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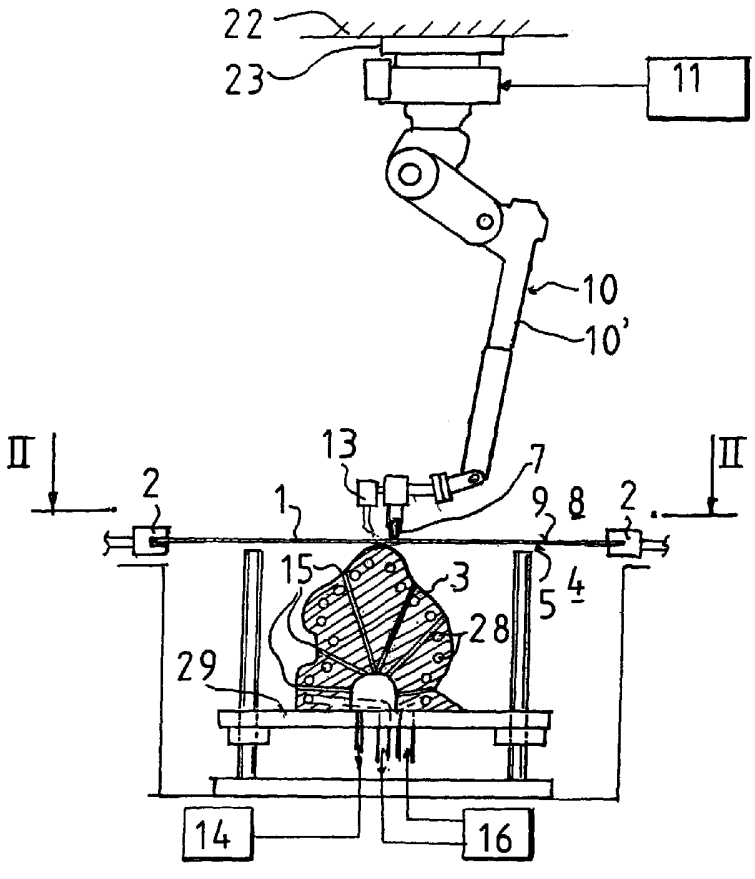
(54) Title: METHOD AND APPARATUS FOR FORMING THREE-DIMENSIONAL SHAPES IN A SHEET METAL



(57) Abstract: In the method and apparatus for forming three-dimensional shapes in a sheet metal (1), a counter support (3) is arranged, the sheet metal (1) is clamped in the vicinity of the counter support by its edge, and the counter support (3) and a first surface (5) of the sheet metal are contacted with one another using a first means of conveyance (6); a second means of conveyance (10) is used to press the pressing device (7) against a second surface (9) of the sheet metal, with surface is opposite with respect to the first surface, at a point which is disposed in the vicinity of the cnotact point between the counter support and the sheet metal; and the pressing device (7) is moved on the second surface of the sheet metal based on the desired shaped along a predetermined path of movement which is growing in respect of its radius around the contact point between the counter support and the sheet metal so that the pressing device presses the sheet metal with a stretching and bending forming force; and the counter support and/or sheet metal are moved with respect to one another as the forming goes on. The movement of the pressing device (7) is controlled by at least a five-axis principle.

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METHOD AND APPARATUS FOR FORMING THREE-DIMENSIONAL SHAPES IN A SHEET METAL

FIELD OF THE INVENTION

The invention relates to a method as defined in the preamble of claim 1. Further, the invention relates to an apparatus as defined in the preamble of claim 18.

BACKGROUND OF THE INVENTION

Generally, the invention relates to the so-called dieless forming of a sheet metal. A method and apparatus for dieless cold forming of a sheet metal are known in prior art e.g. from publication JP 07-132329 and EP 0 970 764 A1 (Amino Corp.) A sheet metal is herein used to mean a metallic sheet metal. A dieless forming is used to mean that the method and apparatus do not use two complementary dies defining the three-dimensional shape, of which one is a movable pressing device and the other one is a counter support against which the pressing device is moved, as is done in a conventional deep drawing method. Instead, the pressing device is a forming tool that forms in a point-form manner or in a small area, which tool is moved with respect to the sheet metal.

From the aforementioned publications, an apparatus is known that has a holding mechanism for clamping the sheet metal by its edge. A fixed counter support is arranged underneath the sheet metal and designed to be in contact with the lower surface of the sheet metal. An upright means of conveyance is arranged to move the holding mechanism in the vertical direction for moving the sheet metal with respect to the fixedly supported counter support. The apparatus further comprises a pressing device which is a bar

provided with a spherical point and which is arranged above the sheet metal for applying a stretching and bending force to the sheet metal on the upper surface thereof. The pressing device is connected to a three-axis portal robot which is able to move the pressing device and to press it against the top surface of the sheet metal with a forming force that stretches and bends the sheet metal. The control device of the apparatus is provided with program means for numerically controlling the movements of the upright means of conveyance and of the portal robot.

In the known method, the lower surface of the sheet metal is contacted with a fixed pressing device. Then the pressing device is used to apply pressure to the sheet metal in the vicinity of the contact point between the pressing device and the sheet metal, and the pressing device is moved based on the desired shape along a predetermined, e.g. a spiral path in the horizontal direction around the contact point between the pressing device and the sheet metal so that the pressing device moves on the top surface of the sheet metal, while at the same time pressing the sheet metal with a stretching and bending forming force.

The problem is that as the pressing device is connected to a three-axis portal robot, the pressing device only has three degrees of freedom, i.e. the possibilities of movement in the x, y and z directions, when the sheet metal is supported on the x-y plane; and the pressing device may therefore only move against the x-y plane in the perpendicular z direction in addition to the x and y directions. The forming force is thus always directed only downwards, and its direction cannot be changed. Therefore, a known device cannot be used to form in the sheet metal straight angles or inwards turning shapes (as shown in the accompanying figures 3, 6 and 8-10), instead one must use a release that is at least of the order of 15°-30°. This

fact imposes a significant limitation on the fact of what kind of three-dimensional shapes it is possible to form in the sheet metal by means of the apparatus.

