can move along a direction orthogonal to plane P between a first position, in which the metal plate 2 is clamped in a certain position, and a second position, in which metal plate 2 is free to advance parallelly to plane P according to direction A.

**[0031]** More precisely, constraint devices 5, 6 comprise respective first surfaces 15, which at the first position, on side opposite to the open end of compartment 17, cooperate with respective opposite side bands of metal plate 2 so as to clamp the metal plate 2 in the predetermined position; otherwise, the first surfaces 15, at the second position, are distanced so as to allow the

advancement of the metal plate 2 itself.

**[0032]** In particular, constraint device 6 is fixed while constraint device 5 is moveable so as to reciprocally move with alternating translational motion along a direction parallel to plane P.

**[0033]** Constraint devices 5, 6 also comprise respective flat walls 16 adapted to each cooperate with portions 10, 11 of respective tool 8, 9.

**[0034]** In particular, surfaces 15 are arranged parallelly with respect to a laying plane P of the non-deformed metal plate while walls 16 are inclined with respect to plane P.

**[0035]** Each tool 8, 9 comprises a respective portion 12, 13 arranged on the opposite side of the respective portion 10, 11 and extends parallelly to it.

**[0036]** Portions 10 and 12 are joined by edge 14a while portions 11 and 13 are joined by edge 14b.

**[0037]** Tools 8, 9 are available in two configurations (figures 1 and 3; and figures 2 and 4), at each of which one of the tools 8, 9 acts as bender, bending portion 3 on the other tool 8, 9, which acts as reference.

**[0038]** More precisely, edge 14a, 14b of tool 8, 9 acting as bender and edge 14b, 14a of tool 9, 8 acting as reference are arranged reciprocally parallelly and staggered with respect to a direction of advancement A of the metal plate 3 itself before bending of portion 3.

**[0039]** In particular, edge 14a, 14b of tool 8, 9 acting as bender is advanced along direction A with respect to edge 14b, 14a of tool 9, 8 acting as reference.

**[0040]** Portions 10 with 12 and 11 with 13 are arranged parallelly to wall 16 of constraint devices 5, 6 while edges 14a, 14b and regions 15a, 15b are arranged parallelly to plane P.

**[0041]** With reference to the configuration shown in figures 1 and 3, tool 9 acts as bender and tool 8 acts as reference.

**[0042]** More precisely, portion 3 of metal plate 2 cooperates, on one only side, with edge 14b of tool 9 acting as bender, while a region adjacent to portion 3 cooperates, on both sides, with edge 14a of tool 8 acting as reference and with edge 14b of tool 9 acting as bender.

**[0043]** In this way, tool 9 acting as bender turns about an axis B orthogonal to plane P essentially coinciding with a segment common to portion 3 and to the adjacent region so that edge 14b bends portion 3 against tool 8 acting as reference.

**[0044]** With reference to the configuration shown in figures 2 and 4, tool 8 acts as bender and tool 9 acts as reference.

**[0045]** More precisely, portion 3 of metal plate 2 cooperates, on one only side, with edge 14a of tool 8 acting as bender while a region adjacent to portion 3 cooperates, on both of its sides, with edge 14b of tool 9 acting as reference and with edge 14a of tool 8 acting as bender.

**[0046]** In this way, tool 8 acting as bender turns about an axis B orthogonal to plane P essentially coinciding with a segment common to portion 3 and to the adjacent region so that edge 14a bends portion 3 against tool 9 acting as reference.

**[0047]** In both the aforesaid configurations, bending tool 8, 9 turns about axis B so as to distance itself from wall 16 of the respective device 5, 6 and so that the respective edge 14a, 14b bends portion 3 stopping at the required angle.

**[0048]** Tools 8, 9 and constraint devices 5, 6 are connected together in a way not shown by linkages and are supported by bearings.

**[0049]** If the length of the machine is short, the linkages may be replaced by two bearings at the ends.

**[0050]** Advantageously, assembly 1 comprises a connection assembly 20 (figures 3 and 4) of each tool 8, 9 to a respective constraint device 5, 6; the connection assembly 20 joins, at each of the aforesaid configurations, the tool acting as reference 9, 8 to the respective constraint device 6, 5 in a fixed way, and the tool acting as bender 8, 9 to the respective constraint device 5, 6 so that the bending tool 8, 9 itself can be moved to act on the end portion 3.

**[0051]** More in detail, connection assembly 20 comprises a pair of wedges 21, 22 (figures 3 and 4), each of which is fixed in a groove 23, 24 throughly engaged within the constraint device 5, 6 and partially protrudes from the respective constraint device 5, 6 itself so as to couple parallelly to direction A with respective tool 8, 9 when the latter acts as reference. More precisely, each wedge 21, 22 couples with a respective groove 25 throughly made in the respective tool 8, 9.

**[0052]** With reference to figures 3 and 4, each wedge 21, 22 is delimited, on opposite sides, by a flat surface 27 arranged orthogonally in use to plane P and by a flat surface 28 arranged in use inclined with respect to plane P and parallel to wall 16; each wedge 21, 22 is also delimited by a pair of surfaces 29, 30 extending between surfaces 27, 28. Alternatively, groove 23 may also be cylindrical.

