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(54) Apparatus for cambering a tool of a bending apparatus.

(57) An apparatus for cambering a tool of a bending apparatus with a lower beam, a tool table mounted on the same and an upper movable up and down and coupled near its end with sensors for measuring the movement of the upper beam, is provided with two adjusting wedges disposed upon eachother and movable with respect to eachother from a neutral position in longitudinal direction. Said adjusting wedges extend along substantially the whole length of the tool between the tool and the corresponding upper or lower beam. The joining complementary surfaces of the adjusting wedges have a somewhat S-shaped curved trend in longitudinal section. In the neutral position the highest and lowest point, respectively, of the curved surfaces of the adjusting wedges are located substantially at the location of the respective sensors.

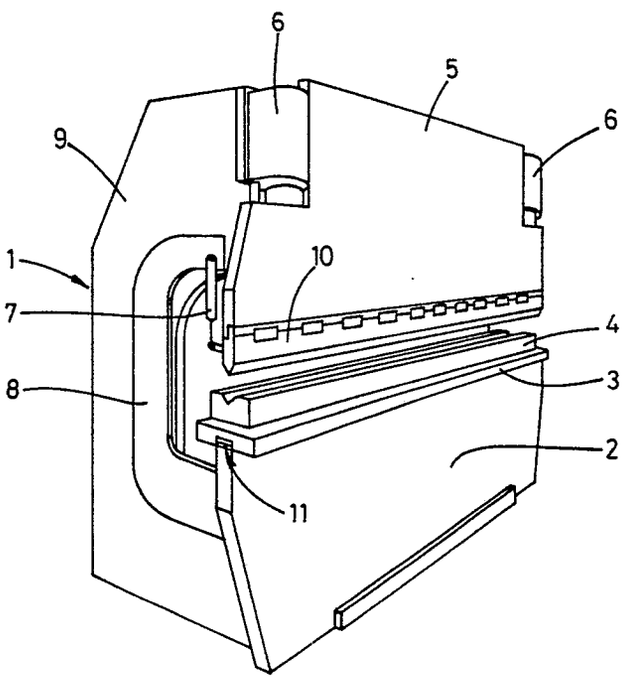

fig.1

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Apparatus for cambering a tool of a bending apparatus.

The invention relates to an apparatus for cambering a tool of a bending apparatus with a lower beam, a tool table mounted on the same and an upper beam movable up and down and coupled near its ends with sensors for measuring the movement of the upper beam.

Such an apparatus serves for adjusting a compensation for the deflection of the upper beam at high loads occurring in a bending apparatus. In the known apparatus usually a high number of adjusting elements along the length of the tool are provided which only provide a local support of the tool. Further for adjusting a desired camber all adjusting elements have to be adjusted accurately. As moreover all adjusting elements have a different shape or design and must be made with a relatively high accuracy, the manufacturing costs of the known apparatus are high.

The invention aims to provide an apparatus of the above mentioned type which is simple and can be made at relatively low costs.

To this end the apparatus according to the invention is characterized by two adjusting wedges disposed upon eachother and movable with respect to eachother from a neutral position in longitudinal direction, said adjusting wedges extending along substantially the whole length of the tool between the tool and the corresponding upper or lower beam, wherein the joining complementary surfaces of the adjusting wedges have a somewhat S-shaped curved trend in longitudinal section and wherein, in the neutral position, the highest and lowest point, respectively, of the curved surfaces of the adjusting wedges are located substantially at the location of the respective sensors.

In this manner a simple made apparatus is obtained wherein the tool is supported along the whole length by the adjusting wedges and wherein the adjusting wedges can be actuated at their free ends.

According to a simple embodiment one adjusting wedge is mounted stationary and the other adjusting wedge is slidable.

In case of a bending apparatus with great length the trend of the curved surfaces in vertical direction can be rather great, whereby the mounting height of the adjusting wedges becomes a disadvantage. According to the invention this disadvantage can be overcome in that both adjusting wedges each consist of two or more adjusting wedge parts connected to eachother, wherein the curved complementary surfaces of the subsequent adjusting wedge parts are staggered in vertical direction.

The mechanical manufacturing of the adjusting wedges becomes simple if the adjusting wedges are made of a relatively soft steel, wherein the movable surfaces of the adjusting wedge(s) are provided with a bronze layer.