One further problem is that to make deep shapes in the sheet metal, one must use in the forming a prolonged-arm pressing device, which results in bending and vibration of the arm, which cause measuring errors and crinkling of the sheet metal.

OBJECTIVE OF THE INVENTION

The objective of the invention is to eliminate the drawbacks referred to above.

One specific objective of the invention is to disclose a method and apparatus that enable inclining of the pressing device for applying the forming force to the sheet metal in a desired angle and for forming inwards turning shapes in the sheet metal.

One further objective is to disclose a method and apparatus that enable measuring errors as small as possible and a smooth forming imprint.

SUMMARY OF THE INVENTION

The method in accordance with the invention is characterised by what is presented in claim 1. Further, the apparatus in accordance with the invention is characterised by what is presented in claim 18.

According to the invention, in the method, the movement of the pressing device is controlled by at least a five-axis principle.

Correspondingly, in the apparatus in accordance with the invention, the second means of conveyance, which moves the pressing device, is at least a five-axis robot. The program means controlling the apparatus include instructions for controlling the robot

in such a manner that the pressing device has at least five degrees of freedom.

The invention has the advantage that the five-axis degrees of freedom of the pressing device enable inclining of the pressing device so that the forming force can be applied to the sheet metal in the desired direction, and it is possible to form in the sheet metal inwards turning shapes. The forming force can be applied perpendicularly towards the sheet metal. In addition, the pressing device arm can be short-arm and sturdy, which reduces the bending and vibration of the pressing device arm and results in a bigger forming accuracy, and there will be no non-desired crinkling of the sheet metal.

The other advantages and features of the invention are apparent from the dependant claims, as well as from the following description of preferred embodiments.

LIST OF FIGURES

In the following, the invention is described in detail with reference to the accompanying drawing, wherein

Fig. 1 is a schematic side view of a first embodiment of the apparatus in accordance with the invention in the initial phase of a forming method in accordance with the invention,

Fig. 2 represents section II-II of Fig. 1.

Fig. 3 represents the apparatus of Fig. 1 in another phase of the forming,

Fig. 4 represents a second embodiment of the apparatus in accordance with the invention,

Fig. 5 represents a third embodiment of the apparatus in accordance with the invention,

Fig. 6 represents a fourth embodiment of the apparatus in accordance with the invention,

Fig. 7 represents a fifth embodiment of the apparatus in accordance with the invention,

Fig. 8 schematically represents two different pressing devices of the apparatus in accordance with the invention in inclined positions, according to the invention, as they form a sheet metal at two points of a model being formed,

Figs. 9 and 10 represent a roller press in inclined positions, according to the invention, as they form a sheet metal,

Fig. 11 is a side view illustrating a roller press, and

Fig. 12 is schematic side view illustrating a counter support which consists of support elements locally supporting the sheet metal.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 shows an apparatus that can be used to form complicated three-dimensional shapes in a sheet metal 1. A rectangular sheet metal 1 is attached to position so as to be horizontal with a frame-like holding mechanism 2, which clamps the edge of the sheet metal along the whole periphery (see also Fig. 2).

Arranged in the lower part of the sheet metal 1 is a counter support 3. The counter support 3 is in this example a die 3 having a shape corresponding to the desired final three-dimensional shape of the sheet metal. Advantageously, the apparatus can include a cooling device 16 for cooling the die 3 during the forming, especially when the sheet metal is heated as the forming goes on. The die 3 that is illustrated in Fig. 1 as being cross-sectioned includes a schematic illustration of a cooling medium channel 28, via which the cooling device 16 circulates the cooling medium. In addition, the die 3 can be provided with suction

ducts 15, in which a vacuum device 14 creates a vacuum. The suction ducts 15 open on the outer surface of the die 3 for sucking the sheet metal tightly against the outer surface of the die 3. The apparatus includes a first means of conveyance 6, which is herein a hoisting device 6 which lifts the die in the vertical direction and by means of which the die is lifted upwards during the forming. The hoisting device 6 includes e.g. a horizontal support plate 29 to be moved in the vertical direction by means of a ball-race screw drive, on top of which plate the die 3 is attached. During the forming, the die 3 is in contact with the lower surface 5 of the sheet metal 1 and supports the sheet metal 3 during the forming.

Arranged in the upper part 8 of the sheet metal 1 is a means of conveyance 10, to which the pressing device 7 is connected for moving the pressing device and pressing against a second surface 9 with a forming force stretching and bending the sheet metal. The second means of conveyance 10 is an articulated arm robot 10´to be controlled by a six-axis principle, the robot being a so-called industrial robot. The base 23 of the robot 10´ is attached to a fixed frame 22. The base 23 is placed from the sheet metal 1 to be formed to such a distance that allows the articulated arm of the robot 10´ to be stretched as straight as possible during the forming process. This is advantageous because an articulated arm robot produces a pressing force as big as possible when kept as straight as possible.

The articulated arm robot 10´is controlled by a control device 11 which has a computer program for numerically controlling the movements of the means of conveyance and the second means of conveyance. The program contains predetermined instructions for controlling the robot 10´in such a manner that the pressing device 7 has at least five degrees of freedom, ad-

vantageously at least degrees of freedom, which are needed in order that the pressing device 7 can be inclined into a suitable angle at each point so that the forming force is directed substantially perpendicularly against the surface of the die 3, and thus against the thickness direction of the sheet metal 1. By suitably inclining the pressing device 7, it is possible to form shapes in the sheet metal, such as inwards turning shapes and straight angles, which were impossible to form using the previous pressing devices having three-axis degrees of freedom.

The apparatus can include a heating device 13 which is installed in the second means of conveyance 10´in the vicinity of the pressing device 7 for applying a local heating to the sheet metal 1. The heating device 13 can include means for applying hot air, combustion gas, radiation or the like to the sheet metal, or the heating device 13 can be an electrical heating element. The points to be heated can be determined based on a CAD model corresponding to the desired shape, as can be done with the path of movement of the robot 10 as well, so that heating is used just at points in which it is specifically needed.

