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(54) Metal plate bending assembly and method

(57) A bending assembly (1,1') of a metal plate (2) comprising a pair of clamping elements (5,6) and a pair of tools (8,9) arranged on opposite sides of said metal plate (2); the tools (8,9) comprising respective edges (14a,14b) cooperating with opposite sides of the metal plate (2) and are 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 the edge (14a;14b) of a bending tool (8;9) while an adjacent region of the metal plate (2) cooperates, on both sides, with an edge (15) of a respective clamping element (5;6) and with the edge (14b;14a) of the other reference tool (9;8); the bending tool (8;9) is turnable about an axis (B), to bend the plate against the reference tool (9,8); the assembly (1,1') comprises connection means (20) to connect the reference tool (9;8) and the bending tool (8;9) to the respective clamping elements (6,5).

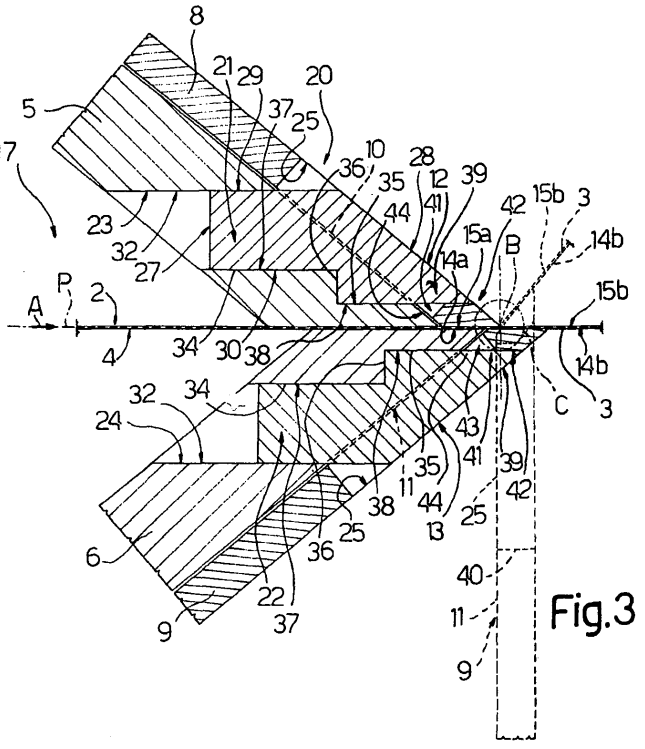

Fig.3

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Description

[0001] The present invention relates to a metal plate bending method.

[0002] 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.

[0003] 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.

[0004] 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.

[0005] 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.

[0006] 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.

[0007] 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.

[0008] More precisely, in each of the aforesaid configurations, the edges are parallelly arranged in a direction of advancement and reciprocally staggered.

[0009] In particular, the edge of the tool acting as bender is advanced with respect to the edge of the reference tool with respect to the aforesaid direction of advancement.

[0010] 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.

[0011] 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.

[0012] 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.

[0013] 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.

[0014] The bending assemblies of the type described above present the following drawbacks.

[0015] 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.

[0016] 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.

[0017] If the bending tool is arranged underneath the metal plate, its own weight determines a further increase of said bending stress.

[0018] 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.

[0019] Such connections present inevitable play, which in time varies due to wear.

[0020] 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.

[0021] 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.

[0022] 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.

