

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: 82304600.8

(51) Int. Cl.<sup>3</sup>: **B 22 D 11/28**  
**B 22 D 11/14**

(22) Date of filing: 01.09.82

(30) Priority: 04.09.81 JP 138426/81

(43) Date of publication of application:  
16.03.83 Bulletin 83/11

(84) Designated Contracting States:  
AT DE FR GB IT

(71) Applicant: Nippon Steel Corporation  
6-3, 2-chome, Ohte-machi  
Chiyoda-ku Tokyo 100(JP)

(72) Inventor: Murakami, Tadashi Nippon Steel Corporation  
Hirohata Works 1 Fuji-cho Hirohata-ku  
Himeji-shi Hyogo-ken(JP)

(72) Inventor: Soejima, Zenzo Nippon Steel Corporation  
Hirohata Works 1 Fuji-cho Hirohata-ku  
Himeji-shi Hyogo-ken(JP)

(72) Inventor: Yamaji, Chihiro Nippon Steel Corporation  
Hirohata Works 1 Fuji-cho Hirohata-ku  
Himeji-shi Hyogo-ken(JP)

(72) Inventor: Kitamura, Haruo Nippon Steel Corporation  
Plant & Machinery Division 46-59 Oaza Nakabaru  
Tobata-ku Kitakyushu-shi Fukuoka-ken(JP)

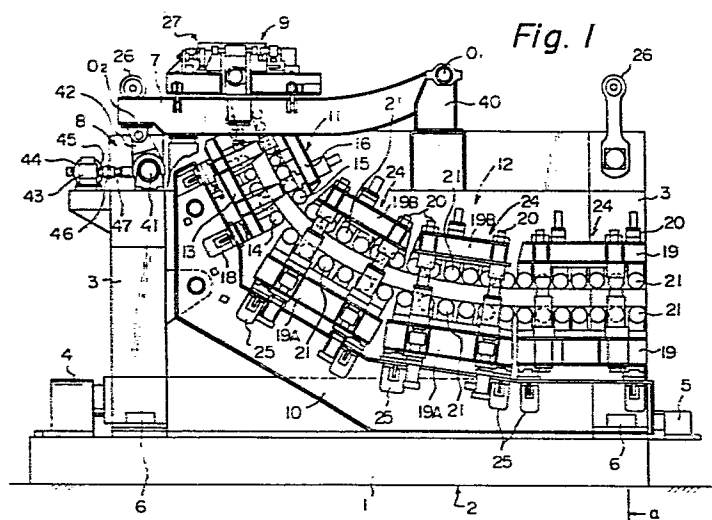
(74) Representative: Pears, David Ashley et al,  
REDDIE & GROSE 16 Theobalds Road  
London WC1X 8PL(GB)

(54) Multi-point straightening bow type continuous-casting machine having a low machine height.

(57) Continuous-casting machine (CCM) which comprises a curved mold (9), an oscillating means (8) for imparting oscillation movement to the curved mold (9), a strand-guiding means (11) in which a plurality of pairs of upper and lower supporting rolls (15, 14) are arranged so as to guide a strand along the basic radius of the curve, a multi-point straightening means (12) in which a plurality of pairs of upper and lower straightening rolls (21) for straightening the strand is arranged and which defines curves having successively increasing radii, and a guiding means for guiding the strand in a horizontal direction.

Maintenance and roll-alignment adjustment of the curved strand-guiding path of the above-mentioned CCM are facilitated in that said CCM further comprises a removable and exchangeable strand (3), which is placed on a stand-carrying base frame (1) and which is provided with the curved mold (9) and the oscillating means (8), and a main frame (10), which is connected to the stand (3) and in which the strand-guiding means (11) and the multi-point straightening means (12) are removably and exchangeably arranged, whereby the curved mold (9), the oscillating means (8), the strand-guiding means (11), and the multi-point straightening means (12) are set in a block in a single stand which is removably and exchangeably arranged at a predetermined position on the base frame.

