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(54) **Continuous sheet metal bending machine**

(57) A sheet metal bending machine (1) comprising two or more bending stations (2) disposed in series, wherein each station (2) is provided with two opposed forming rollers (3, 4) able to define the bending profile

of the sheet metal. Each forming roller (3, 4) is composed of a pair of rotating elements (3a, 3b; 4a, 4b), coaxial and facing each other. Means are also provided to vary the distance between the rotating elements of each pair.

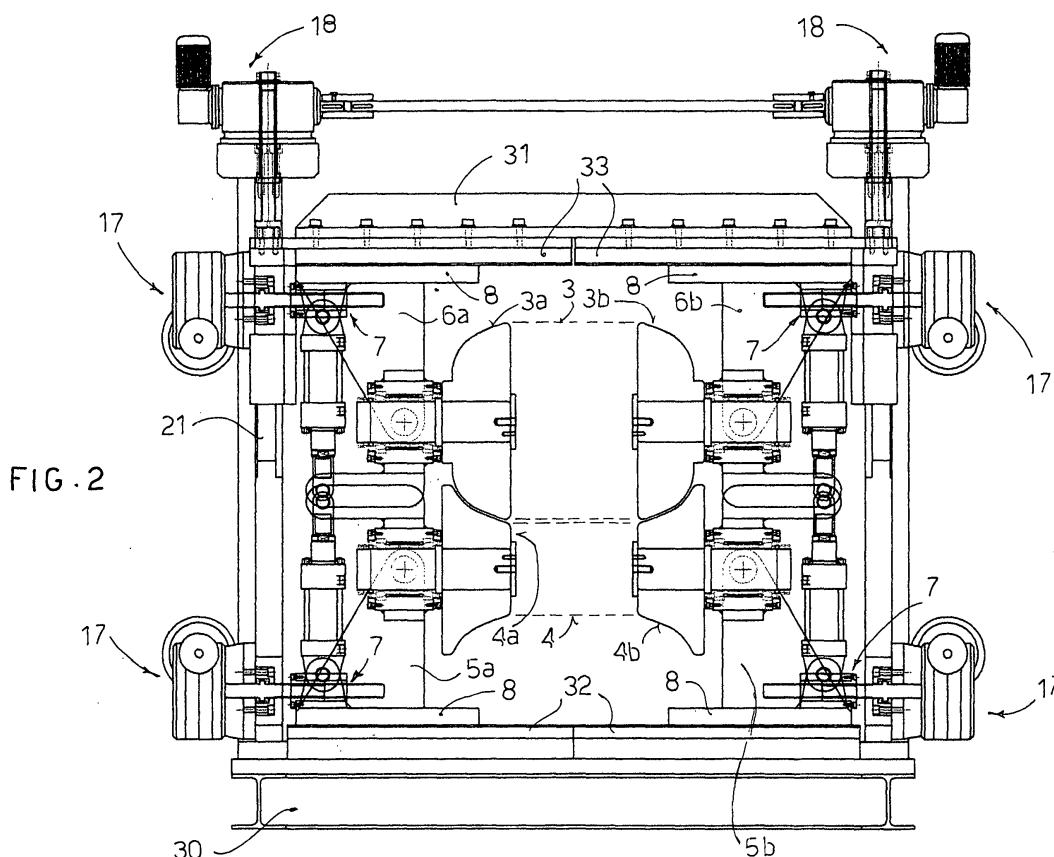


FIG. 2

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## Description

**[0001]** The present invention concerns a machine for continuous sheet metal bending, and in particular a bending machine used in the manufacture of pipes or open profiles.

**[0002]** The bending machines used in pipe manufacturing are those bending machines provided with a series of stations placed in series and suitably spaced apart, wherein each station has a pair of opposed driven forming rollers through which the sheet metal to be processed passes. The rollers of each pair have a complementary profile and in particular, whilst the bottom roller has a concave profile, the top roller has a convex profile which reproduces exactly the curvature of the bottom roller.

**[0003]** Each pair of opposed rollers has a radius of curvature smaller than the radius of curvature of the station situated directly upstream. Therefore, the sheet metal which is in the flat condition at the first station will progressively change its profile as it travels through the machine, taking on a substantially tubular shape at the last station and will thus be ready to be welded.