The objective of the heating is to soften and plastify the material of the sheet metal to be formed to ease the forming. Soft metallic sheet metals, such as aluminium sheet metals, can be formed even without heating, but e.g. a steel sheet may need heating.

By means of the predetermined instructions defined in the control device 11 it is possible to get the hoisting device 6 and the articulated arm robot 10´to mutually cooperate during the forming. To begin with, the highest point of the die 2 and the lower surface 5 of the sheet metal are contacted with one another. Then the pressing device 7 is pressed against the upper surface 9 of the sheet metal at a point which is in the vicinity of the contact point between

the die and the sheet metal. The pressing device 7 is moved on the upper surface of the sheet metal 1 based on the desired shape along a predetermined path which is growing in respect of its radius, the path being illustrated by a dot-and-dash line 30 in Fig. 2, around the aforementioned contact point in such a manner that the pressing device presses the sheet metal with a stretching and bending force, which results in a permanent transformation of the sheet metal 1. The hoisting device 6 is used to lift the die 3 upwards as the forming goes on.

The instructions for controlling the path of movement of the pressing device 7 and the local heating are generated based on the CAD model that defines the desired three-dimensional shape. The program means of the control device 11 are arranged to generate, based on the CAD model, a first set of instructions for controlling the movement of the pressing device 7 by a five-axis principle, and then to determine, based on the CAD model, the additional information that is related to an additional degree of freedom and local heating, which cannot be controlled by the first set of instructions. Further, the program means are arranged to generate, based on the first set of instructions and the additional information, a second set of instructions which control the movement of the pressing device 7 by at least a six-axis principle, and in addition control the second heating device 13 to apply a local heating to the sheet metal at the necessary points.

Fig. 3 illustrates a situation in which the forming has reached a phase in which the pressing device 7, which is controlled in the aforementioned manner, has been used to form in the sheet metal 1 a shape corresponding to the die 3.

Fig. 4 represents an embodiment of the apparatus that differs from the embodiment of Fig. 1 in

that the articulated arm robot 10 that moves the pressing device is disposed next to the sheet metal 1 to be formed. In addition, the base 23 of the robot 10 is supported on guide elements 24, under whose control the robot 10 is wholly controlled so as to be movable in a direction parallel to the plane as shown in Fig. 4. An actuator 25 moves the robot 10 under the control of the guide elements 24.

Fig. 5 represents an embodiment in which as the second means of conveyance 10 that moves the pressing device, a six-axis pusher arm robot 10" is used, which is marketed with the trademark Tricept (SMT Tricept Ab, Sweden). A Tricept pusher arm robot enables one to achieve a sufficiently big pressing force that remains as constant as possible throughout the whole machining area.

Fig. 6 represents an embodiment of the apparatus in which the sheet metal 1 is supported with a holding mechanism 2 into an upright position. Instead of a die, a counter support 3 that supports the sheet metal 1 in a small area is used, which counter support is moved by a first means of conveyance 6, which is herein an articulated arm robot that works on the first side 4 of the sheet metal. The pressing device 7 is moved by a second means of conveyance 10, which also is an articulated arm robot. Both robots 6 and 10 are controlled by at least a five-axis principle, advantageously a six-axis principle, and synchronically in cooperation so that the counter support substantially follows the path of movement of the pressing device 7. One or both of the articulated arm robots 6 and 10 can be substituted by a Tricept pusher arm robot as shown in Fig. 5. The counter support 3 and the pressing device 7 are e.g. roller presses which are explained in more detail in the following with reference to Fig. 8.

Fig. 7 illustrates a schematic diagram from which it can be seen that the apparatus can also be applied to mass production, although dieless forming has been conventionally used for making individual articles and prototypes. The sheet metal 1 can be conveyed e.g. from a coil 26 along a horizontal path by means of some kind of conveyor 21, which conveys the sheet metal 1 to a forming station 27. If the sheet metal 1 is to be preheated, the apparatus may include e.g. an electrical heating device 12, which heats the sheet metal 1 on both sides thereof at least throughout the whole surface area to be formed.

The pressing device 7 as shown in the upper part in Fig. 8 includes a spherical fixed or rotating forming point 18. As can be seen from the pressing device 7 as shown in the upper part in the figure, the pressing device 7 can be a roller press, in which case it includes an arm part 19 which can be attached to the robot, and a forming roller 20 which is rotably mounted on the arm part using bearings. As can be seen from Fig. 11, in the roller press, the arm part 19 is advantageously mounted with bearings on the robot's arm so as to rotate freely. The rotation axis of the arm part 19 is disposed at a distance s aside from the rotation axis of the forming roller 20, thanks to which the rotation level of the roller automatically keeps to the direction of movement of the roller.

Figs. 8-10 show that by suitably inclining the pressing device 7, it is possible to form e.g. straight angles and inwards extending shapes, which were impossible to form using the previous apparatuses and methods of dieless forming.

Furthermore, Fig. 12 illustrates that instead of a die, it is possible to use as the counter support 3 several fixed support elements 17, each of which locally supports the sheet metal at different points of the desired three-dimensional shape.

The invention is not limited merely to examples of its embodiments, instead many variations are possible within the scope of the invention defined by the claims.

CLAIMS

1. A method for forming three-dimensional shapes in a sheet metal (1), which method comprises the steps of:

- arranging a counter support (3),
- clamping the sheet metal (1) by its edge in the vicinity of the counter support (3)
- contacting the counter support (3) and a first surface (5) of the sheet metal with one another,
- pressing a pressing device (7) against a second surface (9) of the sheet metal, which second surface is an opposite surface with respect to the first surface, at a point which is disposed in the vicinity of the contact point between the counter support and the sheet metal,
- moving the pressing device (7) on the second surface of the sheet metal based on the desired shape along a predetermined path which is growing in respect of its radius around the contact point between the counter support and the sheet metal in such a manner that the pressing device presses the sheet metal with a stretching and bending force, and
- moving the counter support and/or sheet metal with respect to one another as the forming goes on, characterised in that the movement of the pressing device (7) is controlled by at least a five-axis principle.