./...



MULTI-POINT STRAIGHTENING BOW TYPE  
CONTINUOUS-CASTING MACHINE HAVING  
A LOW MACHINE HEIGHT

The present invention relates to an improvement in a multi-point straightening type continuous-casting machine (CCM) having a low machine height, which machine comprises a curved mold; an oscillating means for imparting oscillation  
5 movement to the curved mold; a strand-guiding means in which a plurality of pairs of upper and lower supporting rolls is arranged so as to guide a strand along the basic radius of the curve; a multi-point straightening means in which a plurality of pairs of upper and lower straightening rolls  
10 for straightening the strand is arranged and defines curves having successively increasing radii; and a horizontal guiding means for guiding the strand in a horizontal direction. The present invention remarkably improves the maintainability of the parts and equipment of the above-  
15 -mentioned continuous-casting machine constituting the curved path for guiding the strand.

The above described CCM having a low machine-height (low-head) is described in Japanese Unexamined Patent Publication (Kokai) Nos. 56-14062 through 56-14065. The  
20 above-mentioned Japanese unexamined patent publications disclose, in a specific embodiment, a multi-point straightening bow-type low-head CCM with a machine height of a little less than 6 m, a continuous five-point straightening means, and a basic radius of the curve of the curved mold and the  
25 strand-guiding means of 5800 mm. In such a low-head CCM, casting is carried out under a low casting-speed in the range of from 0.7 to 0.75 m/min and under moderate cooling. The continuous five-point straightening means can straighten strand portions where the molten steel has not yet solidi-  
30 fied, i.e., the percentage of solidification of the molten steel is from 40% to 70%, and the solidified shell has high-temperature and is thin: The ferrostatic pressure

applied to said strand portions is low and the straightening internal-strain at each of the five straightening points is 0.35% or less.

The result is a high temperature strand, the surface  
5 temperature of the strand portion in the continuous five-point straightening means being in the range of from 900°C to 1000°C, of a quality not only not inferior to but improved over that of a strand obtained by means of a conventional bow-type CCM having a high machine height  
10 (high-head CCM), in which the basic radius of the curve is from 10.5 to 12.5 m and the straightening of a strand is carried out by means of single unbending or one-point straightening.

An object of the present invention is to provide such a  
15 low-head CCM in which the maintainability of the parts and equipment of the low head CCM constituting the curved strand-guiding path is remarkably improved.

The basic thinking behind the low-head CCM of the present invention is as follow.

20 Trial calculations by the present inventors showed that the total weight of the equipment constituting the curved strand-guiding path in a low-head CCM with a basic curve radius from 3 to 5 m and a 3- to 16-point straightening means, is roughly equal to the total weight of a package  
25 exchangeable stand: comprising, as a set, a curved mold, an oscillating means for imparting oscillation movement to the curved mold, and a strand-guiding means including one or more supporting rolls in a high-head CCM with a basic curve radius from 10.5 to 12.5 m and a one-point straightening  
30 means and that, therefore, it is possible to incorporate into one stand the curved portion of the low-head CCM, comprising a mold-oscillating means, a strand-guiding means, and a multi-point straightening means, and convey this stand by a crane apparatus for package exchange without having to  
35 increasing conventional crane capacities.

The present invention was made on the basis of the above-mentioned discovery.

The gist of the present invention resides in a multi-point straightening bow-type low-head CCM which comprises a curved mold, an oscillating means for imparting oscillation movement to the curved mold, a strand-guiding means in which a plurality of pairs of upper and lower supporting rolls are arranged so as to guide a strand along the basic radius of the curve, a multi-point straightening means in which a plurality of pairs of upper and lower straightening rolls for straightening the strand is arranged and defines curves having successively increasing radii, and a horizontal guiding means for guiding the strand in a horizontal direction. The CCM is characterized in that it further comprises a removable and exchangeable stand, which is placed on a stand-carrying base frame and which is provided with the curved mold and the oscillating means, and a main frame which is connected to the stand and on which the strand-guiding means and the multi-point straightening means are removably and exchangeably arranged. The curved mold, oscillating means strand-guiding means, and multi-point straightening means are thus set in a block in the single stand which is removably and exchangeably arranged at a predetermined position on the base frame.