[0023] The aforesaid object is reached by the present invention in that is relates to a metal plate bending assembly comprising:

- a first and a second clamping element arranged on opposite sides of said metal plate to clamp it on its

opposite sides;

- a first and a second tool arranged on opposite sides of said metal plate and on a same side of said first and second clamping element; said first and second tools comprising respective edges cooperating with respective opposite edges of said metal plate;

said first and second tool being available in two configurations, at each of which a region to be bent of the metal plate cooperates, on one only side, with said edge of one of said tools performing the function of bender while an adjacent region of said metal plate cooperates, on both sides, with the edge of said bending tool with the edge of the other of said tools performing the function of reference; said region adjacent to said metal plate cooperating, in each of said configurations, on both said sides, with respective walls of a respective constraint device;
said bending tool being turnable, in both said configurations, about an axis essentially coinciding with a common segment between said regions of said metal plate so that the respective edge bends said region to be bent against said reference tool;
characterised in that it comprises connection means of each said tool to a respective clamping element; said connection means connecting, at each of said configurations, said reference tool and the respective clamping element in a fixed way, and said bending tool and the respective clamping element so that said bending tool can be actuated to act on said region to be bent.

[0024] The present invention also relates to a bending method of a metal plate comprising the steps of:

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

characterised in that it comprises the step of connecting each said tool to a respective clamping element so that at each of said configurations said reference tool and the respective clamping element are connected in fixed way and that said bending tool can be actuated to act on said region to be bent.

[0025] For a better understanding of the present invention, a preferred embodiment 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 the bending assembly made 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 reciprocatingly 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 a bending assembly according to a different embodiment of 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 α.

[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 α with respect to plane P.

[0081] Preferably, angle α 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 without departing from the scope of protection of the claims.

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).

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)

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).

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).

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).

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 (α) from 0 to 45 degrees.

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').

9. A metal plate (2) bending method comprising the steps of:

- clamping said metal plate (2) by means of a first and second clamping element (5, 6) ar-

ranged 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.

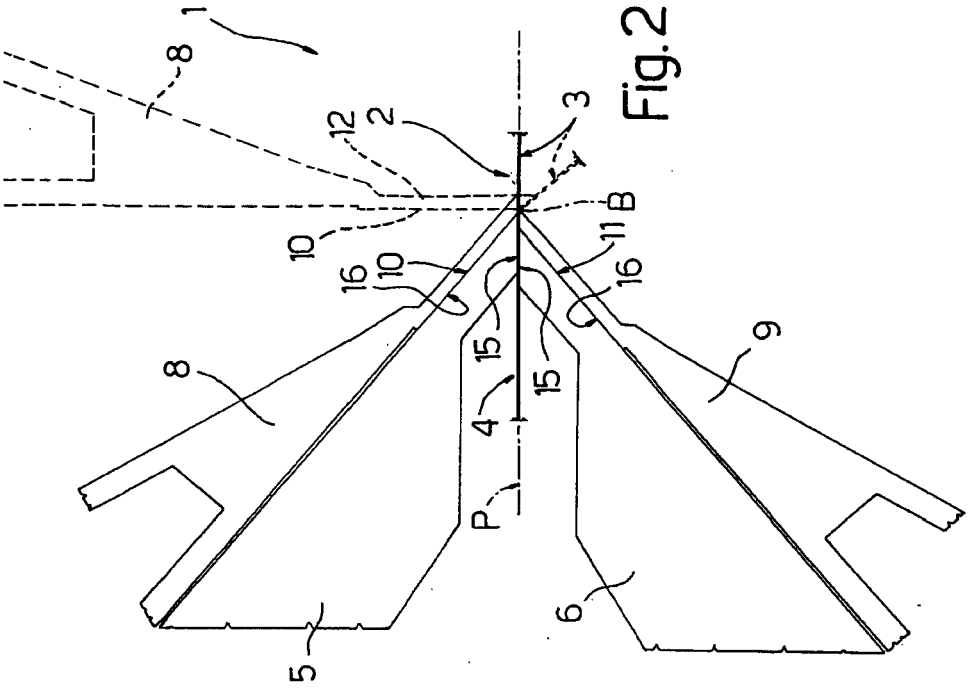
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Fig.2