2. The method according to claim 1, characterised in that the pressing device (7) is moved by at least a five-axis robot (10) which is able to give the pressing device at least five degrees of freedom.

3. The method according to claim 1 or 2, characterised in that the pressing device (7) is moved by a six-axis robot (10) which is able to give the pressing device six degrees of freedom.

4. The method according to any one of claims 1-3, characterised in that the position of the pressing device (7) is adjusted so that the forming force is applied to the sheet metal (1) mainly perpendicularly with respect to the thickness direction of the sheet metal.

5. The method according to any one of claims 1-4, characterised in that substantially the whole sheet metal (1) is heated prior to forming.

6. The method according to any one of claims 1-5, characterised in that a local heating is applied to the sheet metal (1) in the vicinity of the pressing device (7) during the forming.

7. The method according to any one of claims 1-6, characterised in that a die having a shape corresponding to the desired three-dimensional shape of the sheet metal (1) is arranged as the counter support (3).

8. The method according to claim 7, characterised in that between the die (3) and the sheet metal (1), a vacuum is created for pressing the die against the first surface (5) of the sheet metal.

9. The method according to claim 7 or 8, characterised in that the die (3) is cooled during the forming.

10. The method according to any one of claims 1-9, characterised in that one or more support elements are arranged as the counter support (3) to locally support the sheet metal at one or more points.

11. The method according to any one of claims 1-10, characterised in that the sheet metal

(1) is clamped to be substantially horizontal, in which case the counter support (3) is underneath it and the pressing device is above it.

12. The method according to any one of claims 1-11, c h a r a c t e r i s e d in that the sheet metal (1) is clamped into a position differing from the horizontal one, e.g. so as to be substantially vertical.

13. The method according to any one of claims 1-12, c h a r a c t e r i s e d in that the counter support (3) is arranged to support the sheet metal (1) in a substantially small area, and the counter support (3) is moved synchronically with respect to the movement of the pressing device (7) so that the counter support substantially follows the path of movement of the pressing device.

14. The method according to claim 13, c h a r a c t e r i s e d in that the counter support (3) is moved by at least a three-axis robot (6) which is able to give the counter support at least three degrees of freedom.

15. The method according to claim 14, c h a r a c t e r i s e d in that the counter support (3) is moved by means of a robot (6) which is able to give the counter support at least the corresponding degrees of freedom as the pressing device has (7).

16. The method according to any one of claims 1-15, c h a r a c t e r i s e d in that the path of movement of the pressing device (7) and/or the counter support (3) is determined based on a CAD model that defines the three-dimensional shape.

17. The method according to any one of claims 1-16, c h a r a c t e r i s e d by the steps of:

- generating, based on the CAD model, a first set of instructions for controlling the movement of the pressing device (7) by a five-axis principle, and

- defining, based on the CAD model, additional information that is related to an additional degree of freedom and/or local heating, which cannot be controlled by means of the first set of instructions, and

- generating, based on the first set of instructions and the additional information, a second set of instructions which is used to control the movement of the pressing device (7) by at least a six-axis principle and/or to control the local heating.

18. An apparatus for forming three-dimensional shapes in a sheet metal (1), the apparatus comprising:

- a holding mechanism (2) for clamping the sheet metal by its edge,

- a counter support (3), which is arranged on a first side (4) of the sheet metal and designed to be in contact with a first surface (5) of the sheet metal,

- a first means of conveyance (6) for moving the sheet metal and/or the counter support with respect to one another,

- a pressing device (7), which is arranged on a second side (8) of the sheet metal for applying a stretching and bending force to the sheet metal on a second surface (9), which is opposite with respect to the first surface,

- a second means of conveyance (10), to which the pressing device (7) is attached for moving the pressing device and for pressing it against the second surface (9) of the sheet metal with a forming force that stretches and bends the sheet metal, and

- a control device (11) comprising means for numerically controlling the movements of the first means of conveyance and second means of conveyance, the means comprising predetermined instructions

-- for contacting the first surface of the sheet metal with the counter support,

-- for pressing the pressing device on the second side of the sheet metal against the second surface of the sheet metal at a point which is disposed in the vicinity of the contact point between the counter support and the sheet metal, and

-- for moving the pressing device based on the desired shape along a predetermined path of movement which is growing in respect of its radium around the contact point between the counter support and the sheet metal so that the pressing device moves on the second surface of the sheet metal, while at the same time pressing the sheet metal with a stretching and bending forming force, and

-- for moving the counter support and/or sheet metal with respect to one another as the forming goes on, characterised in that the second means of conveyance (10) is at least a five-axis robot, and that the program means comprise instructions for controlling the robot (10) so that the pressing device (7) has at least five degrees of freedom.

19. The apparatus according to claim 18, characterised in that the second means of conveyance (10) is a six-axis robot.

20. The apparatus according to claim 18 or 19, characterised in that the second means of conveyance (10) is an articulated arm robot (10´) or a pusher arm robot (10").

21. The apparatus according to any one of claims 18-20, characterised in that the first means of conveyance (6) is arranged to move the counter support (3) substantially perpendicularly with respect to the thickness direction of the sheet metal (1).

22. The apparatus according to any one of claims 18-21, characterised in that the ap-

paratus comprises a first heating device (12) for heating substantially the whole surface area to be formed.

23. The apparatus according to any one of claims 18-22, c h a r a c t e r i s e d in that the apparatus comprises a second heating device (13) which is installed on the second means of conveyance (10) in the vicinity of the pressing device (7) for applying a local heating to the sheet metal (1).

24. The apparatus according to any one claims 18-23, c h a r a c t e r i s e d in that the apparatus comprises a vacuum device (14) for creating a vacuum, and that the counter support (3) includes suction ducts (15) that are in connection with the vacuum device for creating a vacuum in the suction ducts, which suction ducts open on the outer surface of the counter support (3) for creating a vacuum between the counter support (3) and the sheet metal (1).