Preferably the adjusting wedges are mounted on the lower beam and are received in a recess in the lower side of the tool table.

The invention will be further explained by reference to the drawings in which some embodiments are schematically shown.

Fig. 1 is a perspective view of a bending apparatus comprising an embodiment of the apparatus according to the invention.

Fig. 2 is a partially shown longitudinal section of the lower beam and the tool table of the bending apparatus of fig. 1, wherein an actuating mechanism of one adjusting wedge is shown.

Fig. 3 is a section according to the line III-III of fig. 2.

Fig. 4 schematically shows the adjusting wedges of the apparatus of fig. 2, wherein the adjusting wedges are in a neutral position.

Fig. 5 schematically shows the adjusting wedges of fig. 4, wherein the adjusting wedges are in their maximum camber position.

Fig. 6 is a view corresponding with fig. 4 of an alternative embodiment of the adjusting wedges according to the invention in the neutral position.

Fig. 7 shows the adjusting wedges of fig. 7 in the maximum camber position.

Fig. 1 shows a bending apparatus 1 comprising a stationary lower beam 2, on which a tool table 3 is mounted. A die 4 is fixed on the tool table 3. The bending apparatus 1 further comprises an upper beam 5 movable up and down and driven by two cylinder piston assemblies 6. For measuring the movement of the upper beam 5, sensors 7 are mounted near the cylinder piston assemblies 6, only one of the sensors being shown in fig. 1. Said sensors 7 are supported by substantially C-shaped supports 8 fully free of the frame of the bending apparatus 1, so that a deformation of the web plates 9 (only one of which is shown in fig. 1) during exertion of high forces does not affect the sensors 7.

The upper beam 5 carries a stamp 10 which cooperates with the die 4 for bending a material plate. During bending the upper beam 5 will bend somewhat, which bending-through, in order to obtain an accurate bending of the plate material, must be compensated by providing the stamp 10 or the die 4 with an opposite bending-through. This opposite bending-through is generally indicated as camber. With a correct adjustment of the camber,

a straight bending line is obtained during the bending operation.

For adjusting the camber the bending apparatus 1 is provided with a camber apparatus 11 comprising two adjusting wedges 12, 13 disposed upon eachother and further shown in figs. 2-5. The adjusting wedges 12, 13 are mounted on the lower beam 2, wherein a recess 14 is provided in the lower side of the tool table 3, in which recess the adjusting wedges 12, 13 are received.

The tool table 3 is connected to the lower beam 2 under spring pressure, for which purpose in the shown embodiment three lateral rods 15 are mounted near the ends of the tool table 3 and in the centre of the lower beam 2, respectively, which lateral rods protrude outwardly of the lower beam 2 on both sides. Draw bolts 16 protrude through each lateral rod 15 on both sides of the lower beam 2, by means of which draw bolts 16 the tool table 3 is fixed, wherein Belleville- washers or cupped spring washers 18 are provided between each bolt head 17 and the lateral rods 15.

The adjusting wedges 12, 13 are slidable with respect to eachother in longitudinal direction, in that at the embodiment shown the upper wedge 12 is slidable backward and forward, while the lower adjusting wedge 13 is attached to the lower beam 2. The actuation of the adjusting wedge 12 is provided through a draw/push bolt 19 which is movable backward and forward through a 90° transmission 20 by rotating a shaft 21 of the transmission 20. The shaft 21 can be rotated with a manually operable adjusting wheel or alteratively by means of an electromotor.

In fig. 4 the adjusting wedges 12, 13 are shown in a neutral position, wherein the upper surface 22 of the adjusting wedge 12 extends parallel to the lower surface of the adjusting wedge 13 and therefore no correction of the bending-through of the upper beam or the stamp 10, respectively, takes place. For adjusting a certain correction the upper surface 22 should be provided with a bending-through opposite to the bending-through of the upper beam 5, which opposite bending-through can be indicated as camber curve. In fig. 5 the adjusting wedge has been moved maximum to the left, whereby the upper surface 22 has the maximum opposite bending-through, which is indicated strongly exaggerated in fig. 5 by a dashed line 24 with respect to a straight line 25. Actually the maximum bending-through for a length of the adjusting wedges of 3 m is approximately 1 mm.

