(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 644 292 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.10.2013 Bulletin 2013/40

(51) Int Cl.:
B21D 3/05 *(2006.01)*

(21) Application number: **13158408.8**

(22) Date of filing: **08.03.2013**

(84) Designated Contracting States:
AL 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 RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **26.03.2012 IT MI20120468**

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(54) **Apparatus and method for the straightening of pipes on profile machines**

(57) Apparatus for the straightening of a continuously seamed pipe (10) in cold-laminated steel, positioned in line with a forming machine, said apparatus (10) comprising: a plurality of entry stations (3) and at least one exit station (4), comprising pairs of opposite rollers (5) with fixed axes and pre-set on the basis of the profile of the pipe (10); a straightening station (20) placed between said entry station (3) and said at least one exit station (4), comprising a pair of opposite rollers (21) adjustable on the horizontal axis (X) and a pair of opposite rollers (22) adjustable on the vertical axis (Y), said pairs of rollers (21, 22) being motorised and in forced contact with the profile of the pipe (10), said apparatus likewise comprising: a device (30) for the detecting of the position of the axis of the pipe (10) positioned downstream of said at least one exit station (4) of the pipe; a control unit suitable for comparing the data relating to the position detected of the axis of the pipe (10) with reference data relating to the ideal position of this axis and, in case of deviations, sending correction signals to drives (23, 24) respectively of said pairs of rollers (21) on the horizontal axis (X) and (22) on the vertical axis (Y).

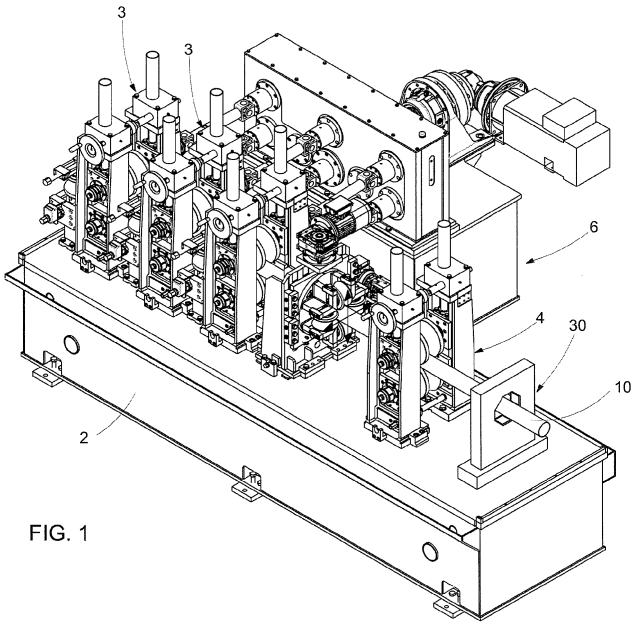


FIG. 1

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Description

[0001] The object of the present invention is an apparatus and a method for the straightening of pipes or tubes_on profile machines.

[0002] In current productions of continuously seamed pipes in cold-laminated steel on profile machines it is necessary to straighten the pipe on the production line by inserting at least one assembly adjustable on the X - Y axes (horizontal and vertical) comprising pairs of opposite rollers which guide the pipe and enclose it on the diameter, keeping it blocked in position.

[0003] The reason why straightening is necessary is that the pipe is formed by successive bendings of strips of sheet metal which are cut longitudinally from reels of coil of greater width, with the possibility of creating tensions or indentations of the coil during cutting. The same reels of coil on the width of lamination may have different thicknesses which after cutting into strips alter the tensions present in the steel.

[0004] Another factor which may cause a displacement of the pipe on the axis of machining is the transformation of the strip of sheet metal into pipe, a process which alters the structure of the steel, causing possible tensions.

[0005] Yet another factor which may cause a misalignment of the pipe is the zone of longitudinal seaming which closes the strip of sheet metal which may take place by different methods, such as TIG, laser, high frequency, etc.

[0006] The factors mentioned above are the reason for having to proceed with a straightening of the pipe in order to keep it in line, whenever, for example, the reel of strip of sheet metal is changed or the system of seaming is altered, increasing or decreasing the temperature of the zone of seaming.