**[0053]** In particular, each surface 29 extends parallelly to plane P, comprises a respective first segment 31 cooperating with a respective surface 32 delimiting the respective groove 23 and a respective second segment 33 protruding from the respective device 5, 6 and crosses respective tool 8, 9 when the latter acts as reference.

**[0054]** Each surface 30 comprises respective end segments 34, 35 parallel to plane P and a respective intermediate segment 36 orthogonal to plane P and joining segments 34, 35.

**[0055]** Each segment 34 is further distanced from plane P than the respective segment 36 so that wedge 21, 22 is not extractable either parallelly to plane P nor according to a direction opposite to the oriented direction A.

**[0056]** Each segment 34, 36 and a portion 38 of each segment 35 cooperate with a respective complementary shaped surface 37, which delimits groove 23 on opposite side of surface 32.

**[0057]** Residual portion 39 of each segment 35 protrudes from the respective element 5, 6 so as to be engagable by the respective tool 8, 9 when the latter acts

as reference.

**[0058]** Each groove 25 is delimited, on opposite sides, by a respective surface 40 orthogonal to the respective wall 10, 11 and by a respective surface 41, which comprises a parallel segment 42, when tool 8, 9 acts as reference, to plane P and a segment 43 orthogonal to the respective wall 10, 11.

**[0059]** Each segment 42 is adapted to cooperate with the respective portion 39 when the respective tools 8, 9 acts as reference and extends from the respective portion 12, 13 towards the respective portion 10, 11 to join with the respective segment 43.

**[0060]** In this way, when tools 8, 9 act as references and are accommodated within the respective groove 25 two triangular cavities 44 within grooves 25 are defined; in particular, each cavity 44 is delimited by respective wall 10, 11, by respective segment 42 and by respective portion 38, and is shaped so as to avoid that during distancing of each tool 8, 9 from the respective constraint device 5, 6, respective surface 41 knocks against the respective wedge 21, 22.

**[0061]** In particular, each segment 43 is completely contained within a respective circle C having as centre axis B and having radius equal to the distance between axis B and segment 42.

**[0062]** In use, metal plate 2 is advanced in compartment 17 according to direction A while devices 5, 6 are available in the second configuration.

**[0063]** Once metal plate 2 reaches its predetermined position, device 5 approaches constraint device 6 orthogonally with respect to plane P so that surfaces 15 clamp metal plate 2 on opposite side bands of metal plate 2 itself.

**[0064]** At this point, constraint devices 5, 6 are arranged in the first configuration and the end portion 3 protrudes from the opposite side of compartment 17 with respect to constraint devices 5, 6.

**[0065]** The end portion 3 may be bent towards constraint device 5 by arranging tools 8, 9 in the first configuration, at which tool 9 acts as bender and tool 8 acts as reference (figures 1 and 3).

**[0066]** Alternatively, (figures 2 and 4), the end portion may be bent towards constraint device 6 by arranging tools 8, 9 in the second configuration, at which tool 8 acts as bender and tool 9 acts as reference.

**[0067]** The operation of unit 1 is described with reference to the first configuration.

**[0068]** Tool 8 acting as reference is connected respectively to constraint device 5 by means of wedge 21, which is fastened within groove 23 of constraint device 5 itself and is engaged by groove 25 of tool 8 itself.

**[0069]** Segment 31 of surface 29 cooperates with surface 32 of groove 23 while segments 34, 35 and portion 38 of each segment 36 cooperate with surface 37 of groove 23.

**[0070]** Portion 39 of each segment surface 35 protrudes from the respective wedge 21 and is accommodated within groove 25 of the tool acting as reference.

**[0071]** At such first configuration, the end portion 3 cooperates only with edge 14b while the region adjacent to end portion 3 itself is clamped, on its opposite sides, between edges 14a, 14b.

**[0072]** Edge 14b is also advanced along direction A with respect to edge 14a.

**[0073]** Therefore, tool 9 is free to turn about axis B so that the respective edge 14b bends the end portion 3 by the required angle.

**[0074]** In particular, wedge 21 effectively maintains coplanar the resting surface of tool 8 acting as reference against edge 14a during the entire bending step by contrasting the force exerted by tool 9 acting as bender.

**[0075]** At this point, tool 9 acting as bender returns to home position and constraint device 5 with tool 8 is distanced from constraint device 6 so as to allow advancement of metal plate 2 along direction A.

**[0076]** Bending of the end portion 3 by tool 8 acting as bender and tool 9 acting as reference is entirely similar and is not described because not necessary for understanding the present invention.

**[0077]** With reference to figures 5 and 6, 1' as a whole shows the further embodiment of the bending assembly according to the present invention.

**[0078]** Assembly 1' is similar to assembly 1 and only the differences thereof will be described; corresponding or equivalent parts of assembly 1 and 1' will be indicated where possible by the same numbers.

**[0079]** In particular, segments 35' of surface 30' of each wedge 21', 22' present on a part opposite to segment 36, an end portion 50' slanted with respect to plane P by an angle  $\alpha$ .

**[0080]** For the purpose of cooperating perfectly with respective segment 35', each segment 42' of surface 41' delimiting groove 25 is inclined by a same angle  $\alpha$  with respect to plane P.