**[0004]** It is obvious that to obtain tubes of different diameters it is necessary to change the opposed rollers and in particular it is necessary to replace them with rollers that have a different radius of curvature.

**[0005]** Connecting carriages provided with idle rollers which also need to be replaced according to the diameter of the tubes processed by the machine are often placed between the various stations.

**[0006]** Replacement of the rollers and in particular the time required for this operation is therefore one of the most critical factors in the production of pipes by bending.

**[0007]** In the machines currently available on the market, replacement of the rollers requires several hours with complete stoppage, during this period of time, of the machine and thus of production. Furthermore, it is possible that on restarting of operation of the machine, increases in production waste may occur due to imperfect adjustment thereof.

**[0008]** The object of the present invention is to solve the problems of the prior art, providing a machine that allows a reduction in set up times for passing from production of a pipe with a certain diameter to a pipe with a different diameter.

**[0009]** Another object of the present invention is to provide a bending machine that allows the production waste due to setting up of the machine to be eliminated.

**[0010]** Another object of the present invention is to simplify production of sheet metal pipes, reducing down time of the bending machine with a consequent improvement in investment and running costs of the machine.

**[0011]** These and other objects are achieved by the present invention which presents the characteristics of appended independent claim 1.

**[0012]** Advantageous embodiments of the invention are apparent from the dependent claims.

**[0013]** Essentially, the bending machine according to the invention has two or more bending stations disposed in series, each station being provided with two opposed forming rollers to define the bending profile of the sheet metal, and is characterised in that each forming roller is defined by a pair of rotating elements, coaxial and facing each other, and in that means to vary the distance between the rotating elements of each pair are provided.

**[0014]** According to a preferential feature of the present invention, the machine further comprises means for varying the inclination of the axis of rotation of each rotating element.

**[0015]** It is therefore possible to vary the distance of the upper and lower rotating elements and the inclination thereof, thus setting up the machine for producing pipes of different diameters or of open sections provided with different radii of curvature. It no longer being necessary to change the rollers according to the diameter of the tube to be produced, it is possible to achieve high savings in time and consequently in production costs.

**[0016]** Furthermore, it is no longer necessary to have available a plurality of sets of rollers, each dedicated to the production of a particular type of tube or of a particular open profile and this leads to an enormous saving in investment costs of the machine.

**[0017]** According to a preferential feature of the present invention, the means for varying the distance comprise a movable support for the rotating element.

**[0018]** According to an advantageous feature of the present invention, the movable support comprises sliding means slidably engageable on guides of the station to vary the reciprocal distance along the axis of rotation of the facing rotating elements.

**[0019]** Each movable support advantageously comprises sliding means slidably engageable on vertical guides of the station to vary the vertical position of said rotating elements.

**[0020]** According to another feature of the present invention, the means for varying the inclination of said rotating elements comprise a cylinder-piston assembly.

**[0021]** The means for varying the inclination of the two rotating elements advantageously comprise at least two points of hinging.

**[0022]** The possibility of translating and rotating the rotating element allows a wide adjustment thereof allowing the machine to be adapted to production of pipes of different diameter.

**[0023]** Further characteristics and advantages of the present invention will be made clearer by the description that follows, made by way of non-limiting illustration with reference to the appended drawings, in which:

- Figure 1 is a side view of a machine for continuous bending of metal sheet according to the present invention;

- Figure 2 is a sectional front view of a forming station according to the present invention, taken along the line A-A of Figure 1; and
- Figure 3 is a detailed view of a movable support for the rotating element according to the present invention.

**[0024]** With reference to Figure 1 a machine 1 for continuous bending of sheet metal according to the present invention is shown. The bending machine 1 comprises a plurality of stations 2 disposed in series. Each station 2, as can be seen better in Figure 2, is provided with two opposed rollers (3, 4) through which the sheet metal to be processed passes, able to define the bending profile of the sheet metal, that is to say the shape taken on by the sheet metal after passing in the station. Each roller (3, 4) is defined by a pair of coaxial rotating elements (3a, 3b; 4a, 4b), facing each other and appropriately spaced apart from each other. In particular the top roller 3 is defined by the two rotating elements 3a and 3b, whilst the bottom roller 4 is defined by the two rotating elements 4a and 4b. Furthermore, whilst the top rotating element 3a cooperates with the rotating element 4a to which it is opposed and together with which defines the outer left bending profile of the sheet metal, the top rotating element 3b cooperates with the rotating element 4b to which it is opposed to define the outer right bending profile of the sheet metal.

