(19) Europäisches Patentamt
European Patent Office
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(11) **EP 2 279 806 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.02.2011 Bulletin 2011/05

(51) Int Cl.:
B21D 5/08 *(2006.01)*

(21) Application number: **09009689.2**

(22) Date of filing: **27.07.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
AL BA RS

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(54) **Roll forming apparatus**

(57) The invention relates to a roll forming apparatus for forming metal sheets having a varying width passing through the apparatus wherein the apparatus comprises a number of successive roll stands (1) provided with forming rolls (2), a support (4) for each roll stand, wherein each roll stand is mounted on a support (4) rotatable around an axis of rotation, guide means (7) for the supports for the roll stands and drive units (18) to move and to rotate the roll stands (1) and wherein drive units act at points at a distance of the axis of rotation on every roll stand (1) to move and rotate the roll stands (1) and that points at a distance of the axis of rotation at facing sides of two successive roll stands are acted on by a single drive unit.

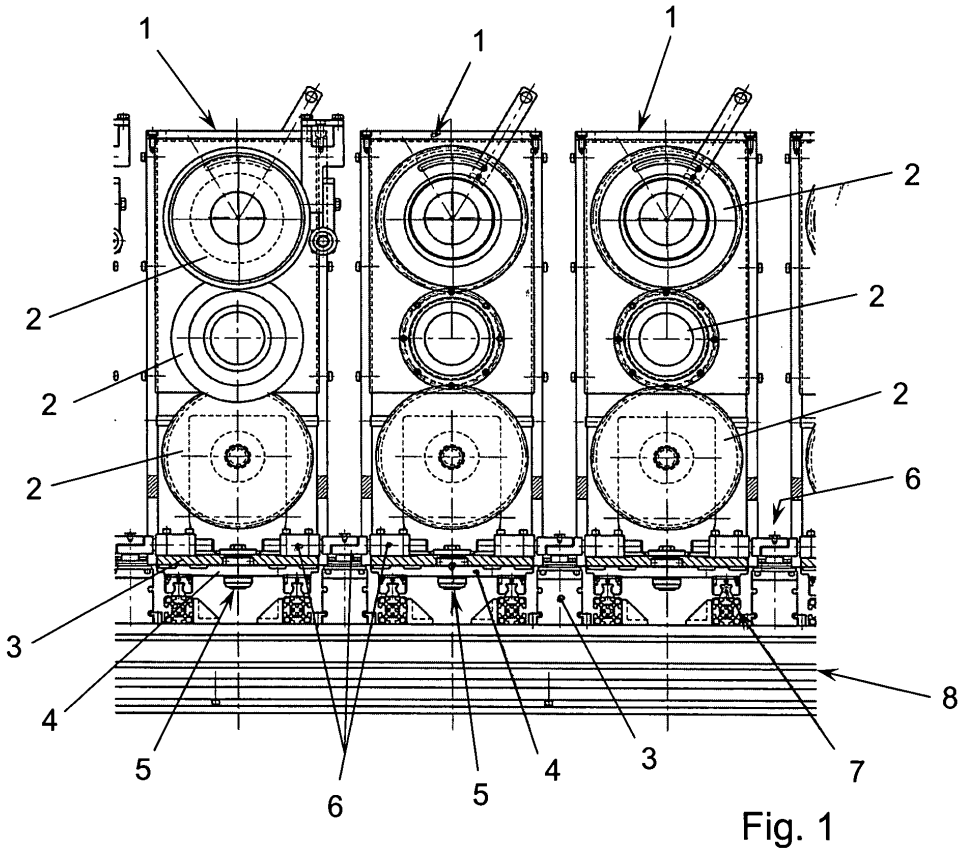

Fig. 1

EP 2 279 806 A1

Description

[0001] The present invention relates to a roll forming apparatus for forming a metal sheet comprising a number of successive roll stands provided with forming rolls, a support for each roll stand, wherein each roll stand is mounted rotatably on a support, guide means for the supports for the roll stands and drive units to move and to rotate the roll stands.