**[0081]** Preferably, angle  $\alpha$  is from zero to forty-five degrees.

**[0082]** The operation of assembly 1' is entirely identical to the operation of assembly 1 and therefore is not described.

**[0083]** From an examination of the features of assembly 1, 1' and of the method according to the present invention, the advantages that it allows to obtain are apparent.

**[0084]** In particular, assembly 1, 1' according to the invention allows to bend the end portion 3 with respect to main portion 4 on both sides of metal plate 2 making any bending angle with minimum joints with high repeatability.

**[0085]** Indeed, wedges 21, 22, 21', 22' allow to maintain in a predetermined position each constraint device 5, 6 and respective tool 8, 9 when the latter acts as reference and is pushed from end portion 3 folded towards respective wall 16.

**[0086]** At the same time, wedges 21, 22, 21', 22' allow distancing of each tool 8, 9 from the respective wall 16 to perform a bending operation.

**[0087]** In this way, it is possible to maintain, during the bending operation, constantly parallel the laying of edge 14a, 14b of tool 8, 9 acting as reference with surface 15 of the respective constraint device 5, 6.

**[0088]** Furthermore, it is possible to obtain high bending angles without over stressing tools 8, 9, because wedges 21, 21', 22, 22' transmit most of the stresses from tools 8, 9 arranged as references for respective constraint devices 5, 6.

**[0089]** It is apparent that changes and variations can be made to the assembly 1, 1' and to the method of the invention within the scope of protection of the claims.

## 15 Claims

1. A bending assembly (1, 1') of a metal plate (2) comprising;

- a first and a second clamping element (5, 6) arranged on opposite sides of said metal plate (2) to clamp it on its opposite sides;

- a first and a second tool (8, 9) arranged on opposite sides of said metal plate (2) and on a same side of said first and second clamping element (5, 6); said first and second tools (8, 9) comprising respective edges (14a, 14b) cooperating with respective opposite sides of said metal plate (2);

said first and second tool (8, 9) being available in two configurations, at each of which a region (3) to be bent of the metal plate (2) cooperates, on one only side, with said edge (14a; 14b) of one of said tools (8; 9) performing the function of bender while an adjacent region of said metal plate (2) cooperates, on both sides, with an edge (14a; 14b) of said bending tool (8) with the edge (14b; 14a) of the other of said tools (9; 8) performing the function of reference; said region adjacent to said metal plate (2) cooperating, on both said sides, with respective walls (15) of a respective constraint device (5; 6);

said bending tool (8; 9) being turnable, in both said configurations, about an axis (B) essentially coinciding with a common segment between said regions of said metal plate (2) so that the respective edge (14a; 14b) bends said region to be bent (3) against said reference tool (9, 8);

**characterised in that** it comprises connection means (20) of each said tool (8, 9) to a respective clamping element (5, 6); said connection means (20) connecting, at each of said configurations, said reference tool (9; 8) and the respective clamping element (6, 5) in a fixed way, and said bending tool (8, 9) and the respective clamping element (5, 6) so that the bending tool (8; 9) can be actuated to act on said region to be bent (3).

2. A bending assembly (1, 1') according to claim 1, **characterised in that** said edge (14a; 14b) of said bending tool (8, 9) and said edge (14b; 14a) of said reference tool (9, 8) are parallel and reciprocally staggered before bending of said region (3) to be bent of said metal plate (2). 5
3. A bending assembly according to claim 2, **characterised in that** said edge (14a; 14b) of said bending tool (8, 9) is advanced with respect to said edge (14b; 14a) of said reference tool (9; 8) according to a direction (A) of advancement of said metal plate (2) before bending of said region (3) to be bent of said metal plate (2) 10
4. An assembly (1, 1') according to any one of the preceding claims, **characterised in that** said connection means (20) comprise a pair of wedges (21, 22, 21', 22'), each of which is inserted between a respective said tool (8, 9) and a respective clamping element (5; 6). 15
5. An assembly (1, 1') according to claim 4, **characterised in that** each wedge (21, 22, 21', 22') is inserted between the respective said tool (8; 9) and the respective clamping element (5, 6) parallelly to said direction (A). 20
6. A bending assembly according to claim 5, **characterised in that** each said wedge (21, 22, 21', 22') is accommodated in a respective groove (23, 24) of said clamping element (5, 6) so as to protrude from said respective seat (16) and to be couplable to the respective tool (8, 9). 25
7. A bending assembly according to claim 5 or 6, **characterised in that** each tool (8, 9) comprises a respective groove (25) adapted to be engaged by the respective wedge (21, 22, 21', 22'); said groove (25) being delimited by respective first surface (42, 42') adapted to cooperate with said wedge (21, 22, 21', 22') and slanted with respect to a laying plane (P) of said non-deformed metal plate (2) by an angle ( $\alpha$ ) from 0 to 45 degrees. 30
8. A bending assembly according to claim 7, **characterised in that** each groove (25) is further delimited by a respective second surface (43) adjacent to said first surface (42, 42') and comprised in a circle (C) having centre on an axis of rotation (B) of the respective tool (8, 9) and having radius equal to the distance between said first plane (P) and said relative first surface (42, 42'). 35
9. A metal plate (2) bending method comprising the steps of: 40
- clamping said metal plate (2) by means of a