[0007] According to the prior art, the operator has to intervene manually, possibly commanding mechanical or electric members, on the straightening stations, correcting the X - Y axes, in such a way as to seek to maintain the pipe in line.

[0008] The disadvantages of such a solution, which is impractical and is in any case subject to possible errors depending on the ability of the operator, are clear.

[0009] DE19651422 discloses a tube straightening apparatus comprising straightening bodies rotatable with respect to rotation axis and movable by means of adjustment means, guide rollers for the workpiece to be straightened disposed upstream and downstream of the straightening bodies and a control unit detecting the peaks and valleys of the tube surface by means of sensors, said control unit adjusting the force exerted by the straightening bodies on the workpiece surface in order to uniform possible detected surface waviness without, however, detecting any displacement of the axis of the tube.

[0010] US5309746 discloses a straightening apparatus for welded tube wherein the tubes advance along a path developed through a straightener between a first and a second pair of opposed rollers and, thereafter, through an alignment control device of the tube with respect to predefined/desired values, with said control devices generating a signal indicative of the deviation of the actual tube position with respect to a desired position and causing the adjustment of the rollers according to the detected signals so that the tube surface takes the correct position or alignment for the subsequent cutting step, a control station separated from the straightener suitable for measuring the displacement of the cut tube with respect to the straight position; however, said apparatus only performs a correction of the tube path for a correct positioning with respect to a cut station placed downstream of the straightening rollers.

[0011] The object of the invention is that of eliminating the aforesaid disadvantages.

[0012] More particularly an object of the invention is that of allowing an automatic regulation in real time of the stations of straightening of the pipe also in the case of slight misalignments during the forward movement.

[0013] Another object of the invention is that of providing a simple and reliable system for the adjustment of the straightening station.

[0014] These and other objects are achieved by the apparatus and by the method according to the invention with the features disclosed in the annexed independent claims 1 and 6, respectively.

[0015] Advantageous embodiments of the invention are disclosed by the dependent claims.

[0016] Substantially, according to the invention, at the exit of the straightening station, the detecting is provided of the deviation of the axis of the pipe and, on the basis of the possible deviation, the sending of signals of correction on the X- Y axes of the straightening machine.

[0017] Conveniently the deviation of the axis of the pipe is detected by means of laser rays and, by means of special software, correction signals are sent to the motor drives which manage the displacements on the X - Y axes of the straightening station. These axes are conveniently provided with multi-turn absolute encoders.

[0018] Further features of the invention will be made clearer by the following detailed description, referred to one of its embodiments purely by way of a non-limiting example illustrated in the accompanying drawings, in which:

Fig. 1 is a perspective view of an apparatus for the calibrating and the straightening of pipes according to the invention;

Figs. 2 and 3 are respectively a side elevation view and a view from above of the apparatus of Fig. 1;

Fig. 4 is a section taken along the plane IV-IV of Fig. 2;

Fig. 5 is an end view taken in the direction of the arrow F of Fig. 2.

[0019] Referring to these drawings, 1 denotes as a whole an apparatus according to the invention for the

straightening of continuously seamed pipes in cold-laminated steel, positioned in line with a machine for forming of the pipe, denoted by reference numeral 10.

[0020] The pipe 10, which in the accompanying drawings has a circular profile, can obviously have any profile, for example square, rectangular or polygonal, and is obtained in a manner in itself known from a strip of sheet metal by means of progressive bends and continuous longitudinal seaming in order to obtain the pipe profile required.

[0021] Without detriment to the fact that the pipe 10 can have any profile, herein below in this description specific reference will be made to the circular section illustrated.

[0022] The apparatus 1 comprises a base 2, whereon a plurality of stations are provided of entry 3 of the pipe with fixed axes, 3 in number in the example given, and an exit station 4, also with fixed axes. Naturally several pipe exit stations 4 can also be provided.