[0002] Roll forming apparatus are known in the art and are used to form metal panels which are used for building purposes such as facades and roofs. In particular for the more complex shapes such as many curved shapes metal sheets are needed having a varying width in the length direction to be able to make the right shaped metal panels. To be able to roll form these metal sheets to get the necessary and/or desired forms in the sheets the successive roll stands of the roll forming apparatus have to be moved in a direction at an angle with the direction of transport of the metal sheet through the apparatus to follow the edge of the metal sheet with a varying width. The successive roll stands also have to be positioned at the right angle to the edge of the passing metal sheet. With the passing of a curved part in the plane of a metal sheet this will mean that the roll stands have to be moved continuously and that also the angle of the roll stand with regard to the edge of the metal sheet has to be adapted continuously.

[0003] In DE 100 11 755 a roll forming apparatus is disclosed wherein a roll stand is moved at an angle to the transport direction of the metal sheet by moving a support for the roll stand along guide means for the support by means of a first drive unit and wherein the angle of the roll stand with respect to the transport direction of the metal sheet is controlled by means of a second drive unit. With two drive units for each roll stand this implies that a great many drive units together with the necessary control means for each drive unit are needed in a roll forming apparatus.

[0004] It is an objective of the invention to provide a roll forming apparatus with a limited number of drive units to move and position the roll stands at the right location and at the right angle with respect to a passing metal sheet.

[0005] It is another objective of the invention to provide a roll forming apparatus that can be manufactured easily and at low costs.

[0006] It is still another objective of the invention to provide a roll forming apparatus with which the roll stands can be moved and positioned at the right location and at the right angle fast and with great precision.

[0007] It is still another objective of the invention to provide a roll forming apparatus which can be used on a building site.

[0008] According to a first aspect of the invention one or more of the objectives are realized by providing that the roll forming apparatus for forming a metal sheet comprises a number of successive roll stands provided with forming rolls, a support for each roll stand, wherein each roll stand is mounted on a support rotatable around an axis of rotation, guide means for the supports for the roll stands and drive units to move and to rotate the roll stands, wherein drive units act at points at a distance of the axis of rotation on every roll stand to move and rotate the roll stands and that points of two successive roll stands are acted on by a single drive unit.

[0009] By providing that a drive unit acts on points of two successive roll stands the total number of drive units needed for the roll forming apparatus is reduced considerably. With such a reduced number of drive units needed to control the roll forming apparatus the total costs for a roll forming apparatus according the invention will be far less than the costs for a conventional roll forming apparatus. Moreover, the weight of the roll forming apparatus can be far less than that of a conventional roll forming apparatus. This has the further advantage that a roll forming apparatus according the invention is easier to transport and can be used at almost any location on a building site. Also, the computer control is simplified because of the reduced number of drive units.

[0010] According to a further aspect of the invention the successive roll stands are connected by connecting means and the drive unit acting on the successive roll stands acts on the successive roll stands by acting on the connecting means. By moving the connecting means between two successive roll stands only at one side of these roll stands, the two successive roll stands are rotated over an angle. By moving the connecting means at both sides of a roll stand the roll stand is moved or is moved and rotated dependent on whether there is a difference in velocity or in the distance travelled. In this way the successive roll stands of a roll forming apparatus can continuously be moved and positioned at the right angle with respect to the edge of the metal sheet passing through the roll forming apparatus. Moving a roll stand by controlling the two drive units acting on that roll stand means that the roll stand is moved with the support along the guide means for the support, which preferably is in a direction at a right angle to the transport direction of a metal sheet through the roll forming apparatus.

[0011] According to a further aspect of the invention the connecting means between two successive roll stands comprises two members, wherein each member at one end engages with a roll stand and at the other end with the other member by means of a mutual pivot. According to a preferred embodiment a drive unit acts on two successive roll stands by acting on the connecting means acts on the mutual pivot.