first and second clamping element (5, 6) arranged on opposite sides of said metal plate (3);  
 - arranging a first and second tool (8, 9) on opposite sides of said metal plate (2) and on the same sides of said first and second clamping element (5; 6) so that the respective edges (14a; 14b) cooperate with respective opposite sides of said metal plate (2);  
 said first and second tool (8, 9) being available in two configurations, at each of which a region (3) to be bent of the metal plate (2) cooperates, on one only side, with said edge (14a) of one of said tools (8; 9) performing the function of bender while an adjacent region of said metal plate (2) cooperates, on both sides, with the edge (14a; 14b) of said bending tool (8) and with the edge (14a; 14b) of the other of said tools (8; 9) performing the function of reference; said adjacent region cooperating, in each of said configurations, on both said sides, with respective walls (15) of said constraint devices (5; 6)  
 - turning said bending tool (8; 9) about an axis (B) essentially coinciding with a common segment between said regions of said metal plate (2) so that the respective edge (14a; 14b) bends said region to be bent (3) against said reference tool (9, 8);

**characterised in that** it comprises the step of connecting each said tool (8; 9) to a respective clamping element (5, 6) so that at each of said configurations said reference tool (9; 8) and the respective clamping element (6; 5) are connected in fixed way and that said bending tool (8; 9) can be actuated to act on said region (3) to be bent. 35

#### Patentansprüche

1. Einrichtung (1, 1') zum Biegen eines Blechs (2), welche die folgenden Merkmale umfasst: 40

- ein erstes und ein zweites auf gegenüberliegenden Seiten des Blechs (2) angeordnetes Klemmelement (5, 6) zum Festklemmen des Blechs an den gegenüberliegenden Seiten;
- ein erstes und ein zweites auf gegenüberliegenden Seiten des Blechs (2) und auf der gleichen Seite des ersten bzw. des zweiten Klemmelements (5, 6) angeordnetes Werkzeug (8, 9), wobei das erste und das zweite Werkzeug (8, 9) jeweils jeweilige Kanten (14a, 14b) umfasst, die mit jeweiligen gegenüberliegenden Seiten des Blechs (2) kooperieren; 45

wobei das erste und das zweite Werkzeug (8, 9) jeweils in zwei Konfigurationen zur Verfügung stehen, bei denen jeweils eine zu biegende Zone (3) des