25. The apparatus according to any one of claims 18-24, c h a r a c t e r i s e d in that the apparatus includes a cooling device (16) for cooling the counter support (3) during the forming.

26. The apparatus according to any one of claims 18-25, c h a r a c t e r i s e d in that the counter support (3) is a die having a shape corresponding to the desired three-dimensional shape of the sheet metal.

27. The apparatus according to any one of claims 18-25, c h a r a c t e r i s e d in that the counter support (3) includes one or more fixed support elements (17), each of which locally supports the sheet metal at the different points of the desired three-dimensional shape.

28. The apparatus according to any of claims 18-27, c h a r a c t e r i s e d in that the first means of conveyance (6) is at least a three-axis robot

which is able to give the counter support (3) at least three degrees of freedom.

29. The apparatus according to claim 28, characterised in that the first means of conveyance (6) is a robot which is able to give the counter support (3) at least the same degrees of freedom as the second means of conveyance (10) gives to the pressing device (7).

30. The apparatus according to any one of claims 18-29, characterised in that the pressing device (7) and/or counter support (3) includes a spherical fixed or rotating forming point (18).

31. The apparatus according to any one of claims 18-30, characterised in that the pressing device (7) and/or counter support (3) includes an arm part (19) which can be attached to the robot, and a forming roller (20) which is rotatably mounted on the arm part.

32. The apparatus according to claim 31, characterised in that the arm part (19) is mounted with bearings on the arm part so as to rotate freely with respect to the robot, and that the rotation axis of the arm part (19) is spaced at a distance (s) from the rotation axis of the forming roller (20).

33. The apparatus according to claim 18-32, characterised in that the holding mechanism (2) is fitted to clamp the sheet metal (1) so that it is horizontal, that the counter support (3) is arranged underneath the sheet metal, and that the pressing device (7) is arranged above the sheet metal.

34. The apparatus according to any one of claims 18-33, characterised in that the apparatus includes a conveyor (21) for conveying the sheet metal (1) to the forming station.

35. The apparatus according to claim 34, characterised in that the apparatus in-

cludes a fixed frame (22), to which the base (23) of the robot that acts as the second means of conveyance (10) is fastened so that the base is disposed at a distance from the sheet metal (1) to be formed above it.

36. The apparatus according to claim 35, characterised in that the second means of conveyance (10) is an articulated arm robot whose base (23) is placed from the sheet metal to be formed to such a distance that allows the articulated arm of the robot to be stretched as straight as possible during the forming process.

37. The apparatus according to any one of claims 18-36, characterised in that the first means of conveyance (6) and the second means of conveyance (10) are both articulated arm robots that are arranged on the opposite sides of the sheet metal to synchronically cooperate.

38. The apparatus according to any one of claims 18-37, characterised in that the apparatus includes guide elements (24) under whose control the second means of conveyance (10) is wholly controlled to be movable, and an actuator (25) for moving the second means of conveyance in guidance of the guide elements.

39. The apparatus according to any one of claims 18-38, characterised in that the control device (11) is provided with program means for determining the path of movement of the pressing device (7) and/or the counter support (3) based on the CAD model that defines the desired three-dimensional shape.

40. The apparatus according to any one of claims 18-39, characterised in that the program means are arranged to generate, based on the CAD model, a first set of instructions for controlling the movement of the pressing device (7) by a five-

axis principle; to determine, based on the CAD model, additional information that is related to an additional degree of freedom and/or to local heating, which cannot be controlled by means of the first set of instructions; and to generate, based on the first set of instructions and the additional information, a second set of instructions which are fitted to be used to control the movement of the pressing device by at least a six-axis principle and/or to control the local heating.