The desired bending-through of the upper surface 22 of the adjusting wedge 12 for compensating the bending-through of the upper beam 5 is obtained in that the joining complementary surfaces 26, 27 in the side view of figs. 4 and 5 has a somewhat S-shaped curved trend, wherein the highest point 28 and the lowest point 29 of the curved surfaces 26, 27 in the neutral position of fig. 4 lies substantially at the location of the respective sensors 7. The trend of the curved surfaces 26, 27 substantially corresponds with the integral of the camber curve 24 shown in fig. 5.

If for adjusting the camber only one adjusting wedge is moved as in the embodiment shown, it is to be preferred to design the curved surfaces 26, 27 in the neutral position in such a manner that the highest point 28 and the lowest point 29 are lying outwardly of the sensors 7 at a distance of substantially half of the stroke of the slidable adjusting wedge 12.

When the bending apparatus is designed for bending plate material of great sizes so that the length of the lower beam 2 and the upper beam 5 is for example 6 m, the overall height of the adjusting wedges 12, 13 could be too high for mounting in the recess 14 in the tool table 3. In order to reduce the overall height of the adjusting wedges 12, 13 in case of great length, both adjusting wedges 12, 13 can for example consist of two interconnected adjusting wedge parts 30, 31 and 32, 33, respectively, wherein the curved complementary surfaces 26, 27 of the subsequent adjusting wedge parts 30, 31 and 32, 33, respectively, are staggered in vertical direction as shown in figs. 6, 7.

The described camber apparatus 11 shows the advantage that the adjusting wedges 12, 13 extend along the whole length of the die 4 to be cambered, so that the support of the tool table 3 and thereby of the die 4 is provided along substantially the whole length. The operation of the camber apparatus 11 is very simple. Further the manufacturing of the adjusting wedges 12, 13 is not very complicated so that the manufacturing costs are relatively low.

Although in the described bending apparatus the camber apparatus is mounted on the lower beam, it is of course also possible to incorporate the camber apparatus in the upper beam. Further only the lower adjusting wedge 13 or both adjusting wedges 12, 13 could be movable instead of the upper adjusting wedge 12.

Preferably the adjusting wedges 12, 13 are made of relatively soft steel, whereby the mechanical machining of the curved surfaces 26, 27 is relatively simple. For increasing the durability the surfaces 22 and 26 of the movable adjusting wedge 12 are provided with a layer of bronze.

Although in the described embodiment of the camber apparatus two separate adjusting wedges 12, 13 are used, it is possible according to a favourable alternative embodiment that one of the adjusting wedges 12, 13 is integrated with the tool table 3 or the lower beam 2 of the bending appara-

tus, respectively. Thereby the manufacturing costs are decreased.

The invention is not restricted to the above-described embodiments which can be varied within a number of ways within the scope of the invention.

Claims

1. Apparatus for cambering a tool of a bending apparatus with a lower beam, a tool table mounted on the same and an upper beam movable up and down and coupled near its ends with sensors for measuring the movement of the upper beam, characterized by two adjusting wedges disposed upon eachother and movable with respect to eachother from a neutral position in longitudinal direction, said adjusting wedges extending along substantially the whole length of the tool between the tool and the corresponding upper or lower beam, wherein the joining complementary surfaces of the adjusting wedges have a somewhat S-shaped curved trend in longitudinal section and wherein, in the neutral position, the highest and lowest point, respectively, of the curved surfaces of the adjusting wedges are located substantially at the location of the respective sensors.

2. Apparatus according to claim 1, characterized in that one adjusting wedge is mounted stationary and in that the other adjusting wedge is slidable.

3. Apparatus according to claim 2, characterized in that the highest and the lowest points of the upper surface of the lower adjusting wedge are lying at a distance outwardly of the sensors corresponding substantially to half of the stroke of the slidable adjusting wedge.

4. Apparatus according to anyone of the preceding claims, characterized in that both adjusting wedges each consist of two or more adjusting wedge parts connected to eachother, wherein the curved complementary surfaces of the subsequent adjusting wedge parts are staggered in vertical direction.

5. Apparatus according to anyone of the preceding claims, characterized in that the adjusting wedges are made of a relatively soft steel, wherein the movable surfaces of the adjusting wedge(s) are provided with a bronze layer.

6. Apparatus according to anyone of the preceding claims, wherein the tool supported on the tool table is cambered, characterized in that the adjusting wedges are mounted on the lower beam and are received in a recess in the lower side of the tool table.