[0023] The stations 3 and 4, in a manner in itself known, comprise pairs of opposite rollers on the horizontal axis X and on the vertical axis Y, whose position is fixed beforehand on the basis of the "calibre" of the pipe 10 exiting from the forming machine.

[0024] These rollers, generically denoted by reference numeral 5 in the drawings, have a concave profile in order to adapt to the external profile of the pipe 10 with circular section and are motorised. It is however clear that these rollers 5 can have any profile according to the profile of the pipe 10, and can also not be motorised.

[0025] The block to the side of the entry stations 3, denoted generically by reference numeral 6 in Figures 1 and 3, which will not be described further, serves to actuate various parts of these stations 3.

[0026] Between the stations of entry 3 and the station of exit 4 of the pipe 10 a station of straightening or forcing 20 of the pipe 10 is provided, comprising two pairs of opposite rollers with adjustable axes: a first pair of horizontal forcing rollers 21 with vertical axes adjustable along the horizontal axis X (Figure 3) and a pair of vertical forcing rollers 22 with horizontal axes, adjustable along the vertical axis Y (Figure 2). In the drawings reference numerals 23 and 24 denote the drives respectively of the horizontal 21 and vertical 22 pairs of rollers, along the X and Y axes respectively.

[0027] According to the invention, downstream of the station of exit 4 of the pipe 10 a device 30 is provided for the detecting of the axis of the pipe 10.

[0028] In the preferred embodiment schematically shown in Fig. 5, the device for detecting 30 is a device with multi-axis laser beams 31 directed on the exiting pipe 10, such as to determine with extreme exactness the spatial position of the axis of the pipe.

[0029] A control unit in itself known, and which therefore will not be described, will compare the data detected relating to the effective position of the axis of the pipe with the data relating to the ideal position of this axis and, in case of deviation, will send feedback signals to the aforesaid drives 23 and 24 in order to correct the position of the pairs of rollers 21 and 22 respectively on the horizontal axis X or on the vertical axis Y, in such a way as to return in perfect alignment the axis of the pipe 10.

[0030] The straightening of the pipe 10 therefore takes place in a wholly automatic manner and in real time by monitoring continuously the forward movement of the pipe 10 and intervening instantly in order to straighten it in the case of misalignments, unlike what occurs in the prior art, whereby the operator had to intervene manually on the members of adjustment of the straightening station.

[0031] Naturally the device 30 for detecting of the axis of the pipe 10 can be of any other type, not necessarily with laser beams.

[0032] From what has been disclosed the advantages appear clear of the system of straightening of pipes according to the invention with respect to prior art systems.

[0033] Naturally the invention is not limited to the particular embodiment previously described and illustrated in the accompanying drawings, but instead numerous detail changes can be made thereto, within reach of the person skilled in the art, without thereby departing from the scope of the same invention as defined in the annexed claims.

Claims

1. Apparatus for the straightening in continuous and in real time of a continuously seamed pipe (10) in cold-laminated steel, positioned in line with a forming machine, said apparatus (10) comprising:

- a plurality of entry stations (3) and at least one exit station (4), comprising pairs of opposite rollers (5) with fixed axes and pre-set on the basis of the profile of the pipe (10);
- a straightening station (20) positioned between said entry station (3) and said at least one exit station (4), comprising a pair of opposite rollers (21) adjustable on the horizontal axis (X) and a pair of opposite rollers (22) adjustable on the vertical axis (Y), said pairs of rollers (21, 22) being motorised and in forced contact with the profile of the pipe (10),

characterised in that it further comprises:

- a device (30) for multi-axis detecting the position of the axis of the pipe (10) placed downstream of said at least one station of exit (4) of the pipe and suitable for determining the spatial position of the axis of the pipe;
- a control unit suitable for comparing the data relating to the detected position of the axis of the pipe (10) with reference data relating to the ideal position of this axis and, in case of devia-

tions, sending correction signals to drives (23, 24) respectively of said pairs of rollers (21) on the horizontal axis (X) and (22) on the vertical axis (Y).