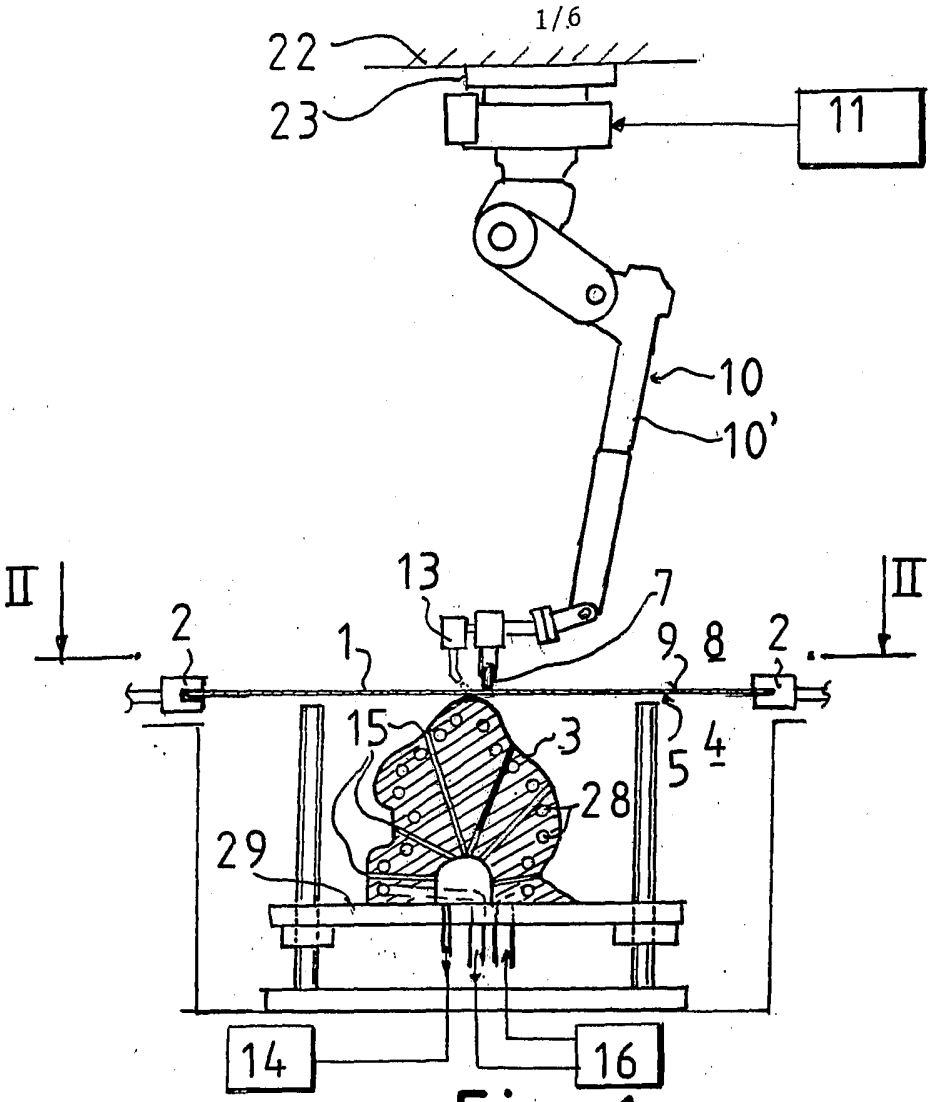


Fig 1

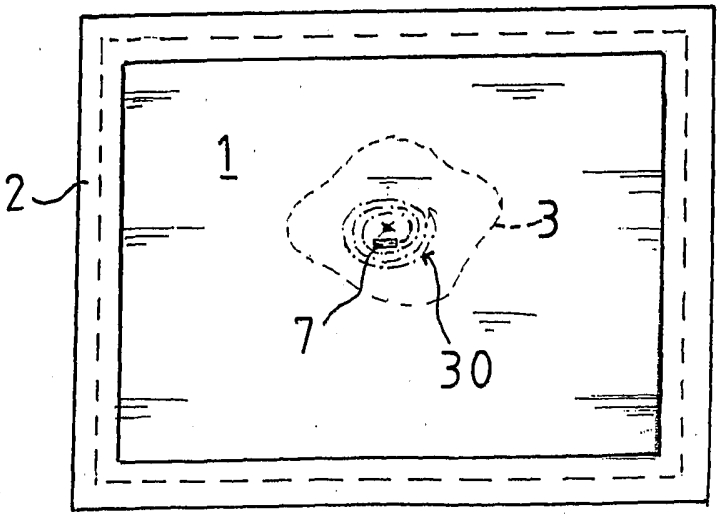


Fig 2

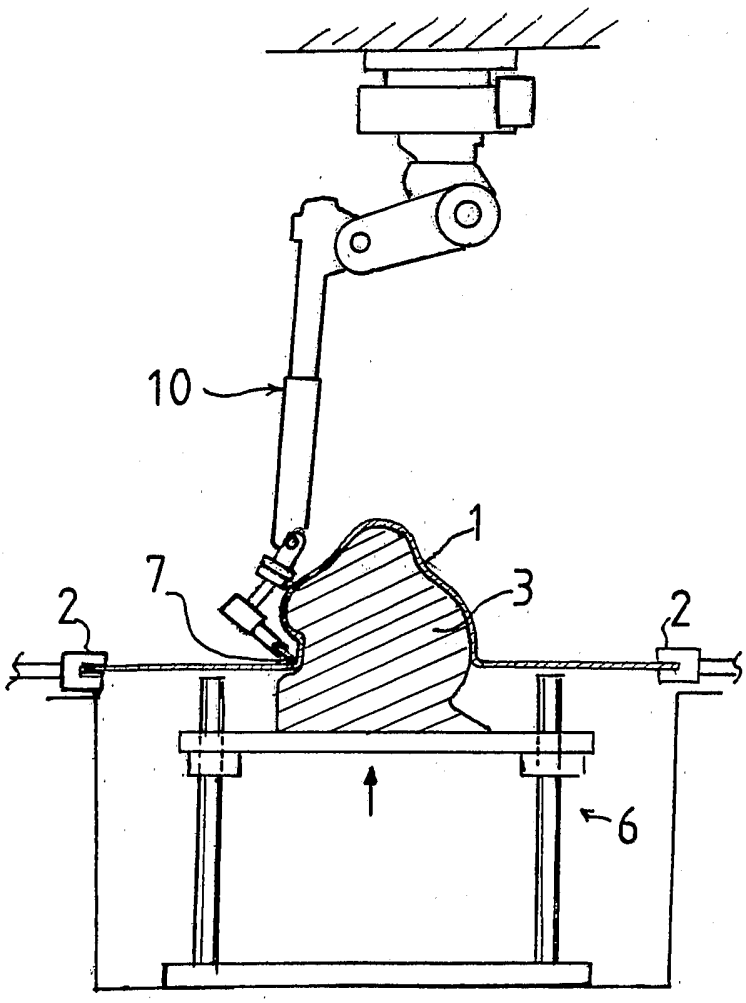


Fig 3

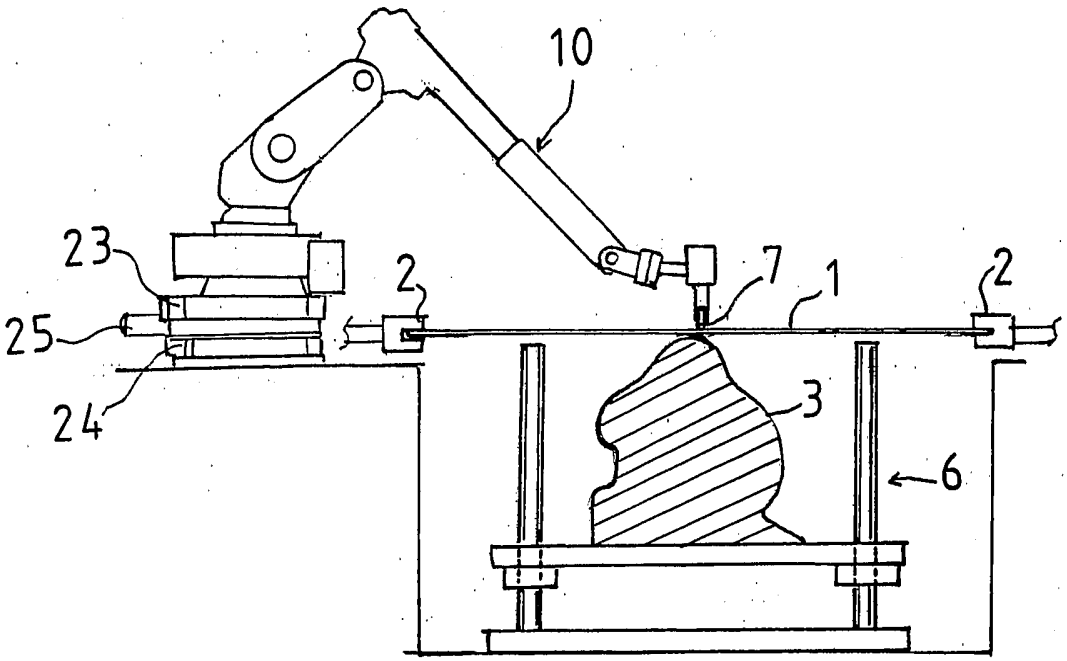