7. Apparatus according to claim 6, characterized in that the stationary adjusting wedge is formed by the lower side of the tool table or the upper side of the lower beam, respectively.

8. Apparatus according to claim 6 or 7, characterized in that the tool table is connected with the lower beam under spring pressure.

9. Apparatus according to claim 8, characterized in that the tool table is connected to the lower beam at least near the ends and near the centre by draw bolts, wherein springs are mounted between the head of each draw bolt and the cooperating stop face of the lower beam.

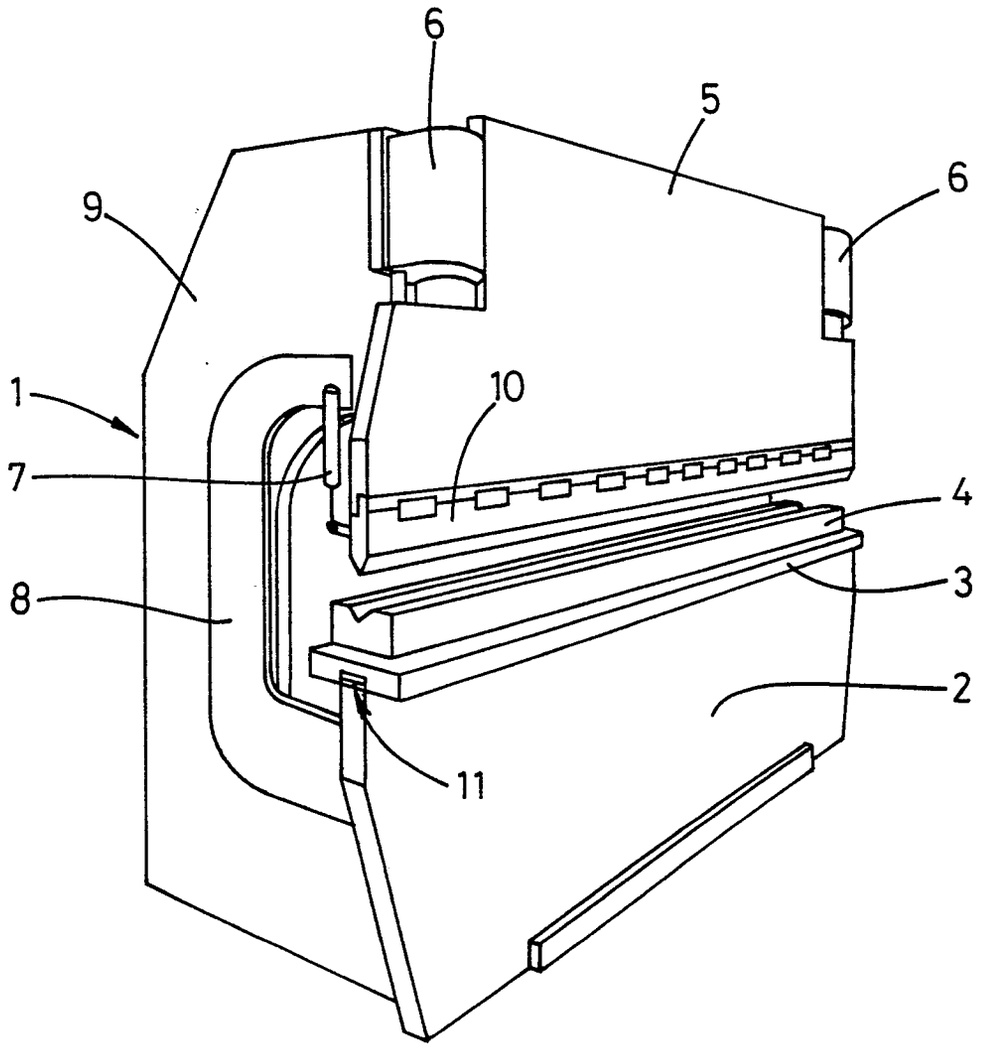

fig.1

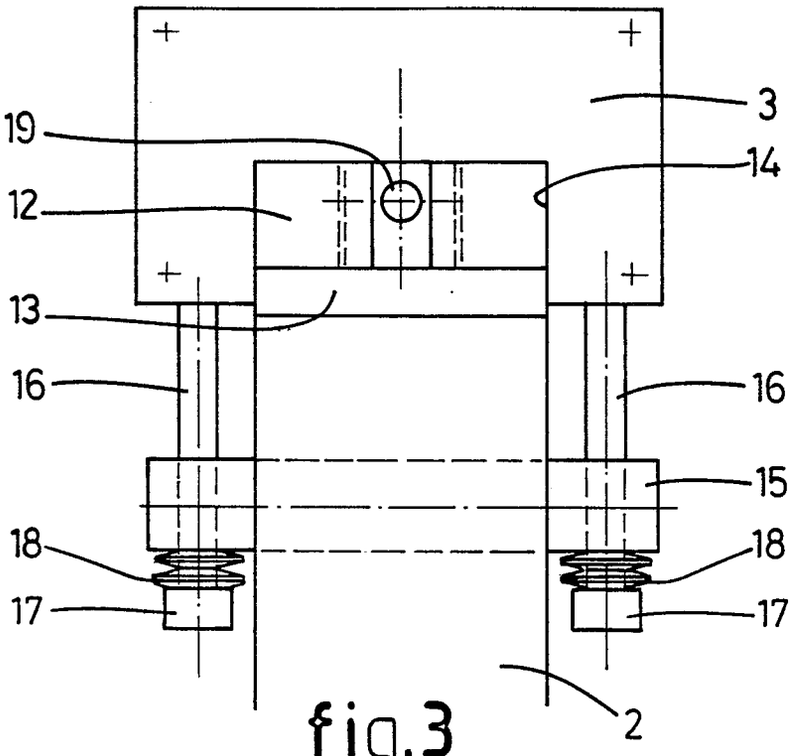

fig.3

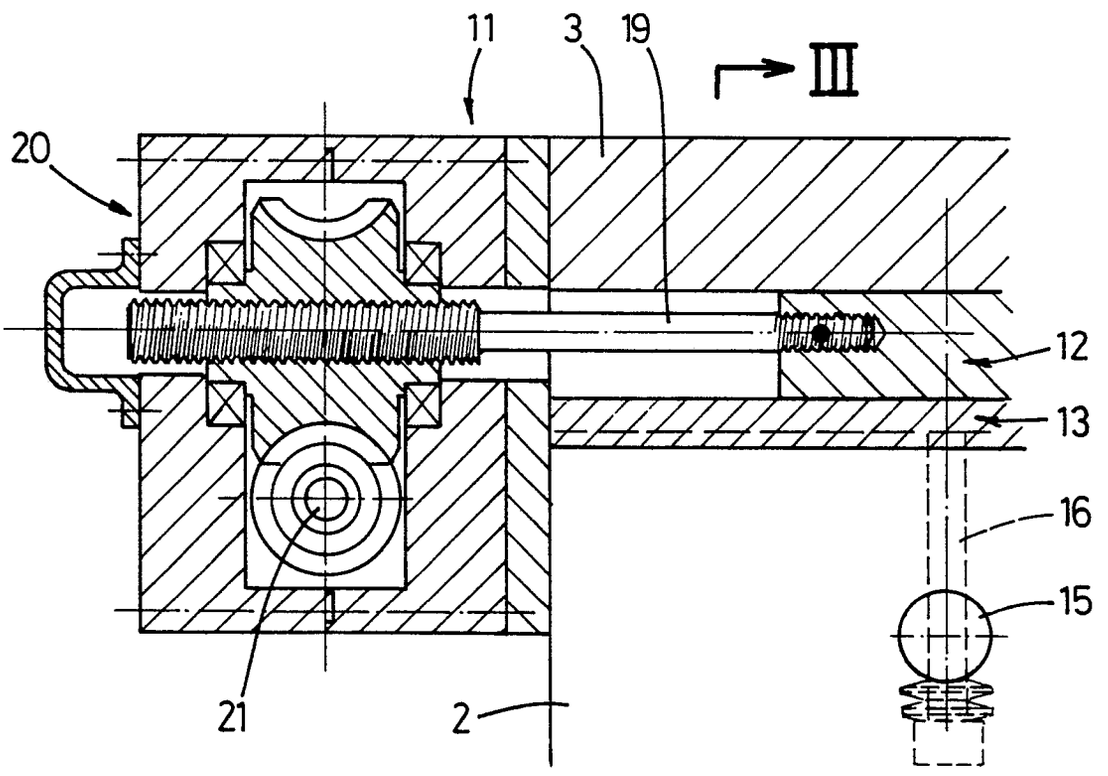

fig.2

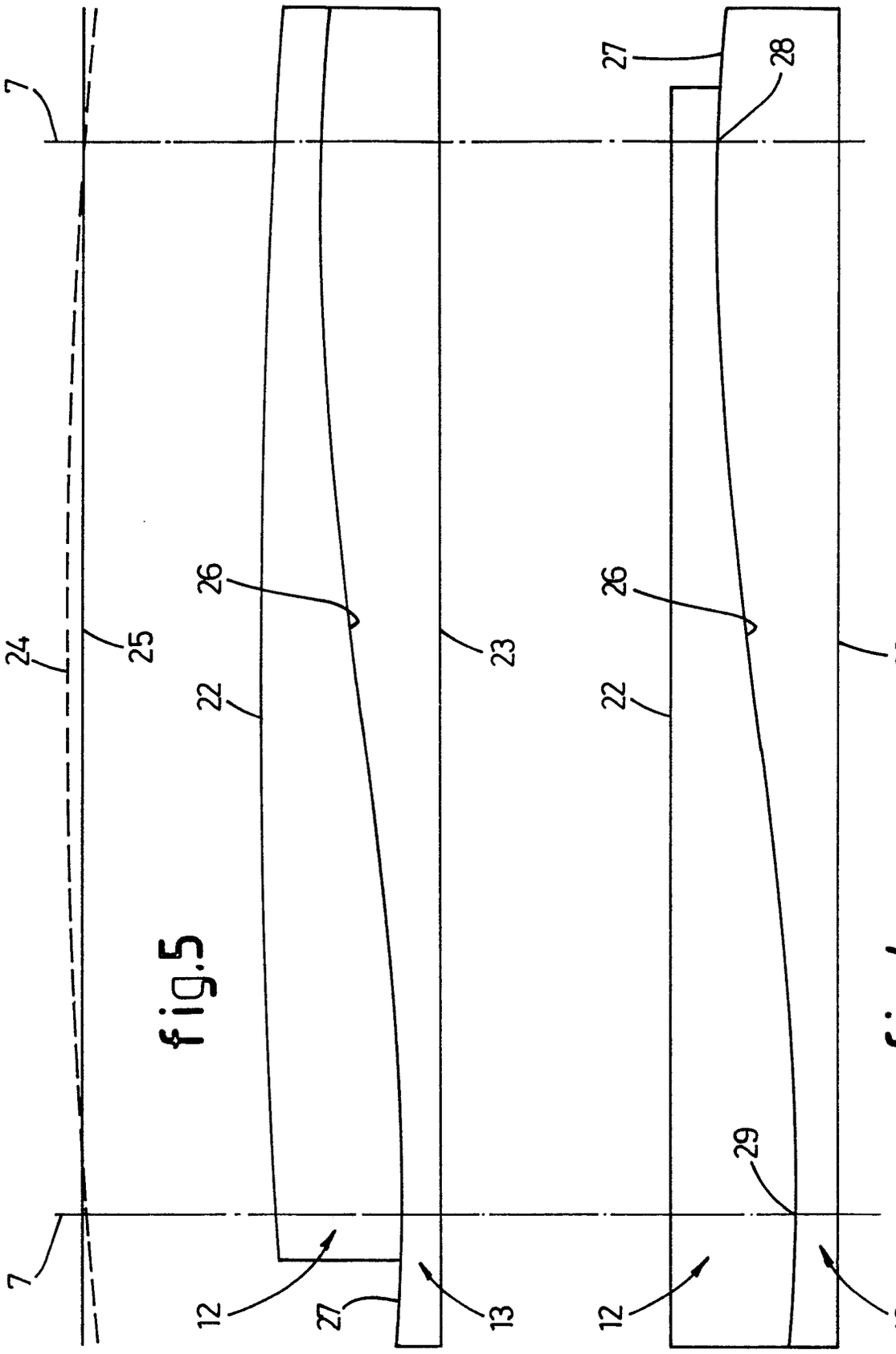

fig.5

fig.4