[0012] In order to be able to change the angle of successive roll stands with respect to the transport direction of a metal sheet it is further provided that one end of a member of the connecting means is slidably connected to a roll stand or the pivot. This feature provides that the distance between the mutual pivot and the point on which a connecting member of the connecting means act on a roll stand can vary which allows for changes of the angle

of the roll stand with respect to the transport direction of the metal sheet.

[0013] Although the feature can be realized by either providing a slidable connection of a connecting member to a roll stand or a slidable connection of each of the connecting members of the connecting means to the pivot, it is preferred to have the roll stands provided with a sleeve to slidably receive a connecting member of the connecting means. With this embodiment low play and consequently great accuracy in positioning of the roll stand can be realized.

[0014] The last roll stands on both ends of a row of successive roll stands differ from the other roll stands in that there is only a successive roll stand on one side of each of the last roll stands. In order to control location and angle of the last roll stands it is provided that each of the last roll stands of the successive roll stands is acted on by two drive units, wherein one of these drive units only acts on one roll stand. As a consequence thereof the total number of drive units needed for a row of x roll stands is x+1 drive units. For a conventional roll forming apparatus the total number of drive units will be 2x, which is certainly with the number of roll stands commonly used in roll forming apparatuses almost the double amount.

[0015] For the drive units of these last roll stands it is provided that a drive unit acting on one roll stand acts on a connecting member engaging at one end with the roll stand and at the other end with the drive unit. With these last drive units it is also provided that one end of the connecting member is slidably connected to a roll stand or to a pivot connected to the drive unit. Preferably the roll stands are provided with a sleeve to slidably receive the connecting member acted on by the last drive units.

[0016] The drive units used to move and rotate the roll stands are linear drive units, which can be an electric linear drive unit or a drive unit with a mechanical transmission. Preferably it is provided that each of the drive units comprises a threaded spindle and nut wherein the pivot is fixed to the nut.

[0017] The guide means for a support for a roll stand can be realized with many different embodiments, however, the guide means preferably comprise at least one rail guide and a guide part at least partly complementary to the rail guide. With this embodiment the roll stand is always kept in the right path without the possibility of any deviation in any direction at all.

[0018] According to a further embodiment the forming rolls of the roll forming apparatus are suitable for forming metal sheets into roll formed parts for a roof or a façade. The roll formed parts for a roof are for instance parts for a standing seam roof.

[0019] The roll forming apparatus according the invention is further elucidated on hand of the example given in the drawing, wherein:

fig.1 shows a view of a number of roll stands of the roll forming apparatus on the side with the forming rolls,

fig.2 shows in detail the support for a roll stand, guide means for the support and the connecting means between two successive roll stands,

fig.3 shows schematically a number of successive roll stands and the respective drive units for these roll stands in a view from above, and

fig.4 shows a number of profiled sheets.

[0020] Fig. 1 shows a number of roll stands 1 provided with various forming rolls 2 for forming a metal sheet. The framework of a roll stand 1 has a basis 3 which is mounted on a support 4 and is rotatable with respect to support 4 around an axis of rotation formed by mounting means 5. The successive roll stands 1 are connected by means of connecting means 6.

[0021] The support 4 is movable along guide means 7 in a direction at an angle to the direction of transport of the metal sheet which is to be formed by means of the forming rolls 2. The guide means 7 are mounted on frame 8 of the roll forming apparatus.

[0022] Fig.2 shows in more detail basis 3 and support 4 of two successive roll stands 1. The mounting means 5 which form the axis around which a roll stand 1 is rotatable with respect to its support 4 comprises a bolt 9 which is mounted in a bearing 10 in basis 3 and is connected to the support with a nut 11 or the like.

[0023] The connecting means 6 between successive roll stands 1 have two connecting members 12,13 connected at one end to the roll stands 1 by means of sleeves 14,15 and at the other end to a mutual pivot 16. The connecting members 12,13 are slidable in the sleeves 14, 15 to allow for changes in the distance between pivot 16 and the point on the roll stand 1 on which the connecting members 12, 13 act. The possibility to allow a change in said distance is necessary to allow changes in the angle at which a roll stand should be positioned with respect to a metal sheet with a varying width passing through the roll forming apparatus.