2. Apparatus according to claim 1, **characterised in that** said device (30) for detecting of the position of the axis of the pipe (10) is a device with multi-axis laser beams (31) directed on the exiting pipe (10).

3. Apparatus according to claim 1 or 2, **characterised in that** the motor drives of the horizontal axis (X) and vertical axis (Y) of the straightening station (20) are provided with multi-turn absolute encoders.

4. Apparatus according to any one of the preceding claims, **characterised in that** said pairs of opposite rollers (5) of at least some of said entry stations (3) with fixed axes of the pipe (10) are motorised.

5. Apparatus according to any one of the preceding claims, **characterised in that** said pairs of opposite rollers (21, 22) of the straightening station (20) have a shape which reproduces the external profile of the pipe (10).

6. Method for the straightening in continuous and in real time of a continuously seamed pipe (10) in cold-laminated steel, exiting from a forming machine, consisting of making said pipe (10) pass in a plurality of entry stations (3) and in at least one exit station (4) with fixed axes and in a straightening station (20) placed between said entry stations (3) and said at least one exit station (4), **characterised in that** it further comprises the following steps:

- detecting in continuous and multi-axis of the position of the axis of the pipe (10) downstream of said at least one exit station (4);
- comparing of the data relating to the position detected of the axis of the pipe (10) with reference data relating to the ideal position of this axis;
- in case of deviations, sending of correction signals of the horizontal axis (X) and/or of the vertical axis (Y) to the straightening station (20).

7. Method according to claim 6, **characterised in that** said detecting of the position of the axis of the pipe (10) takes place by means of multi-axis laser beams (31) directed on the pipe (10).