- Blechs (2) auf nur einer Seite mit der Kante (14a, 14b) von einem der Werkzeuge (8, 9) zum Durchführen der Funktion einer Biegevorrichtung kooperiert, während eine angrenzende Zone des Blechs (2) auf beiden Seiten mit einer Kante (14a, 14b) des Biegewerkzeugs (8) mit der Kante (14b, 14a) des anderen Werkzeugs (9, 8) kooperiert, um die Bezugsfunktion durchzuführen, während die an das Blech (2) angrenzende Zone auf beiden Seiten mit jeweiligen Wänden (15) einer jeweiligen Begrenzungsvorrichtung (5, 6) kooperiert; wobei das bei beiden Konfigurationen um eine Achse (B) drehbare Biegewerkzeug (8, 9), die im Wesentlichen mit einem gemeinsamen Segment zwischen den Zonen des Blechs (2) so zusammentrifft, dass die jeweilige Kante (14a, 14b) die zu biegende Zone (3) gegen das Bezugswerkzeug (9, 8) biegt; **dadurch gekennzeichnet, dass** sie eine Verbindungsvorrichtung (20) des jeweiligen Werkzeugs (8, 9) mit einem jeweiligen Klemmelement (5, 6) umfasst, wobei die Verbindungsvorrichtung (20) bei jeder der Konfigurationen das Bezugswerkzeug (9, 8) und das jeweilige Klemmelement (6, 5) auf feste Weise und das Biegewerkzeug (8, 9) und das jeweilige Klemmelement (5, 6) so miteinander verbindet, dass das Biegewerkzeug (8, 9) zum Einwirken auf die zu biegende Zone (3) betätigt werden kann.
2. Einrichtung zum Biegen (1, 1') gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die Kante (14a, 14b) des Biegewerkzeugs (8, 9) und die Kante (14b, 14a) des Bezugswerkzeugs (9, 8) parallel und vor dem Biegen der zu biegenden Zone (3) des Blechs (2) gegenseitig versetzt sind.
3. Einrichtung zum Biegen gemäß Anspruch 2, **dadurch gekennzeichnet, dass** die Kante (14a, 14b) des Biegewerkzeugs (8, 9) bezüglich der Kante (14b, 14a) des Bezugswerkzeugs (9, 8) in Entsprechung mit einer Vorschubrichtung (A) des Blechs (2) vor dem Biegen der zu biegenden Zone (3) des Blechs (2) vorgeschoben ist.
4. Einrichtung (1, 1') nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Verbindungsvorrichtungen (20) jeweils ein Paar Keile (21, 22, 21', 22') umfassen, die jeweils zwischen einem jeweiligen Werkzeug (8, 9) und einem jeweiligen Klemmelement (5, 6) eingefügt sind.
5. Einrichtung (1, 1') nach Anspruch 4, **dadurch gekennzeichnet, dass** jeder Keil (21, 22, 21', 22') parallel zu der Richtung (A) zwischen dem jeweiligen Werkzeug (8, 9) und dem jeweiligen Klemmelement (5, 6) eingefügt ist.
6. Einrichtung zum Biegen gemäß Anspruch 5, **dadurch gekennzeichnet, dass** jeder Keil (21, 22, 21', 22') in einer jeweiligen Nut (23, 24) des Klemmelements (5, 6) so angeordnet ist, dass er aus dem jeweiligen Sitz (16) hervorsticht und mit dem jeweiligen Werkzeug (8, 9) verbindbar ist.
7. Einrichtung zum Biegen gemäß Anspruch 5 oder 6, **dadurch gekennzeichnet, dass** jedes Werkzeug (8, 9) eine jeweilige Nut (25) umfasst, die für ein Einlocken durch den jeweiligen Keil (21, 22, 21', 22') ausgeführt ist, wobei die Nut (25) durch eine jeweilige erste Fläche (42, 42') begrenzt ist, die zum Kooperieren mit dem Keil (21, 22, 21', 22') ausgeführt und bezüglich einer Anlegeebene (P) des ungeformten Blechs (2) in einem Winkel ( $\alpha$ ) von 0 bis 45 Grad schräg angeordnet ist.
8. Einrichtung zum Biegen gemäß Anspruch 7, **dadurch gekennzeichnet, dass** jede Nut (25) ferner durch eine jeweilige zweite Fläche (43) begrenzt ist, die an die erste Fläche (42, 42') angrenzt und einen Kreis (C) umfasst, dessen Mittelpunkt auf einer Drehachse (B) des jeweiligen Werkzeugs (8, 9) liegt und dessen Radius dem Abstand zwischen der ersten Ebene (P) und der relativen ersten Fläche (42, 42') entspricht.
9. Verfahren zum Biegen eines Blechs (2), welches die folgenden Schritte umfasst:
- Festklemmen des Blechs (2) mittels eines ersten und eines zweiten, jeweils auf gegenüberliegenden Seiten des Blechs (3) angeordneten Klemmelements (5, 6);
  - Anordnen eines ersten und eines zweiten Werkzeugs (8, 9) auf gegenüberliegenden Seiten des Blechs (2) und auf der gleichen Seite des ersten und des zweiten Klemmelements (5, 6) in der Weise, dass die jeweiligen Kanten (14a, 14b) mit jeweiligen gegenüberliegenden Seiten des Blechs (Z) kooperieren;
- wobei das erste und das zweite Werkzeug (8, 9) in zwei Konfigurationen zur Verfügung stehen, bei denen jeweils eine zu biegende Zone (3) des Blechs (2) auf nur einer Seite mit der Kante (14a) von einem der Werkzeuge (8, 9) zum Durchführen der Funktion einer Biegevorrichtung kooperiert, während eine angrenzende Zone des Blechs (2) auf beiden Seiten mit der Kante (14a, 14b) des Biegewerkzeugs (8) und mit der Kante (14a, 14b) des anderen Werkzeugs (8, 9) zum Durchführen der Bezugsfunktion kooperiert, während die angrenzende Zone bei jeder der Konfigurationen auf beiden Seiten mit jeweiligen Wänden (15) der Begrenzungsvorrichtung (5, 6) kooperiert;

- Drehen des Biegewerkzeugs (8, 9) um eine Achse (B), die im Wesentlichen mit einem gemeinsamen Segment zwischen den Zonen des Blechs (2) so zusammentrifft, dass die jeweilige Kante (14a, 14b) die zu biegender Zone (3) gegen das Bezugswerkzeug (9, 8) biegt;

**dadurch gekennzeichnet, dass** es den Schritt eines Verbindens der einzelnen Werkzeuge (8, 9) mit einem jeweiligen Klemmelement (5, 6) in der Weise umfasst, dass bei jeder der Konfigurationen das Bezugswerkzeug (9, 8) und das jeweilige Klemmelement (6, 5) auf feste Weise miteinander verbunden sind und das Biegewerkzeug (8, 9) zum Einwirken auf die zu biegender Zone (3) betätigt werden kann.

### Revendications

1. Ensemble (1, 1') de pliage d'une plaque métallique (2) comprenant :

- des premier et second éléments (5, 6) de serrage agencés sur des côtés opposés de ladite plaque métallique (2) pour la serrer sur ses côtés opposés ;

- des premier et second outils (8, 9) agencés sur des côtés opposés de ladite plaque métallique (2) et sur le même côté desdits premier et second éléments (5, 6) de serrage ; lesdits premier et second outils (8, 9) comprenant des bords respectifs (14a, 14b) coopérant avec des côtés opposés respectifs de ladite plaque métallique (2) ;

lesdits premier et second outils (8, 9) étant disponibles en deux configurations, dans chacune desquelles une région (3) à plier de la plaque métallique (2) coopère, sur un seul côté, avec ledit bord (14a ; 14b) de l'un desdits outils (8 ; 9) assurant la fonction de plieuse tandis qu'une région adjacente de ladite plaque métallique (2) coopère, sur les deux côtés, avec un bord (14a ; 14b) dudit outil (8) de pliage, le bord (14b ; 14a) de l'autre desdits outils (9 ; 8) assurant la fonction de référence ; ladite région adjacente à ladite plaque métallique (2) coopérant, sur lesdits deux côtés, avec des parois respectives (15) d'un dispositif (5 ; 6) de contrainte respectif ;

ledit outil (8 ; 9) de pliage pouvant pivoter, dans lesdites deux configurations, autour d'un axe (B) coïncidant essentiellement avec un segment commun entre lesdites régions de ladite plaque métallique (2) de sorte que le bord respectif (14a ; 14b) plie ladite région à plier (3) contre ledit outil (8, 9) de référence ;