Fig 4

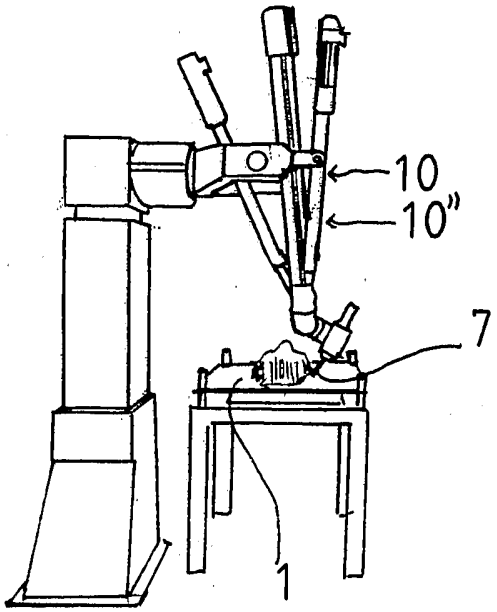


Fig 5

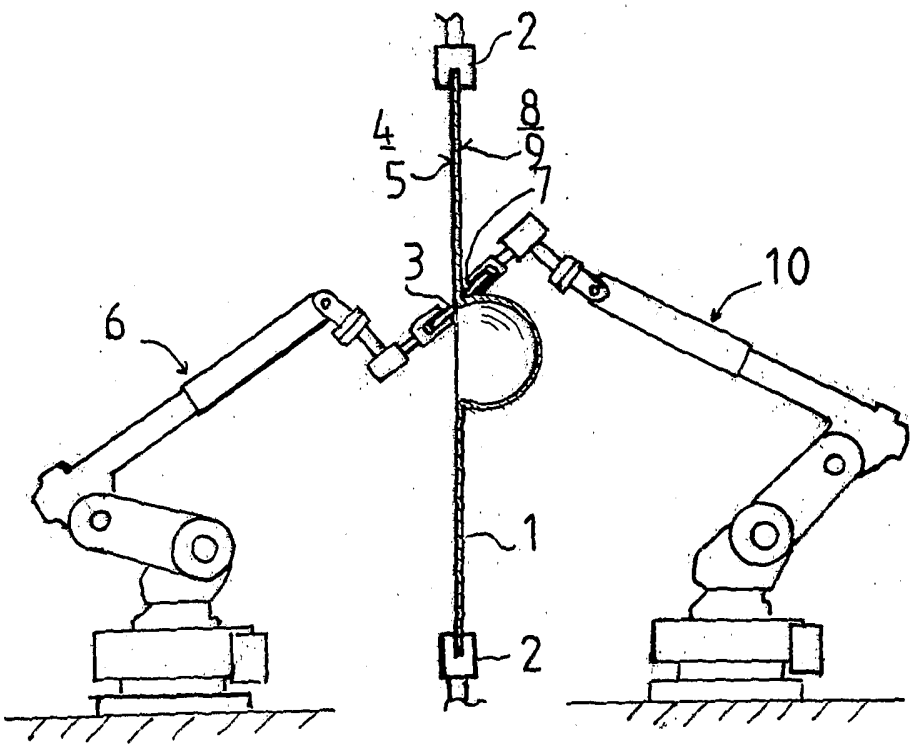


Fig 6

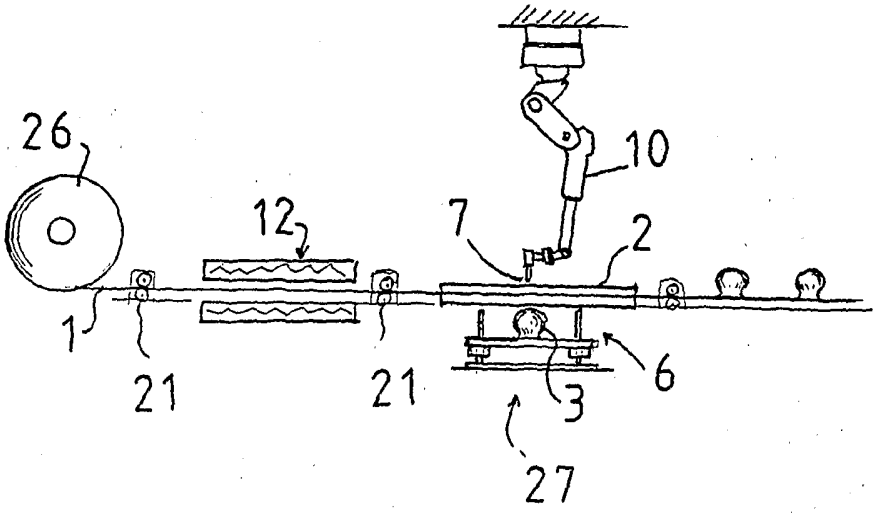
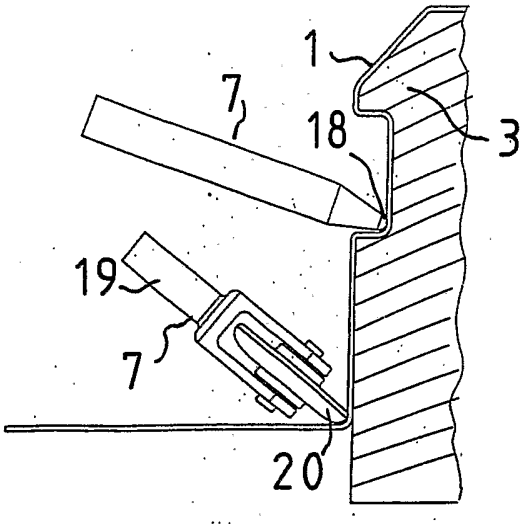