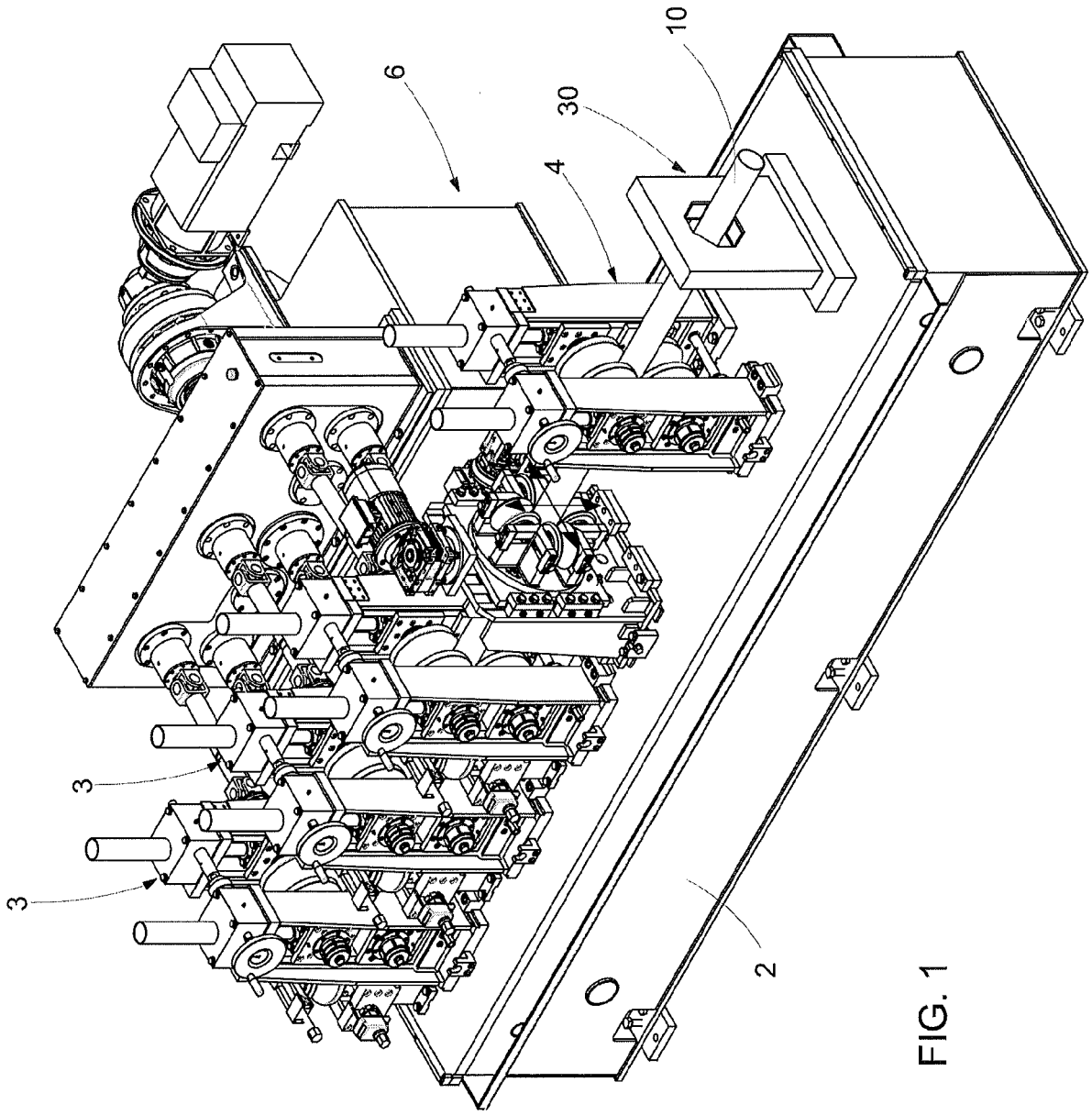