**caractérisé en ce qu'il** comprend un moyen (20) de mise en prise de chaque dit outil (8, 9) avec un

élément (5, 6) de serrage respectif ; ledit élément (20) de mise en prise mettant en prise de façon fixe, dans chacune desdites configurations, ledit outil (9 ; 8) de référence et l'élément (5, 6) de serrage respectif, et ledit outil (8, 9) de pliage et ledit élément (5, 6) de serrage respectif de sorte que l'outil (8 ; 9) de pliage peut être actionné pour agir sur ladite région à plier (3).

2. Ensemble (1, 1') de pliage selon la revendication 1, **caractérisé en ce que** ledit bord (14a ; 14b) dudit outil (8, 9) de pliage et ledit bord (14b ; 14a) dudit outil (9, 8) de référence sont parallèles et réciproquement étagés avant le pliage de ladite région (3) à plier de ladite plaque métallique (2).

3. Ensemble de pliage selon la revendication 2, **caractérisé en ce que** ledit bord (14a ; 14b) dudit outil (8, 9) de pliage avance par rapport audit bord (14b ; 14a) dudit outil (9 ; 8) de référence en fonction d'un sens (A) d'avance de ladite plaque métallique (2) avant le pliage de ladite région (3) à plier de ladite plaque métallique (2).

4. Ensemble (1, 1') selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit moyen (20) de mise en prise comprend une paire de coins (21, 22, 21', 22') dont chacun est introduit entre l'un, respectif, dudit outil (8, 9) et l'un, respectif, dudit élément (5, 6) de serrage.

5. Ensemble (1, 1') selon la revendication 4, **caractérisé en ce que** chaque coin (21, 22, 21', 22') est introduit entre ledit outil respectif (8 ; 9) et l'élément (5, 6) de serrage respectif parallèlement audit sens (A).

6. Ensemble de pliage selon la revendication 5, **caractérisé en ce que** chaque dit coin (21, 22, 21', 22') est reçu dans une rainure respective (23, 24) dudit élément (5, 6) de serrage de façon à venir en saillie dudit logement respectif (16) et à pouvoir être couplé avec ledit outil respectif (8, 9).

7. Ensemble de pliage selon la revendication 5 ou 6, **caractérisé en ce que** chaque outil (8, 9) comprend une rainure respective (25) adaptée pour engagement par le coin respectif (21, 22, 21', 22') ; ladite rainure (25) étant délimitée par une première surface respective (42, 42') adaptée pour coopérer avec ledit coin (21, 22, 21', 22') et étant inclinée, d'un angle ( $\alpha$ ) allant de 0 à 45 degrés, par rapport à un plan (P) de disposition de ladite plaque métallique non déformée (2).

8. Ensemble de pliage selon la revendication 7, **caractérisé en ce que** chaque rainure (25) est en outre délimitée par une seconde surface respective (43)

adjacente à ladite première surface (42, 42') et comprise dans un cercle (C) dont le centre se trouve sur un axe de rotation (B) de l'outil respectif (8, 9) et dont le rayon égale la distance qui sépare ledit premier plan (P) et ladite première surface relative (42, 42'). 5

9. Procédé de pliage d'une plaque métallique (2) comprenant les étapes, dans lesquelles :

- on serre ladite plaque métallique (2) à l'aide de premier et second éléments (5, 6) de serrage agencés sur des côtés opposés de ladite plaque métallique (2) ; 10