The present invention is hereinafter described with reference to the drawings, wherein:

Fig. 1 is an explanatory front view of a multi-point straightening bow type low-head CCM according to one embodiment of the present invention; Fig. 2 is a side view of the leg of the stand shown in Fig. 1, as seen in a direction of the arrow a; Fig. 3 is a front view of a preferred embodiment of a strand-straightening roll segment constituting the multi-point straightening means shown in Fig. 1; Fig. 4 is a cross-sectional view along line A-A of Fig. 3; Fig. 5 is a cross-sectional view along line B-B of Fig. 4; Fig. 6 is an enlarged cross-sectional view of the portion of Fig. 3; and Fig. 7 is an explanatory view of the oscillating means of the low-head CCM.

Figure 1 illustrates one embodiment of the present

invention. In Fig. 1, a stand-carrying base frame 1 for carrying a stand 3 is secured to the upper surface of a foundation 2. The stand 3 is secured to a predetermined position on the base frame 1 while being held between a stand-fixing means 4 and a stand-pressing means 5. A guide 6 secured to the base frame 1 serves to regulate the position where the stand 3 is secured to the base frame 1.

Figure 2 is a side view of the leg of the stand 3 shown in Fig. 1. In Fig. 2, a projection 22 provided on the base frame 1 fits in a groove 23 formed in the lower surface of the leg of the stand 3 so as to regulate the position where the stand 3 is secured to the base frame 1.

Referring back to Fig. 1, an oscillating table 7 mounted on the stand 3 is caused to oscillate by an oscillating means 8. The oscillating means 8 is mounted on the stand 3. A curved mold 9 is mounted on the oscillating table 7.

The oscillating table 7 is pivotably supported at its supporting point  $O_1$  and at its oscillation point  $O_2$  by means of a blanket 40 mounted on the stand 3 and by means of an oscillating-driving lever 42 including an oscillation-generating cam shaft 41 of the oscillating means 8, respectively. An oscillation-driving reduction unit 43 and a driving motor 44 are also mounted on the stand 3. A rotary driving shaft 47 of the oscillation-generating cam shaft 41 is connected to a rotary driving shaft 45 of the reduction unit 43 through a coupling 46. The rotation of the rotary driving shaft 47 is transmitted to the oscillation-generating cam shaft 41 through a transmission mechanism (not shown).

A main frame 10 is connected to and is located within the stand 3. A strand-guiding means 11 and a multi-point straightening means 12 are removably and exchangeably mounted on the main frame 10. The strand-guiding means 11 is one conventionally used in the high-head CCM and is composed of a strand-guiding roll segment consisting of a plurality of pairs of upper and lower supporting rolls. More particularly, the strand-guiding roll segment comprises a plurality of

lower supporting rolls 14 rotatably supported by a lower segment frame 13 and a plurality of upper supporting rolls 15 rotatably supported by an upper segment frame 16. Each of the upper supporting rolls 15 has a corresponding lower supporting roll 14 positioned opposite thereto. The upper segment frame 16 is connected to the lower segment frame 13 through a coupling rod (not shown). The strand-guiding means 11, in the form of a segment, is connected to the main frame 10 by a coupling 18. Each of the lower supporting rolls 14 of the strand-guiding means 11, whose lower frame 13 is mounted on the main frame 10, is arranged along the basic radius of the curve.