**[0025]** The station 2 is provided with means for varying the reciprocal distance of the two facing rotating elements.

**[0026]** In other words, means are present for horizontally translating along the common axis of rotation the position of the two rotating elements which define the same roller.

**[0027]** Each station is also provided with means, described in greater detail further on, for varying the inclination of each rotating element (3a, 3b; 4a, 4b) and in particular the inclination of the axis of rotation of each rotating element.

**[0028]** This allows the station 2 - and consequently the machine 1 - to be adapted, in a minimum time, to produce pipes or profiles of different diameters.

**[0029]** For this purpose each rotating element (3a, 3b; 4a, 4b) is advantageously supported by a mobile support (5a, 5b; 6a, 6b) provided with sliding means 8 able to engage a guide (not shown) disposed level with the base 30 or with the top 31 of the station 2, parallel to the axes of rotation of the rotating elements. In detail, supports 5a and 5b of the bottom rotating elements slide on slides 32 disposed on the base 30 of the station 2, whilst the top supports 6a and 6b slide on slides 33 disposed at the top 31 of the station 2.

**[0030]** The means for varying the inclination of each rotating element (3a, 3b; 4a, 4b), as can be seen better in Figure 3, are formed by an upright 9 hinged at 16 to an L-shaped crosspiece 10 fixed to a supporting metal tube 23 of the rotating element. The upright 9 in turn

consists of a cylinder-piston assembly formed by a cylinder 11 provided with an inner chamber wherein a piston, not shown directly, slides. The latter is provided with a stem 12 which extends outside the cylinder 11 and is hinged at 16 to the crosspiece 10.

**[0031]** The cross piece 10, at the end not constrained to the upright 9, has a point 14 of hinging with the movable support (5a, 5b; 6a, 6b).

**[0032]** Each supporting metal tube 23, and thus the rotating element (3a, 3b; 4a, 4b) associated therewith, is fixed rotatably to the mobile support (5a, 5b; 6a, 6b) through a pin provided in the hinging point 14 which in this manner forms the pivot around which the rotating element (3a, 3b; 4a, 4b) rotates to vary its inclination.

**[0033]** Furthermore, the upright 9 has, level with its base, a further hinging point 15.

**[0034]** By way of example, with reference to the support shown in Figure 3, raising of the stem 12 of the piston leads to a clockwise rotation, as shown by the arrow F, of the rotating element around the point of hinging 14, whilst on the contrary, lowering thereof leads to an anti-clockwise rotation of the rotating element around the same point 14, as shown again in Figure 3 by the arrow M. The three hinging points 14, 15 and 16 and the cylinder-piston assembly give the station endless possibilities of adjustment which allow same to adapt to the production of different sheet metal pipes or open profiles and to various positions of the machine corresponding to different processing stages.

**[0035]** Positioning relative to the rotating elements (3a, 3b; 4a, 4b) is adjusted by suitable automation means. In particular, there are present hydraulic operating means of the cylinder piston assemblies, four electric motors 17 each of which is dedicated to sliding a support (5a, 5b; 6a, 6b) and two motors 18, disposed at the top of the station 2, for vertical movement of the rollers 3 and 4.

**[0036]** In particular, each support (5a, 5b; 6a, 6b) has, for horizontal translation thereof, a nut screw type engagement 7 with a motor 17.

**[0037]** The top supports 6a and 6b are slidably engaged in vertical guides 21 which allow, under the guidance of the motors 18, vertical translation of said top supports 6a and 6b. Vertical translation of the supports 6a and 6b leads to vertical translation of the rotating elements 3a and 3b.