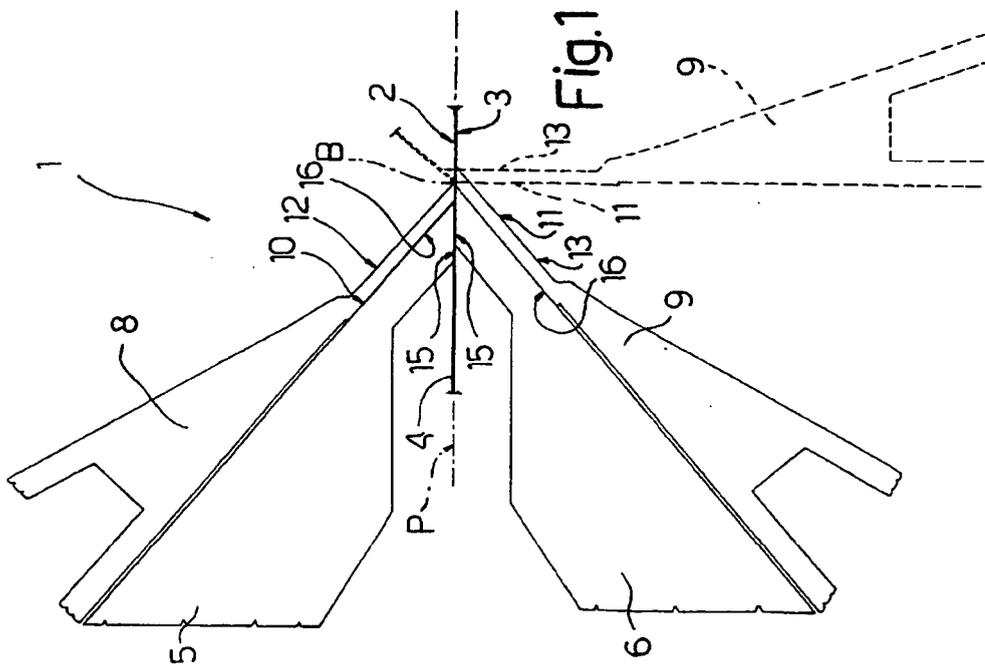
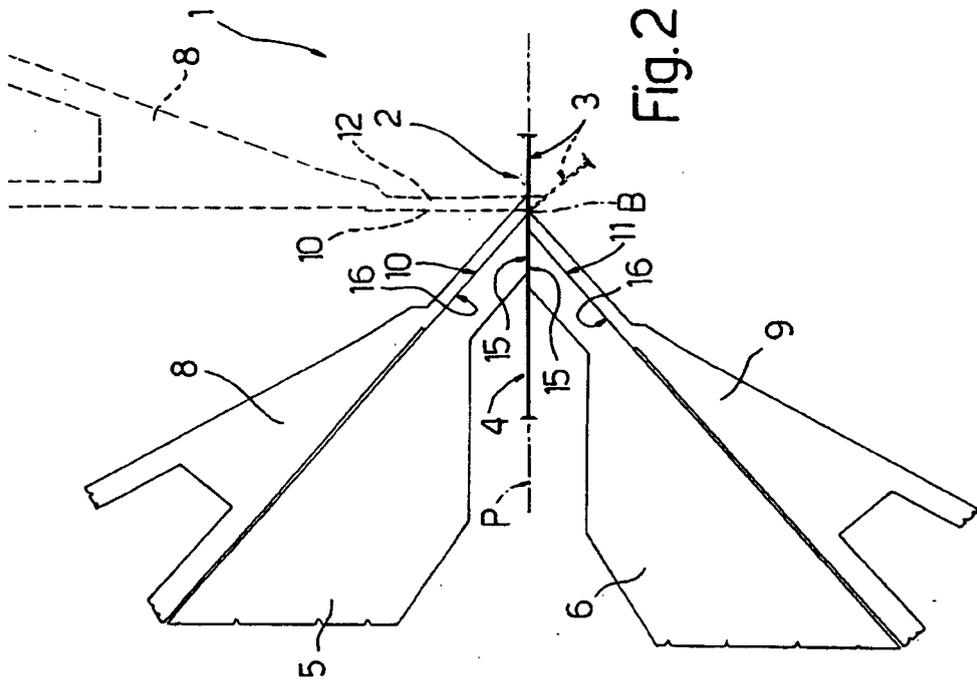
- on agence des premier et second outils (8, 9) sur des côtés opposés de ladite plaque métallique (2) et sur les mêmes côtés desdits premier et second éléments (5 ; 6) de serrage de sorte que les bords respectifs (14a ; 14b) coopèrent avec des côtés opposés respectifs de ladite plaque métallique (2) ; 15 20

lesdits premier et second outils (8, 9) étant disponibles en deux configurations, dans chacune desquelles une région (3) à plier de la plaque métallique (2) coopère, sur un seul côté, avec ledit bord (14a) de l'un desdits outils (8 ; 9) assurant la fonction de plieuse, tandis qu'une région adjacente de ladite plaque métallique (2) coopère, sur les deux côtés, avec le bord (14a ; 14b) dudit outil (8) de pliage et avec le bord (14a ; 14b) de l'autre desdits outils (8 ; 9) assurant la fonction de référence ; ladite région adjacente coopérant, dans chacune desdites configurations, sur lesdits deux côtés, avec des parois respectives (15) desdits dispositifs (5 ; 6) de contrainte ; 25 30 35

- on fait pivoter ledit outil (8 ; 9) de pliage autour d'un axe (B) coïncidant essentiellement avec un segment commun entre lesdites régions de ladite plaque métallique (2) de sorte que le bord respectif (14a ; 14b) plie ladite région à plier (3) contre ledit outil (9, 8) de référence ; 40

**caractérisé en ce qu'il** comprend l'étape de mise en prise de chaque dit outil (8 ; 9) avec un élément (5, 6) de serrage respectif de sorte que, dans chacune desdites configurations, ledit outil (9 ; 8) de référence et l'élément (6 ; 5) de serrage respectif sont mis en prise de façon fixe et que ledit outil (8 ; 9) de pliage peut être actionné pour agir sur ladite région (3) à plier. 45 50