FIG. 1

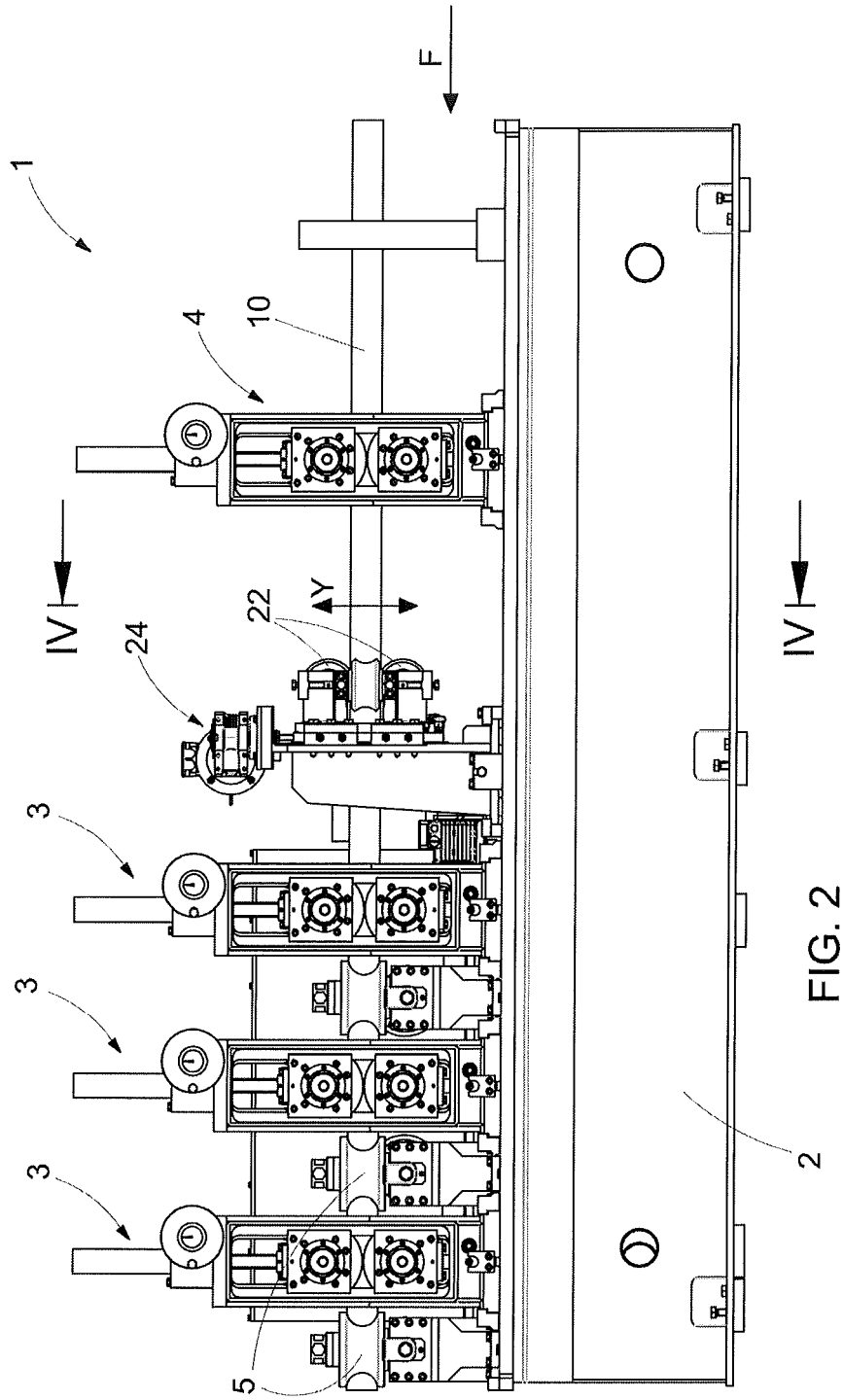