[0024] The pivot 16 is mounted on a slide or carriage 17 mounted on housing 19 of drive unit 18 and driven by drive unit 18. The drive unit 18 has an electromotor 20 (fig.3) driving a spindle the spindle being provided with a nut. The nut is moved along the spindle by rotation of the spindle therewith moving the slide or carriage 17 with pivot 16 over the housing 19 of drive unit 18.

[0025] The support 4 rests on guide means 7 mounted on frame 8 of the roll forming apparatus. The guide means 7 comprise a guide rail 21 mounted on a support profile 22 and a guide part 23 fixed to support 4 on which a roll stand 1 rests. The guide part 23 is at least partly complementary to the profile of the guide rail 21 so that the support 4 and the roll stand 1 on the support are kept precisely in the right track. Moreover, the guide means 21,23 are shaped such that it is not possible at all that a roll stand 1 comes off the guide means and therewith off the frame 8 of the roll forming apparatus. This feature is necessary to be able to move a roll stand precisely to a desired location, but it will also keep the roll stands at-

tached to the guide means during transport from one building site to the next.

[0026] In fig.3 a number of successive roll stands 1 and the respective drive units 18 for these roll stands are shown schematically in a view from above. A roll stand 1 is moved forwards and backwards by moving simultaneously the connecting members 12, 13 connected to a basis 3 of a roll stand 1. The angle of a roll stand 1 with respect of a metal sheet passing through the roll forming apparatus is changed by moving one connecting member 12,13 acting on the roll stand 1 or by moving both connecting members 12,13 acting on the roll stand 1 over different distances. With every change of the angle of a roll stand the connecting members 12,13 slide in the respective sleeves 14,15.

[0027] Although not shown in the drawing the roll forming apparatus is provided with shearing means for adapting the width of the metal sheet to be formed.

[0028] In fig.4 a number of profiled sheets are shown with a varying width or tapered shape which can at least partly be formed using the roll forming apparatus according the invention. From the top left in clockwise direction an elliptically curved, a hyperbolically curved and respectively two freeform rolled parts for a roof and or façade are shown.

Claims

1. Roll forming apparatus for forming a metal sheet comprising a number of successive roll stands provided with forming rolls, a support for each roll stand, wherein each roll stand is mounted on a support rotatable around an axis of rotation, guide means for the supports for the roll stands and drive units to move and to rotate the roll stands, **characterized in that** drive units act at points at a distance of the axis of rotation on every roll stand to move and rotate the roll stands and that points of two successive roll stands are acted on by a single drive unit.

2. Roll forming apparatus according to claim 1, **characterized in that** successive roll stands are connected by connecting means and that a drive unit acting on successive roll stands acts on the successive roll stands by acting on the connecting means.

3. Roll forming apparatus according to claim 2, **characterized in that** the connecting means between two successive roll stands comprises two members, wherein each member at one end engages with a roll stand and at the other end with the other member by means of a mutual pivot.

4. Roll forming apparatus according to claim 3, **characterized in that** one end of a member of the connecting means is slidably connected to a roll stand or the pivot.

5. Roll forming apparatus according to claim 4, **characterized in that** the roll stands are provided with a sleeve to slidably receive a member of the connecting means.

6. Roll forming apparatus according to one or more of claims 3-5, **characterized in that** a drive unit acts on the pivot for the members of the connecting means between two successive roll stands.

7. Roll forming apparatus according to one or more of claims 1-6, **characterized in that** each of the last roll stands of the successive roll stands is acted on by two drive units, wherein one of these drive units only acts on one roll stand.

8. Roll forming apparatus according to claim 7, **characterized in that** a drive unit acting on one roll stand act on a connecting member engaging at one end with the roll stand and at the other end with the drive unit.