Fig 7



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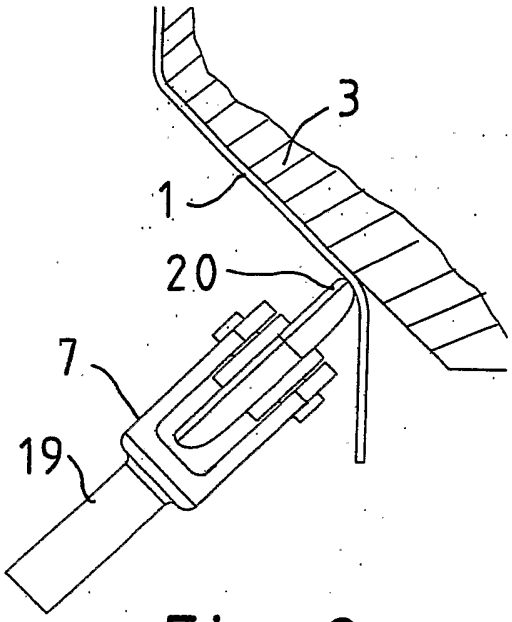

Fig 9

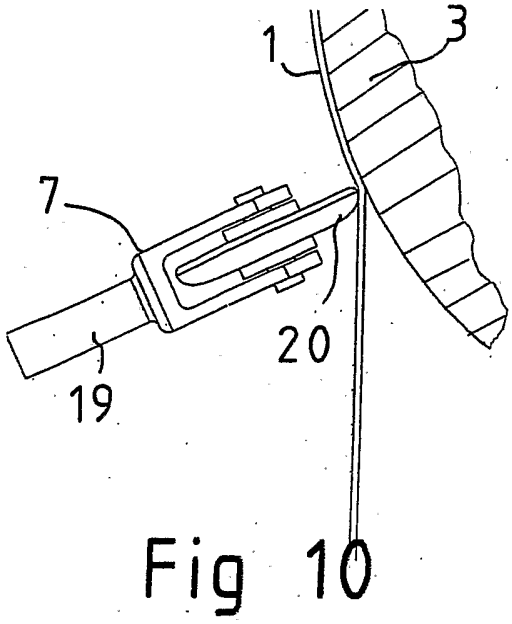

Fig 10

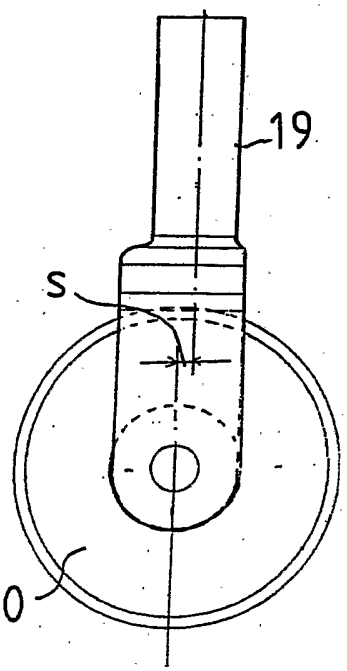

Fig 11

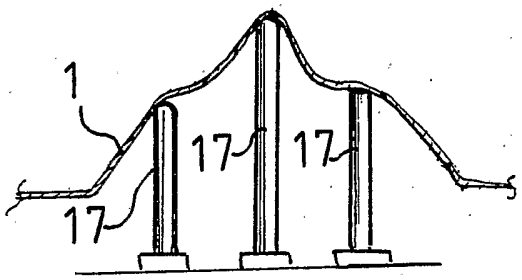

Fig 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 03/00727

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B21D 22/26, B21D 25/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B21D, B21J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
D,A	PATENT ABSTRACTS OF JAPAN VOL.1995, NO. 08 29 september 1995(1995-09-29) & JP 7132329 A (SHIGEO MATSUBARA et al) 23 May 1995 (1995-05-23) abstract ---	1-40
D,A	EP 0970764 A1 (AMINO CORPORATION), 12 January 2000 (12.01.00), abstract ---	18-40
P,A	US 6532786 B1 (CLINT ALLEN LUTTGEHARM), 18 March 2003 (18.03.03), column 6, line 53 - line 65, figures 2,3, abstract ---	1,2,4,7,10, 11,16

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 December 2003	17 -12- 2003
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Katarina Ekman/MP Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 03/00727

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5115661 A (JOSEPH MCGOWAN), 26 May 1992 (26.05.92), figures 1,2, abstract -- US 4557135 A (CHRISTIAN RAGETTLI ET AL), 10 December 1985 (10.12.85), figures 5,6, abstract -- US 2945528 A (P. ROUX), 19 July 1960 (19.07.60) -- --------	1-40 1-40 18-40

INTERNATIONAL SEARCH REPORT

Information on patent family members

31/10/03

International application No.
PCT/FI 03/00727

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		ES 2010027 A	16/10/89
		GB 8719495 D	00/00/00
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		JP 59133919 A	01/08/84
US 2945528 A	19/07/60	NONE	