**[0038]** On the other hand, the bottom supports 5a and 5b are mounted, for their vertical movements, on slides 32 vertically slidable in the guides 21. The slides 32 also are guided in their vertical movements by motors 18 which thus allow the position of the bottom rotating elements 4a and 4b to be varied vertically.

**[0039]** The vertical movements of the opposed rotating elements, although guided by the same motor 18, are separate. In other words, it is possible to raise or to lower the support (6a, 6b) of a top rotating element (3a, 3b) leaving the position of the bottom rotating element (5a, 5b) unchanged or alternatively it is possible to raise

and to lower the top (6a, 6b) and bottom supporting element (5a, 5b) at the same time. The possibility of moving each supporting element (5a, 5b; 6a, 6b) vertically in a separate manner makes it possible to carry out both so-called fixed centre pipe processing - where the axis of symmetry of the pipe remains fixed and thus the sheet metal is bent around said axis as it travels through the successive stations 2 of the machine - and fixed throat processing where the central portion of the metal sheet which will form the bottom end of the pipe remains fixed.

[0040] All the motors 17 and 18 and the cylinder-piston assemblies are adjusted by an electronic processor, not shown, per se known in the art and normally used for this purpose, able to memorize the relative positions of the rotating elements according to the type of pipe or of open section being produced and operate the motors 17, 18 and/or the cylinder-piston assemblies to vary the position of the rotating elements according to the pipe or to the profile processed.

[0041] Furthermore, the processor is able to respond to messages sent by suitable position control instruments, such as optical rulers or incremental encoders, not directly shown, to vary the relative position of the rotating elements (3a, 3b; 4a, 4b) so that the latter match each other perfectly in the pre-set radiuses of curvature.

[0042] The rotating elements of the stations 2 are all idle, but it would nevertheless be possible to motorise them without departing from the scope of the present invention.

[0043] To move the sheet metal between the various stations of the machine, intermediate stations 20 provided with driven rotating members are present between two adjacent stations, as shown in Figure 1.

[0044] As previously mentioned, the rotating elements have a cylindrical shape provided with curved surfaces.

[0045] In detail, the top rotating elements have a convex curved side profile and the bottom rotating elements have a concave curved side profile corresponding to that of the top rotating elements to define together therewith the outer bending shape of the sheet metal.

## Claims

1. A sheet metal bending machine (1) comprising two or more bending stations (2) disposed in series, each of said stations (2) being provided with two opposed forming rollers (3, 4) to define the bending profile of the sheet metal, **characterised in that** each forming roller (3, 4) is defined by a pair of rotating elements (3a, 3b; 4a, 4b) coaxial and facing each other, and **in that** means to vary the distance between the rotating elements (3a, 3b; 4a, 4b) of each pair are provided.
2. A machine (1) according to claim 1, **characterised in that** it comprises means of for varying the incli-

nation of the axis of rotation of each rotating element (3a, 3b; 4a, 4b).

3. A machine (1) according to claim 1 or 2, **characterised in that** said means for varying the distance comprise a movable support (5a, 5b; 6a, 6b) for each rotating element (3a, 3b; 4a, 4b).
4. A machine (1) according to claim 2 or 3, **characterised in that** said movable support (5a, 5b; 6a, 6b) comprises sliding means (8) slidably engageable on guides of said station (2) to vary the distance between said facing rotating elements (3a, 3b; 4a, 4b).
5. A machine (1) according to any one of the preceding claims from 2 to 4, **characterised in that** said moveable support (5a, 5b; 6a, 6b) comprises sliding means slidably engageable on vertical guides (21) of said station (2) to vary their vertical position.
6. A machine (1) according to claims 2 to 5, **characterised in that** said means for varying the inclination of said rotating elements (3a, 3b; 4a, 4b) comprise a cylinder-piston assembly acting on a supporting metal tube (23) of the rotating element, each supporting metal tube being rotatably constrained to a moveable support (5a, 5b; 6a, 6b).
7. A machine (1) according to any one of claims 2 to 6, **characterised in that** said means for varying the inclination of said rotating elements (3a, 3b; 4a, 4b) comprise at least two hinging points.
8. A machine (1) according to any one of the preceding claims, **characterised in that** it further comprises automation means to vary the position of said rotating elements (3a, 3b; 4a, 4b).
9. A machine (1) according to claim 8, **characterised in that** said automation means comprise at least one electric motor, at least one processor and hydraulic operating means for said cylinder-piston assembly.
10. A machine (1) according to any one of the preceding claims, **characterised in that** it comprises control means of the reciprocal position of said rotating elements (3a, 3b; 4a, 4b).
11. A machine (1) according to any one of the preceding claims, **characterised in that** said rotating elements (3a, 3b; 4a, 4b) have a curved profile shape.
12. A machine (1) according to claim 8, **characterised in that** the top rotating elements (3a, 3b) have a convex curved profile and **in that** the bottom rotating elements (4a, 4b) have a concave curved profile corresponding to that of said top rotating elements