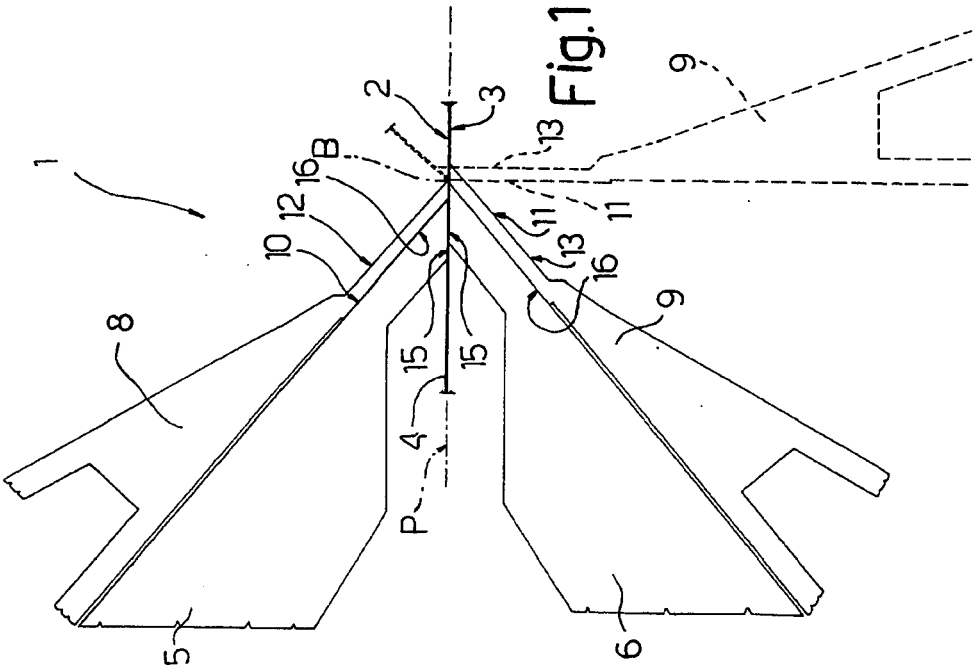
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Fig.1