The multi-point straightening means 12 comprises a series of three strand-straightening roll segments 24 arranged removably and exchangeably on the main frame 10. Each of the strand-straightening roll segments 24 comprises a plurality of pairs of straightening rolls 21 rotatably supported on opposing surfaces of a lower segment frame 19A and an upper segment frame 19B. The upper segment frame 19B is removably secured to coupling rods 20 installed at four corners of the lower segment frame 19A. The straightening rolls 21, which are rotatably supported by the lower segment frame 19A, are positioned so as to define curves having successively increasing radii. The strand-straightening roll segments 24 are connected to the main frame 10 by means of a coupling 25.

A guiding means for guiding a strand in the horizontal direction (horizontal guiding means) comprises a group of horizontal guiding roll segments and is installed after the multi-point straightening means 12 located within the stand 3. The horizontal guiding means is not shown in the drawings. Reference numeral 26 denotes a lifting fitting provided on the stand 3.

In accordance with a low-head CCM 27 having the above-mentioned structure, the curved mold 9, the oscillating means 8, the strand guiding means 11 and the multi-point straightening means 12 are directly or indirectly set in the

single stand. In addition, release of the force of the stand-pressing means 5, pressing the stand 3 against the stand-fixing means 4 allows rapid exchange of the stand 3 with another stand (not shown) of the same construction, located off line and ready for use, by means of a crane (not shown). After the stand 3 is removed off line from the base frame 1, the curved strand-guiding apparatus, which comprises the curved mold 9, the strand-guiding means 11, and the multi-point straightening means 12, i.e., the three strand-  
10 -straightening roll segments 24, can be subjected to inspection and maintenance. If necessary, the curved mold 9, the strand-guiding means 11 or the multi-point straightening means 12 can then be replaced.

The low-head CCM of the present invention therefore  
15 enables roll-alignment adjustment between the segments 11, 24 off line, compared with the conventional high-head CCM where such roll alignment adjustment has been effected on line. Therefore, more precise roll-alignment adjustment becomes possible in the present invention.

20 Generally, when the stand 3 is off line for exchange of the straightening rolls 21, supported by the opposing surfaces of the segment frame 19, of the three strand-straightening roll segments 24, the multi-point straightening means 12 is removed from the main frame connected to the  
25 stand 3.

Referring to Fig. 7, the oscillation-driving reduction unit 43 and the driving motor 44 of the oscillating means 8 are mounted on a holder 48 secured to the foundation 2. The oscillation-generating cam shaft 41 of the oscillating  
30 means 8 is mounted on the stand 3 which is removably and exchangeably placed on the stand-carrying base frame 1. The rotary driving shaft 45 of the oscillation driving reduction unit 43 is removably connected to the rotary driving shaft 47 of the oscillation-generating cam shaft 41 through a connecting and disconnecting mechanism 49. So as to minimize  
35 the time required for the exchange work of the stand 3, the numbers of necessary oscillation-driving reduction units 43

and driving motors 44 have been keep at one each.

The construction of the connecting and disconnecting mechanism 49 is as follows. A spline shaft 50 is fitted to the rotary driving shaft 45 of the oscillation-driving  
5 reduction unit 43. A shaft 51 having a spline bore is fitted to the end of the rotary driving shaft 47 of the oscillation-generating cam shaft 41. A bearing 52 located on the holder 48 is displaceable forward and backward guided by a guide 58. A transmission shaft 53 is rotatably sup-  
10 ported by the bearing 52. The end portion of the transmission shaft 53 forms a spline shaft 54 which is removably fitted in the spline bore of the shaft 51.

A shaft 55 has a spline bore into which the spline shaft 50 of the oscillation-driving reduction unit 43 is  
15 inserted, is slidable in the direction of the spline shaft 50, and is fitted in the rear end of the transmission shaft 53.

A hydraulic cylinder 56 is connected to the rear end of the guide 58 located on the holder 48. The cylinder shaft 57 is connected to the bearing 52.

20 With the above connecting and disconnecting mechanism 49, forward driving of the hydraulic cylinder 56 of the holder 48 enables connection of the rotary driving shaft 45 of the oscillation-driving reduction unit 43, located on the holder 48, to the rotary driving shaft 47 of the oscillation-  
25 -generating cam shaft 41, installed on the stand 3 mounted on the stand-carrying base frame 1. Backward driving of the hydraulic cylinder 56 enables release of the above connection.