(3a, 3b).

13. A machine (1) according to any of the preceding claims, **characterised in that** said rotating elements (3a, 3b; 4a, 4b) are idle. 5
14. A machine (1) according to any one of the preceding claims, **characterised in that** it comprises intermediate stations (20) provided with driven rollers to move the sheet metal between the various stations (2) of the machine (1). 10
15. A station for a bending machine provided with two opposed forming rollers (3,4) to define the bending profile of the sheet metal, **characterised in that** each forming roller (3, 4) is defined by a pair of rotating elements (3a, 3b; 4a, 4b), coaxial and facing each other, and **in that** means for varying the distance between the rotating elements of each pair (3a, 3b; 4a, 4b), means for varying the inclination of the axis of rotation of said rotating elements (3a, 3b; 4a, 4b) and means for vertically moving at least one of said pairs of rotating elements (3a, 3b; 4a, 4b) are provided. 15 20 25

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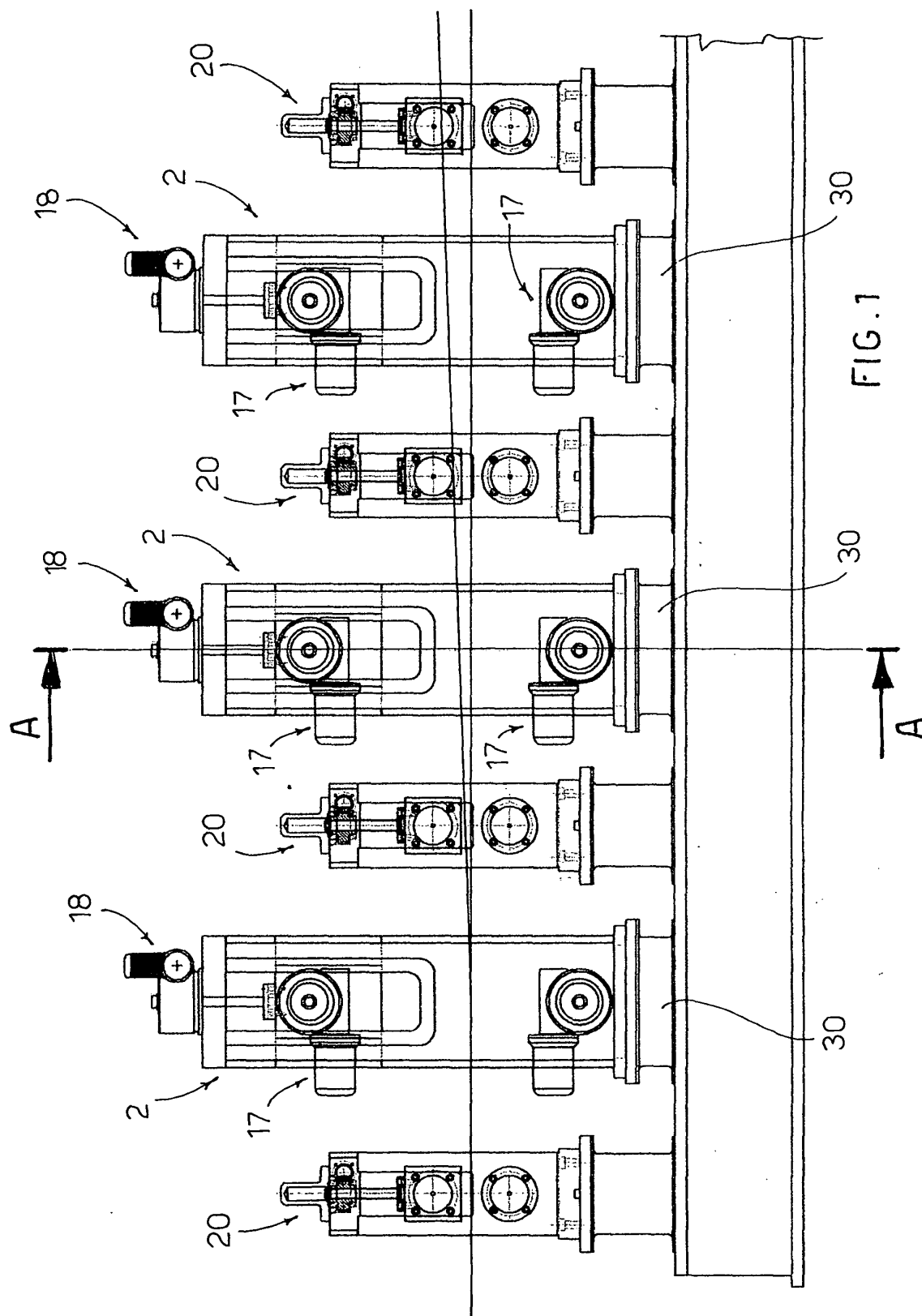
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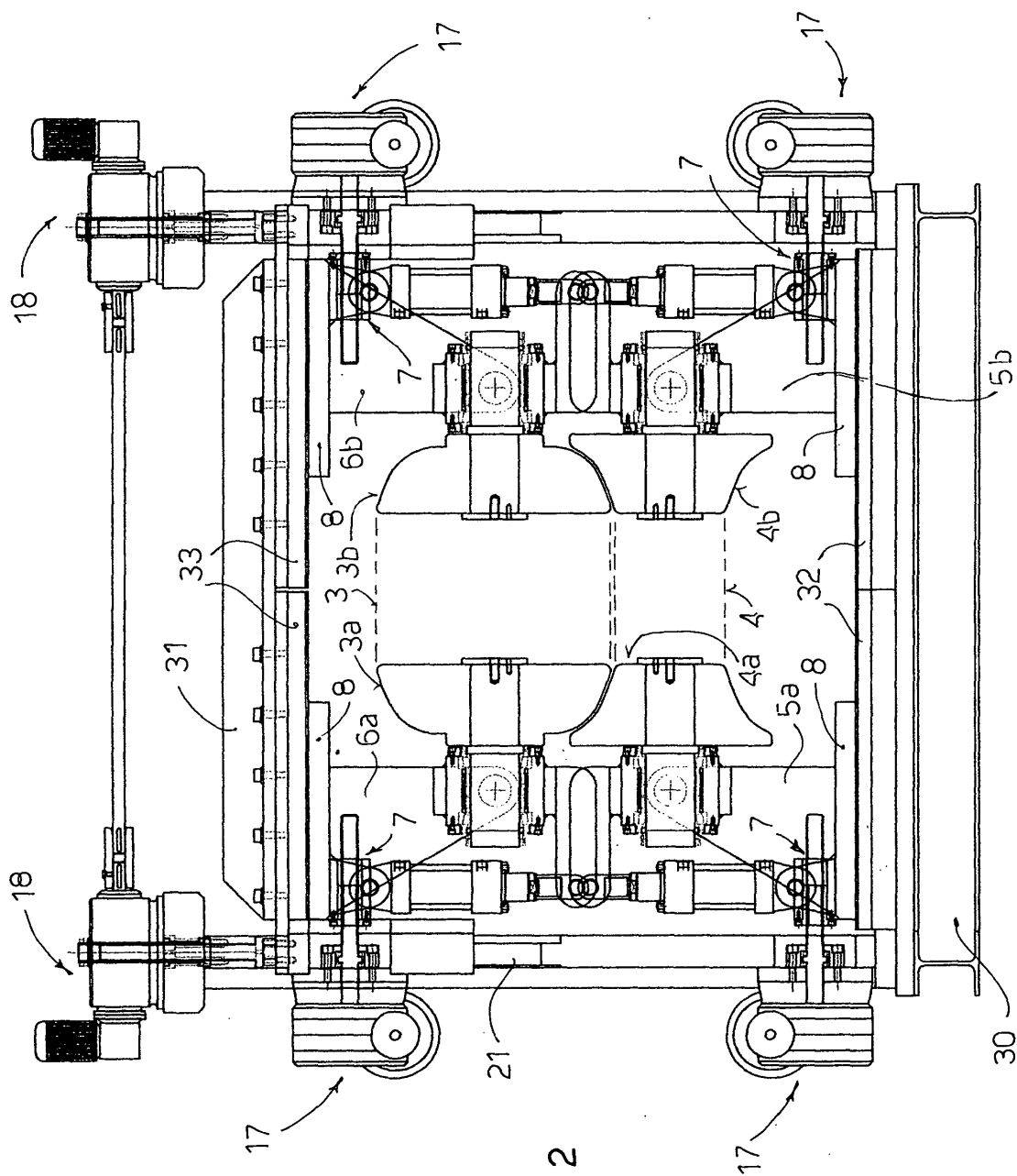
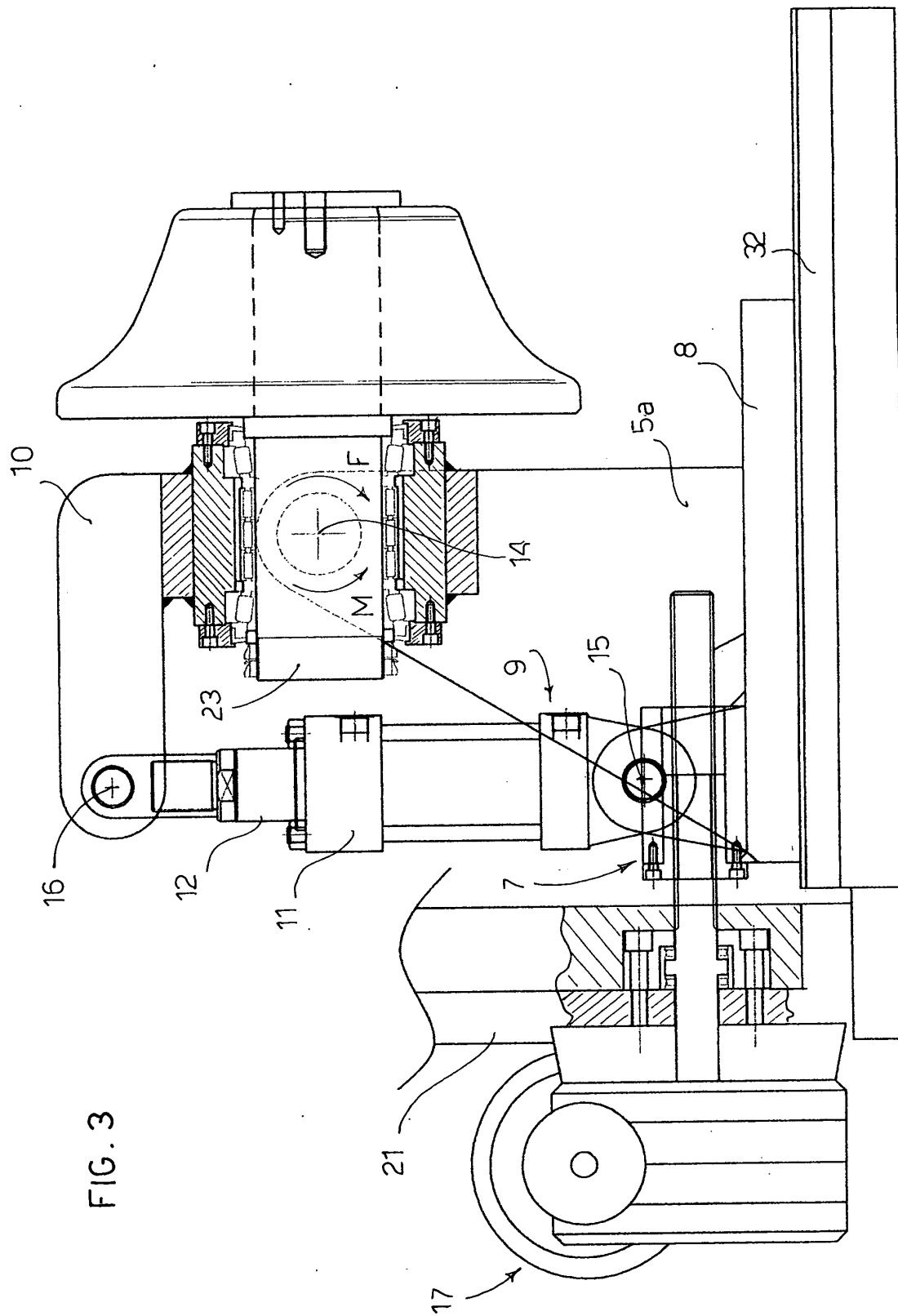