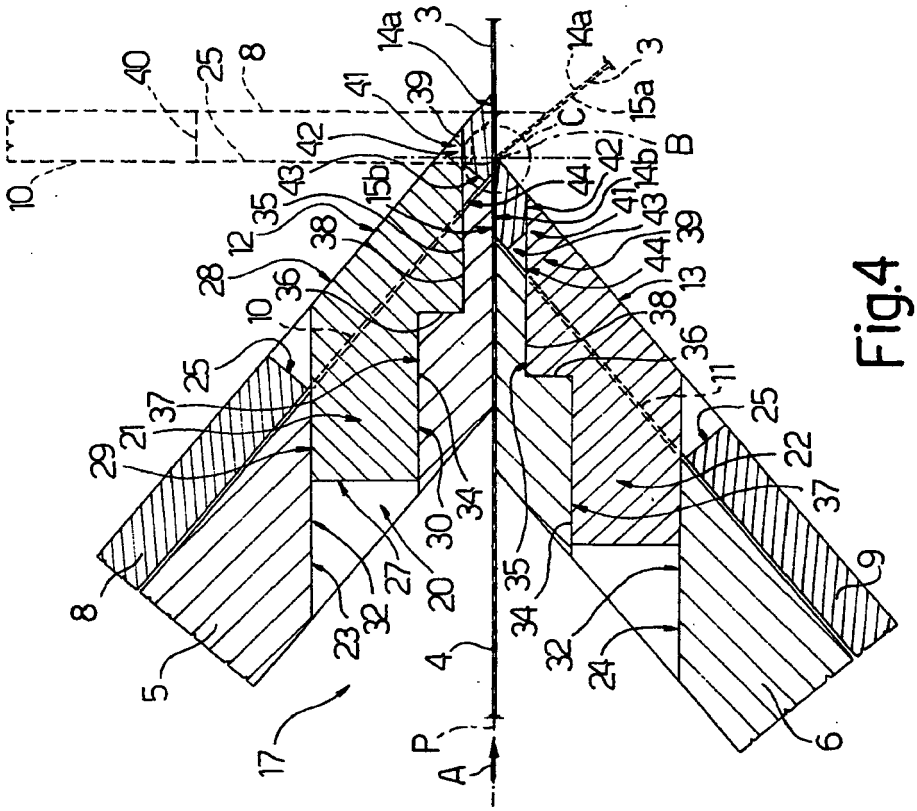

Fig.4

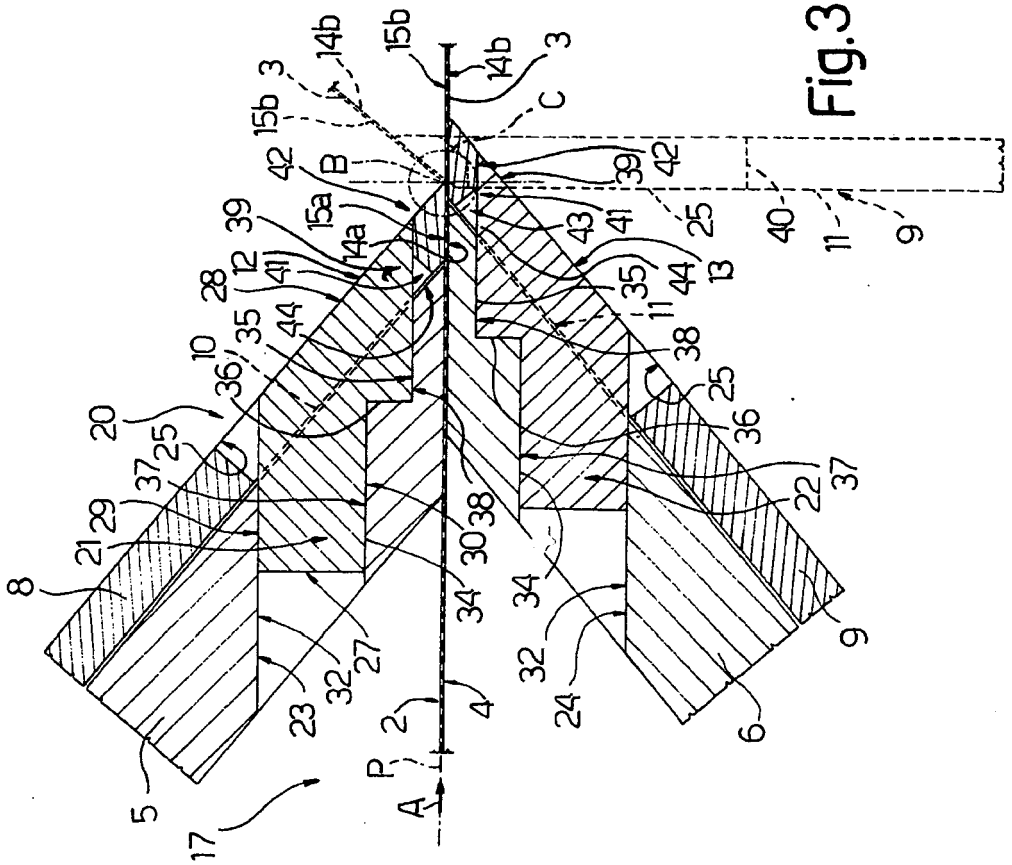

Fig.3

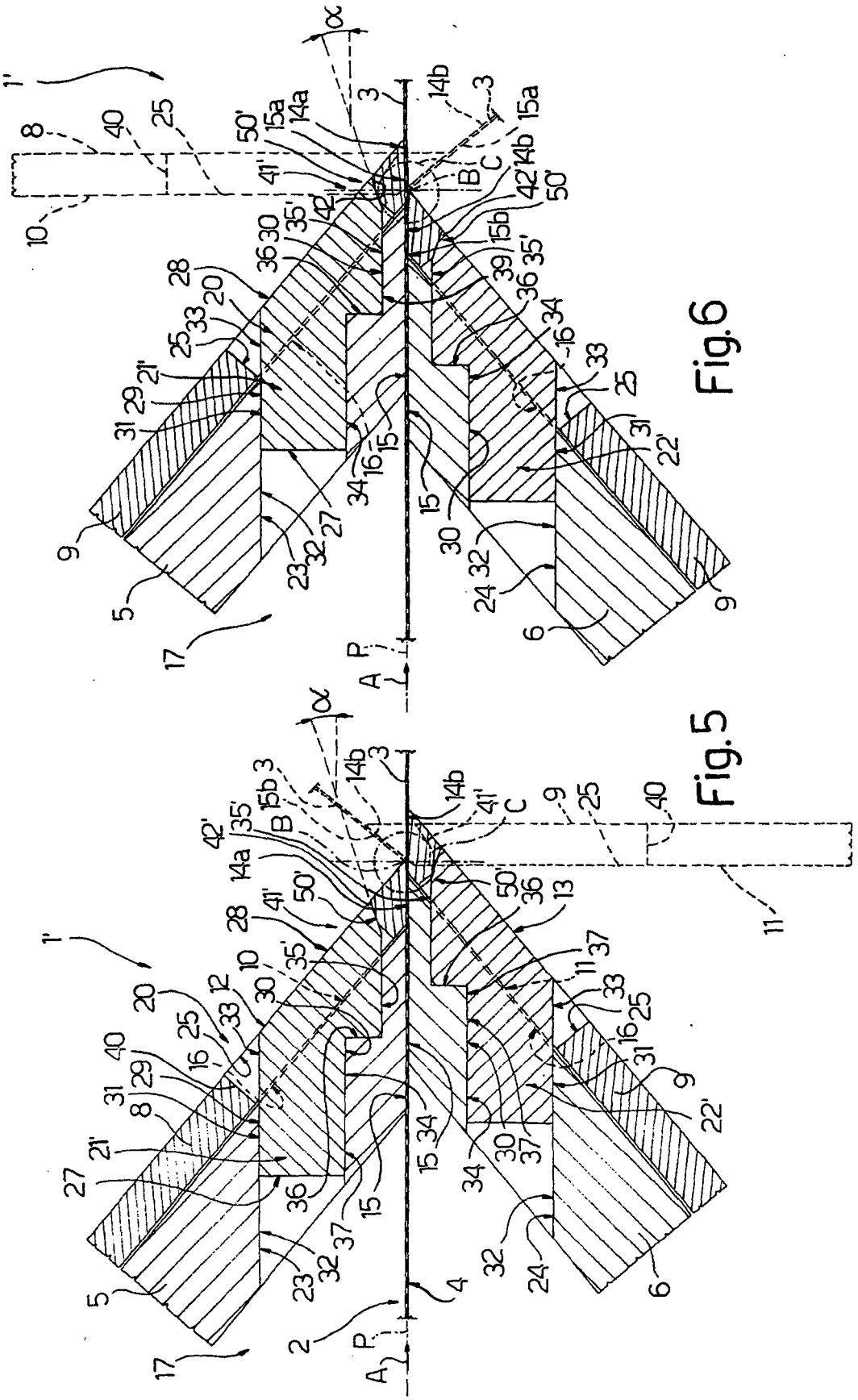

Fig.5

Fig.6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 42 5311

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 4 043 165 A (BADGER DOUGLAS V ET AL) 23 August 1977 (1977-08-23) * column 8, lines 23-29,57-68; figures 6a,6b *	1,9	INV. B21D5/04

TECHNICAL FIELDS SEARCHED (IPC)

B21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	13 October 2006	Knecht, Frank

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 42 5311

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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13-10-2006

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82