Now, with the multi-point straightening means 12 of the low-head CCM 27 (Figs. 1 and 7), a larger number of straight-  
30 ening points is preferable so as to disperse the strain. For this reason, the diameter of and the distance between the straightening rolls 21 are smaller than those of rolls of a strand-guiding roll segment of a high-head CCM. With such a roll arrangement, one-piece rolls of a two-point  
35 support structure after unsatisfactory mechanical strength as the straightening rolls 21, though the case may vary depending on the width of the strands. It is therefore

preferable to use rolls supported at three or more points, i.e., so-called divided rolls, as the straightening rolls.

In the strand-guiding roll segment of the conventional high-head CCM, the rolls supported by the upper or lower segment frames are rotatably and removably disposed in roll-bearing boxes secured to the frame surface by means of nuts and bolts.

Use of the above-mentioned roll removable method of the high-head CCM for the divided rolls of the low-head CCM (Figs. 1 and 7), however, would mean three or more bearing boxes would have to be detached from the frame surface. This would take a disadvantageously long time when exchanging all of the large number of divided rolls arranged in the multi-point straightening means 12.

In order to eliminate the above-mentioned disadvantage, strand-straightening roll segments having the structure shown in Figs. 3 through 6, in which divided rolls can be easily exchanged, are used for the strand-straightening roll segments 24 of the multi-point straightening means 12 shown in Fig. 1.

Figure 3 is a front view of the strand-straightening roll segment 24. Figure 4 is a cross-sectional view along line A-A of Fig. 3. Figure 5 is a cross-sectional view along line B-B of Fig. 4. Figure 6 is an enlarged cross-sectional view of the portion of Fig. 3.

Referring to Figs. 3 through 6, each of the lower and upper segment frames 19 A and B is provided with rectangular apertures 29 into which a cassette frame 28 for supporting divided straightening-rolls is fitted. Furthermore, screw shafts 30 (Fig. 6) are screwed at the two outer sides of the rectangular apertures 29. A pair of straightening rolls 21 each having roll-bearing boxes 31 at the ends thereof are placed in juxtaposition to each other. The roll-bearing boxes 31 are secured to the cassette frame 28 in a conventional manner. Taper surfaces 33 are formed at the bottom surfaces of the two ends of the cassette frame 28,

which surfaces are positioned in the rectangular apertures 29. The two taper surfaces 33 are opposite to one another. In addition, the two ends of the cassette frame 28 are provided with penetrating apertures 32 through which the screw shaft 30 of the lower and upper segment frames 19 A and B is projected. Thus, a cassette type roll assembly 34 is constructed.

In Fig. 6, the screw shaft 30 is fitted in a taper block 36 having an elliptical aperture 35. The end of a bolt 38 engaged with a nut means 37 is secured to the upper surface of the cassette frame 28 outside the taper block 36. A bolt 38 engaged with the nut means 37 is connected at an end thereof to the rear surface of the taper block 36 so that the taper block 36 can be displaced forward and backward by rotation of the bolt 38.

When the cassette type roll assembly 34 is mounted on the lower and upper segment frames 19 A and 19 B, the screw shafts 30 are fitted in the penetrating apertures 32 of the cassette frame 28 of the cassette type roll assembly 34 so that the cassette frame 28 rests on the tapered surface of the taper block 36. Then the taper block 36 is displaced forward and backward by rotating the bolt 38, thereby to condition the roll surface. Thereafter, nuts 39 (Fig. 3) are engaged with the screw shafts 30 so as to fix the cassette type roll assembly 34 in place.