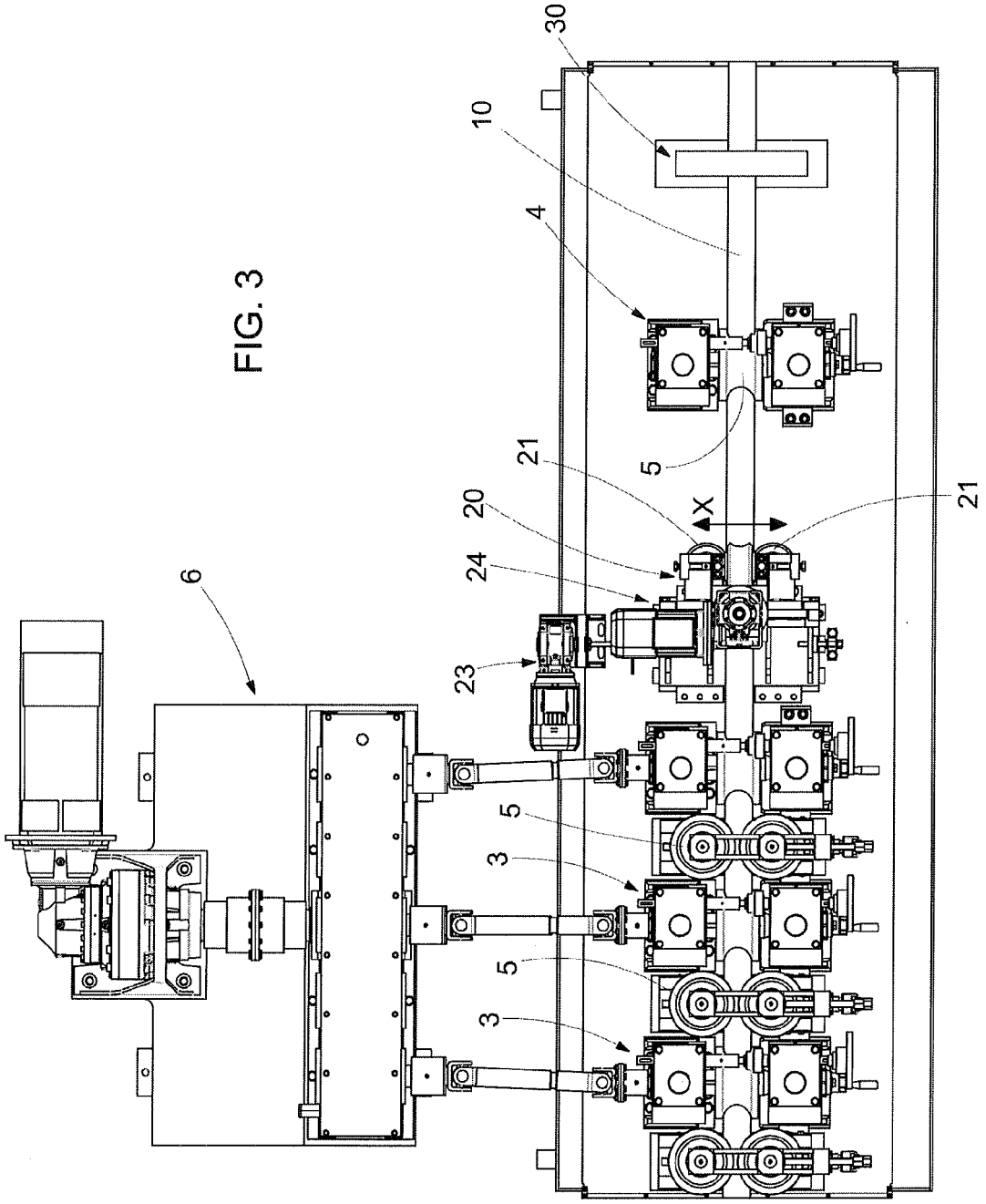