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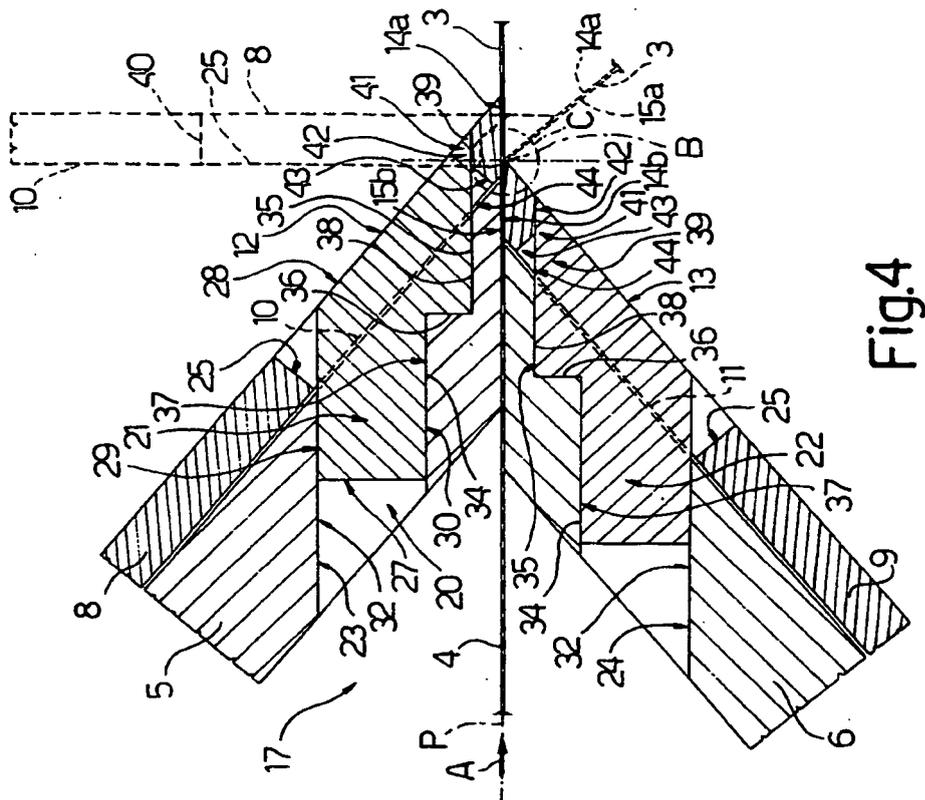


Fig.4

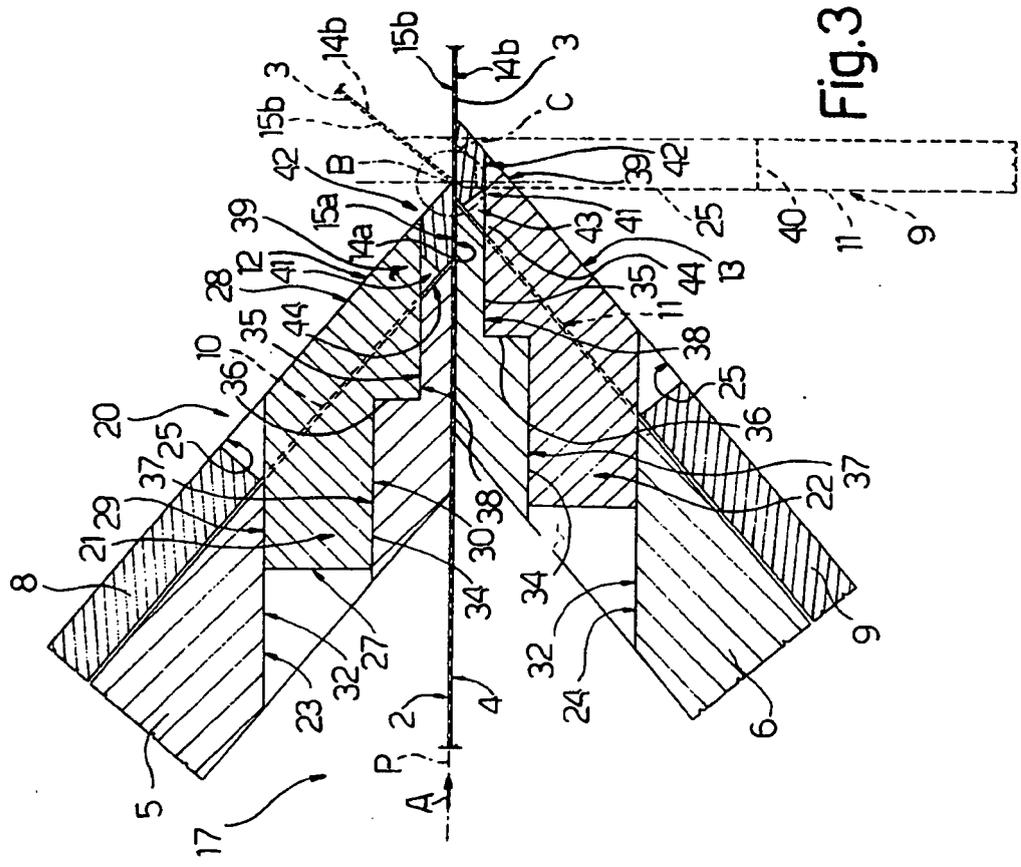


Fig.3



**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

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