The lower and upper segment frames 19 are connected to each other by means of the coupling rods 20 in a conventional manner, as shown in Fig. 3. In accordance with the strand-straightening roll segment 24 comprising the lower and upper segment frames 19 A and 19 B and with the removable cassette type roll assembly 34, the divided straightening rolls 21 can be rapidly exchanged with new divided straightening rolls (not shown) merely by removing two nuts 39 on both sides of the cassette frame 28 and by exchanging the corresponding cassette type roll assembly 34 with a spare cassette type roll assembly (not shown). Also, the roll alignment adjustment of the new

divided straightening rolls 21 can be carried out merely by adjusting the position of the taper blocks 36 on both sides of the cassette frame 28. Therefore, the roll alignment adjustment can also be effected rapidly and certainly.

- 5       After the cassette type roll assembly 34 is removed from the lower and upper segment frame 19 A and 19 B, the divided straightening rolls 21 may be removed from the cassette frame 28 and exchanged with other divided straightening rolls.

CLAIMS

1. A multi-point straightening bow-type continuous-casting machine having a low machine height which comprises a curved mold, an oscillating means for imparting oscillation movement to the curved mold, a strand-guiding means in which  
5 a plurality of pairs of upper and lower supporting rolls are arranged so as to guide a strand along the basic radius of the curve, a multi-point straightening means in which a plurality of pairs of upper and lower straightening rolls for straightening the strand is arranged and defines curves  
10 having successively increasing radii, and a horizontal guiding means for guiding the strand in a horizontal direction; characterized in that said continuous casting machine further comprises a removable and exchangeable stand (3), which is placed on a stand-carrying base frame (1)  
15 and which is provided with said curved mold and said oscillating means, and a main frame (10) which is connected to said stand (3) and on which said strand-guiding means (11) and said multi-point straightening means (12) are removably and exchangeably arranged, whereby said curved mold, said  
20 oscillating means, said strand-guiding means (11), and said multi-point straightening means (12) are set in a block in the single stand which is removably and exchangeably arranged at a predetermined position on said base frame.