FIG. 2

FIG. 3



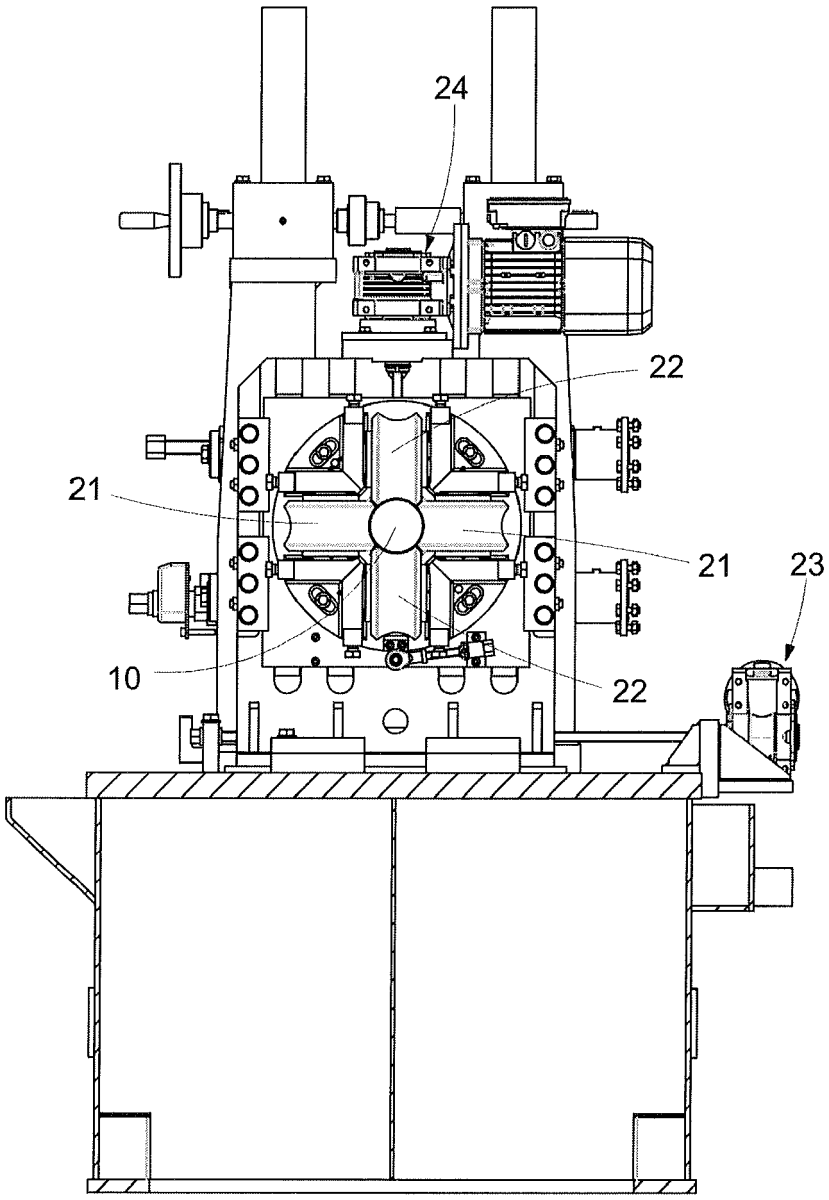


FIG. 4

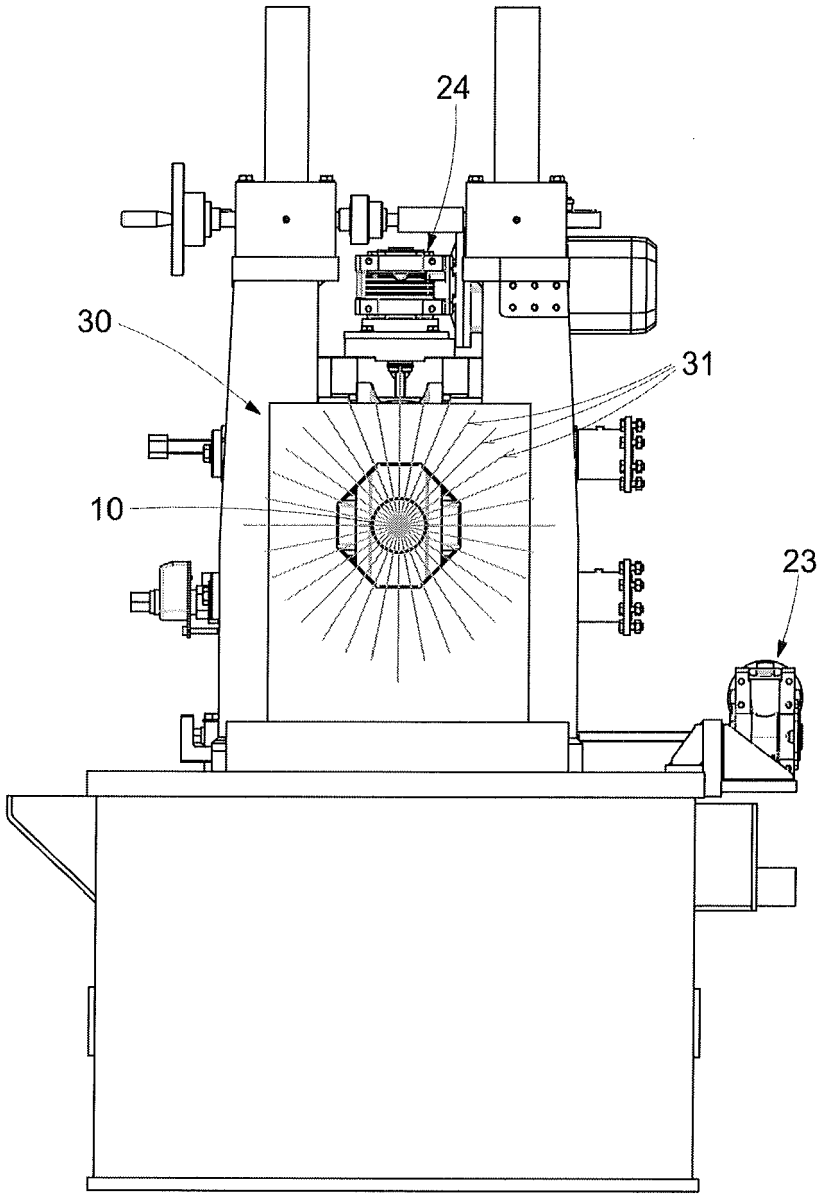


FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 13 15 8408

DOCUMENTS CONSIDERED TO BE RELEVANT

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TECHNICAL FIELDS SEARCHED (IPC)

B21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	6 May 2013	Pieracci, Andrea

CATEGORY OF CITED DOCUMENTS

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

REFERENCES CITED IN THE DESCRIPTION

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