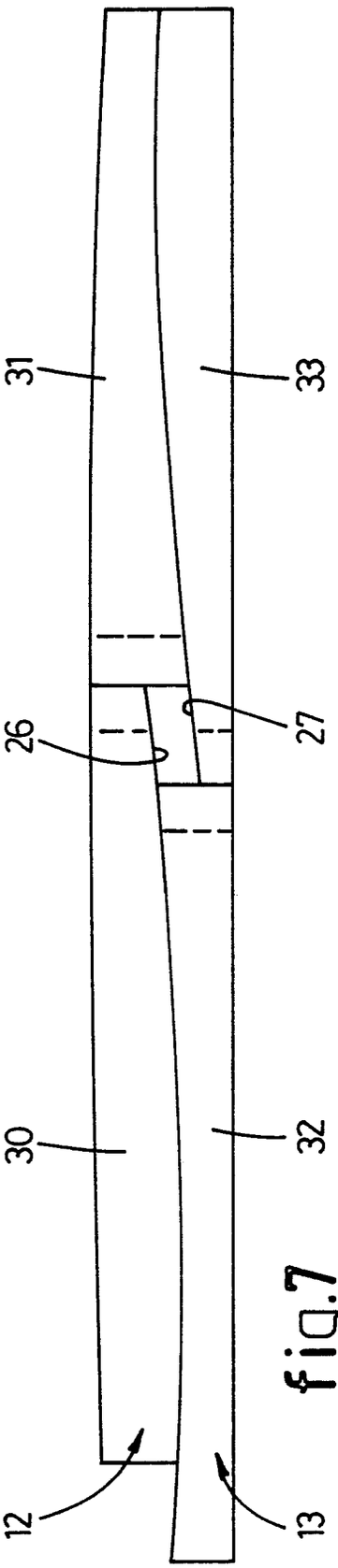

fig.7

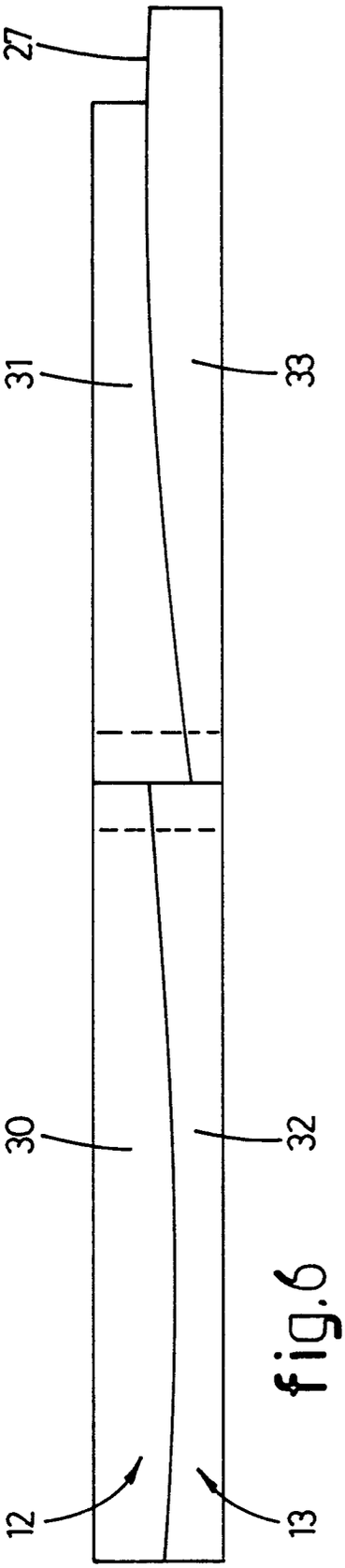

fig.6

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EUROPEAN SEARCH REPORT

Application Number

EP 89 20 0337

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
X	EP-A-0 067 766 (PROMECAM SISSON-LEHMANN) * Page 4, lines 11-16; page 5, lines 27-33; page 6; page 9, lines 18-35; pages 10-14; figures *	1,2,5-9	B 21 D 5/02
X	FR-A- 783 147 (WEINGARTEN) * The whole patent *	1-9	
A	DE-A-2 914 744 (WEINBRENNER)		
A	DE-A-1 452 677 (HEITMANN)		
A	DE-A-1 752 346 (WIRL)		
A	DE-A-2 534 664 (FASTI-WERK)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)
B 21 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23-05-1989	PEETERS L.

CATEGORY OF CITED DOCUMENTS

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