9. Roll forming apparatus according to claim 8, **characterized in that** one end of the connecting member is slidably connected to a roll stand or to a pivot connected to the drive unit.

10. Roll forming apparatus according to one or more of claims 1-9, **characterized in that** the drive units are linear drive units.

11. Roll forming apparatus according to claim 10, **characterized in that** the drive unit comprises a threaded spindle and nut wherein the pivot is attached to the nut.

12. Roll forming apparatus according to claim 3, **characterized in that** the guide means for a support for a roll stand comprise at least one rail guide and a guide part at least partly complementary to the rail guide.

13. Roll forming apparatus according to one or more of claims 1-12, **characterized in that** shearing means are provided for adapting the width of the metal sheet to be formed.

14. Roll forming apparatus according to one or more of claims 1-13, **characterized in that** the forming rolls are suitable for forming metal sheets into roll formed parts for a roof or a façade.

15. Roll forming apparatus according to claim 14, **characterized in that** roll formed parts are parts for a standing seam roof.

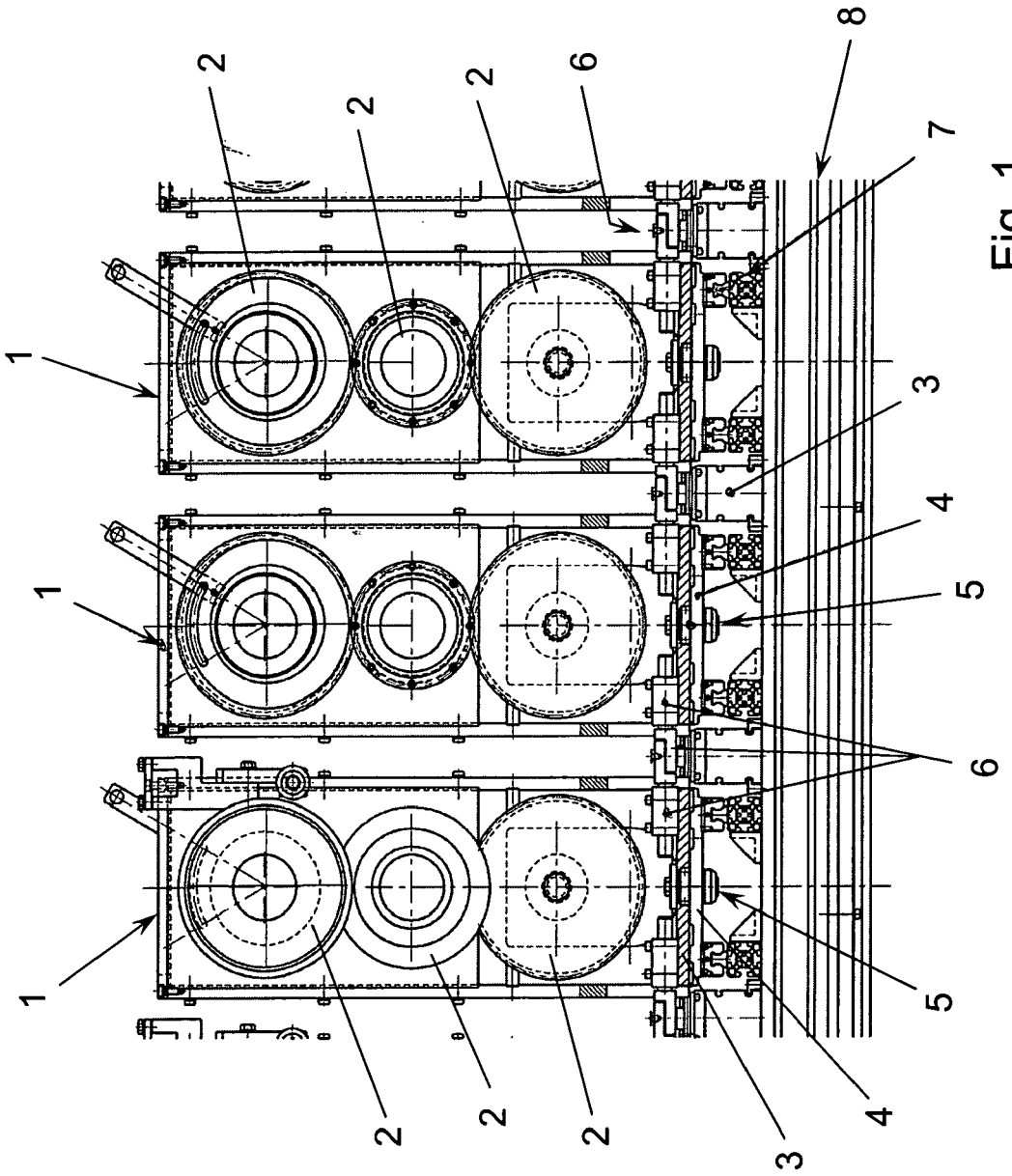

Fig. 1

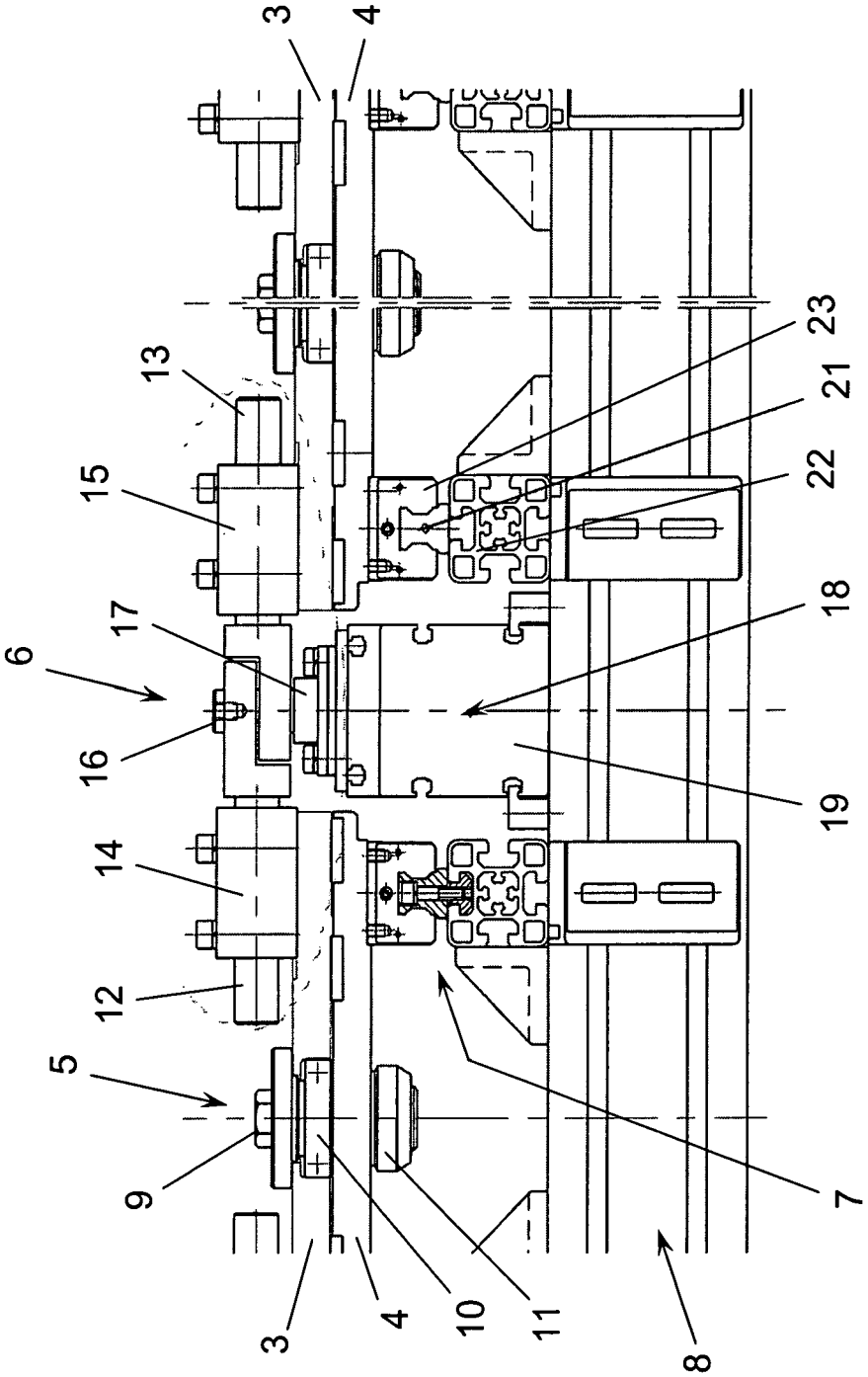