FIG. 2







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# EUROPEAN SEARCH REPORT

Application Number  
EP 03 01 7934

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.7)
X	US 5 704 243 A (HADA KENJI ET AL) 6 January 1998 (1998-01-06) * column 1, line 18-25 * * column 4, line 66 - column 5, line 9; figure 8 *	1-4,7,8, 10-13,15	B21D5/12 B21D5/08
A	* column 8, line 10-23; figure 9 * ---	5,9	
X	US 5 301 869 A (TOYOOKA TAKAAKI ET AL) 12 April 1994 (1994-04-12)	1,3,4,8, 10-12,15	
A	* figures 1-3,7,28,31 * ---	2,5-7,9, 13,14	
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 07, 29 September 2000 (2000-09-29) -& JP 2000 117330 A (AIDA ENGINEERING CO LTD), 25 April 2000 (2000-04-25)	1	
A	* abstract; figures * ---	2-15	
X	PATENT ABSTRACTS OF JAPAN vol. 016, no. 217 (M-1252), 21 May 1992 (1992-05-21) -& JP 04 041021 A (SUMITOMO METAL IND LTD), 12 February 1992 (1992-02-12)	15	TECHNICAL FIELDS SEARCHED (Int.Cl.7) B21D B21C
A	* abstract; figures * --- PATENT ABSTRACTS OF JAPAN vol. 1998, no. 01, 30 January 1998 (1998-01-30) -& JP 09 239448 A (HITACHI METALS LTD), 16 September 1997 (1997-09-16) * abstract; figures * -----	1-7,15	
The present search report has been drawn up for all claims			
Place of search <b>MUNICH</b>		Date of completion of the search <b>19 September 2003</b>	Examiner <b>Meritano, L</b>
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 03 01 7934

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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19-09-2003

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
US 5704243	A	06-01-1998	JP	5317979 A	03-12-1993
			JP	2642575 B2	20-08-1997
			JP	6154888 A	03-06-1994
			DE	69327045 D1	23-12-1999
			DE	69327045 T2	29-06-2000
			EP	0623403 A1	09-11-1994
			WO	9407621 A1	14-04-1994
-----					
US 5301869	A	12-04-1994	JP	4182034 A	29-06-1992
			JP	6098402 B	07-12-1994
			JP	1908857 C	24-02-1995
			JP	3174923 A	30-07-1991
			JP	6036943 B	18-05-1994
			JP	3174922 A	30-07-1991
			JP	3180211 A	06-08-1991
			JP	1972923 C	27-09-1995
			JP	3180212 A	06-08-1991
			JP	6104252 B	21-12-1994
			DE	69027786 D1	14-08-1996
			DE	69027786 T2	09-01-1997
			EP	0607430 A1	27-07-1994
			KR	9311517 B1	10-12-1993
			AU	639738 B2	05-08-1993
			AU	6876791 A	26-06-1991
			CA	2046317 A1	05-06-1991
			WO	9108064 A1	13-06-1991
-----					
JP 2000117330	A	25-04-2000	NONE		
-----					
JP 04041021 0	A		NONE		
-----					
JP 09239448 0	A		NONE		
-----					