Fig. 2

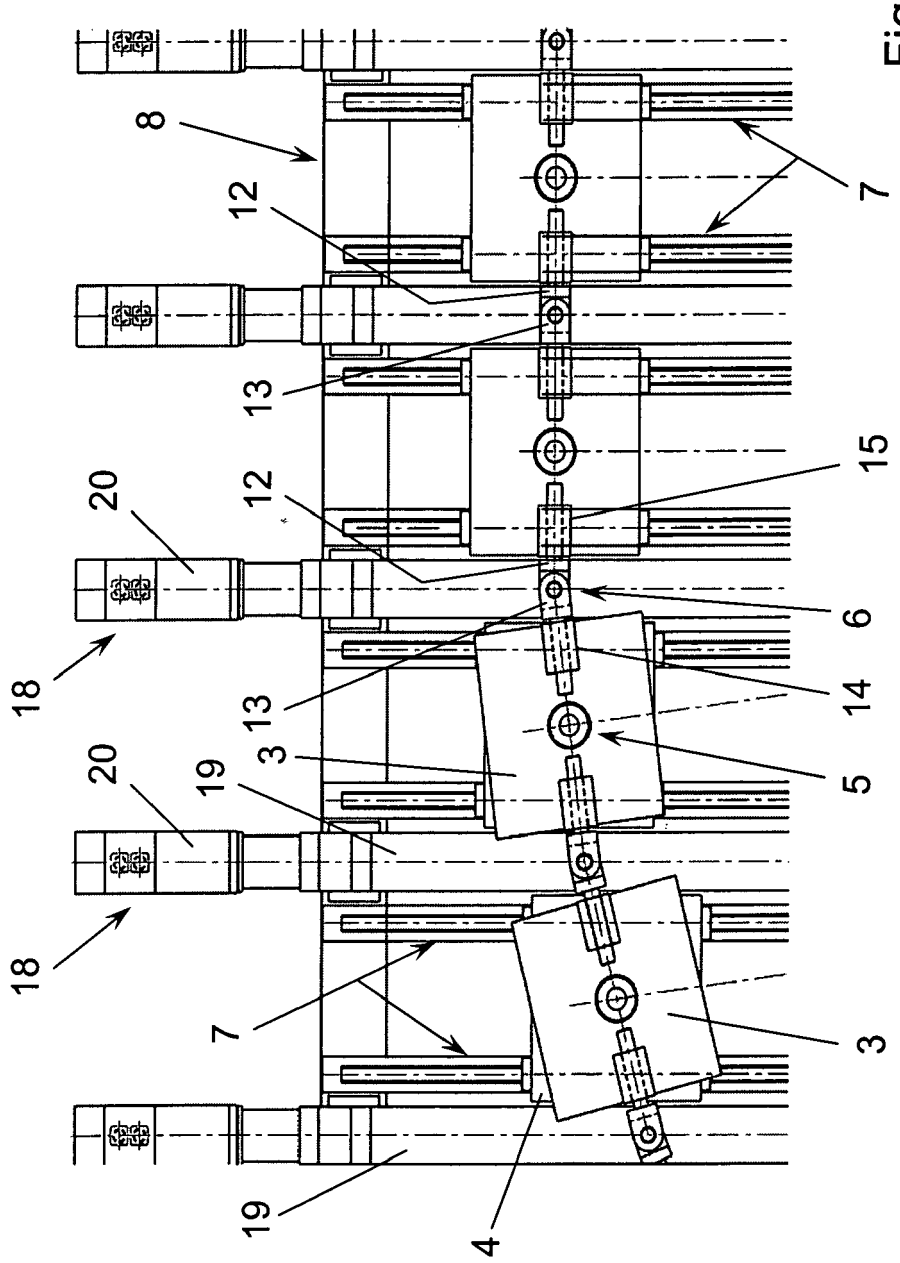

Fig. 3

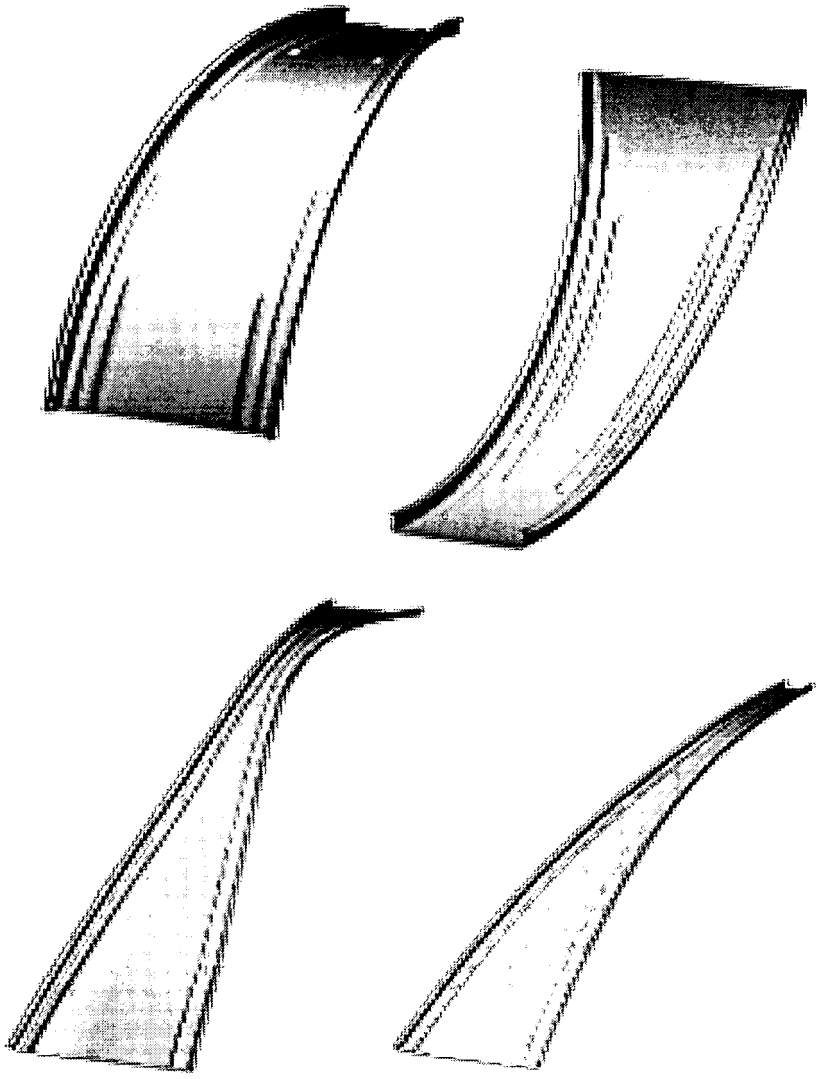

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 09 00 9689

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B21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 January 2010	Knecht, Frank

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 00 9689

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