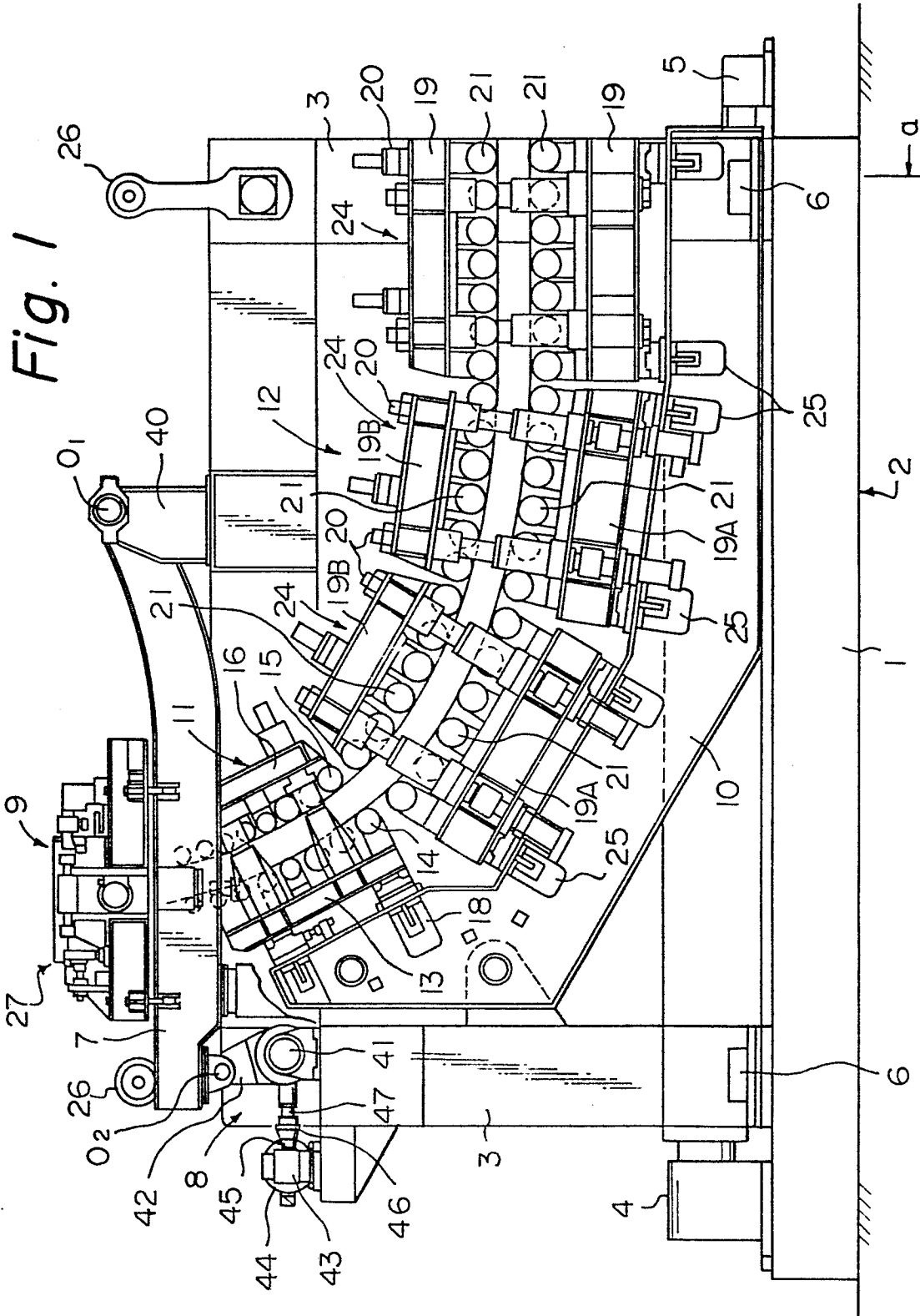
2. A continuous-casting machine according to claim 1,  
25 wherein an oscillation driving reduction unit (43) and a driving motor (44) of said oscillation means (8) are mounted on a holder (48) secured to the foundation, an oscillation-generating cam shaft (41) of said oscillation means (8) is mounted on said stand (3) which is removably and exchangeably  
30 placed on said stand-carrying base frame (2), and a rotary driving shaft (45) of said oscillation-driving reduction unit (43) is removably connected to said rotary driving shaft (45) of said oscillation-generating cam shaft (41).

3. A continuous casting machine according to claim 1  
35 or 2, wherein a plurality of pairs of straightening rolls (21) are supported by lower and upper segment frames

(19 A and 19 B) which is provided with rectangular apertures (29) into which a cassette frame (28) for supporting divided straightening rolls (21) is inserted.

4. A continuous casting machine according to claim 3, wherein said cassette frame (28) is provided with taper surfaces (33) on a portion of the surfaces thereof, said surfaces being positioned in said rectangular apertures (29), and a taper block (36) which is displaced by a bolt (38) is engaged with each of said taper surfaces (33).

10 5. A continuous casting machine according to claim 1, wherein said strand-guiding means (11) and said multi-point straightening means (12) comprise lower and upper segment frames (13, 16) and (19A, 19B), respectively, for supporting a plurality of pairs of rolls.



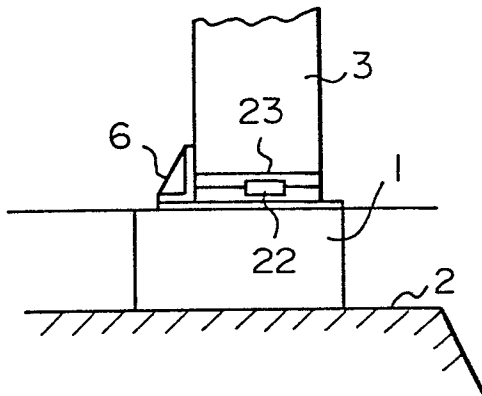
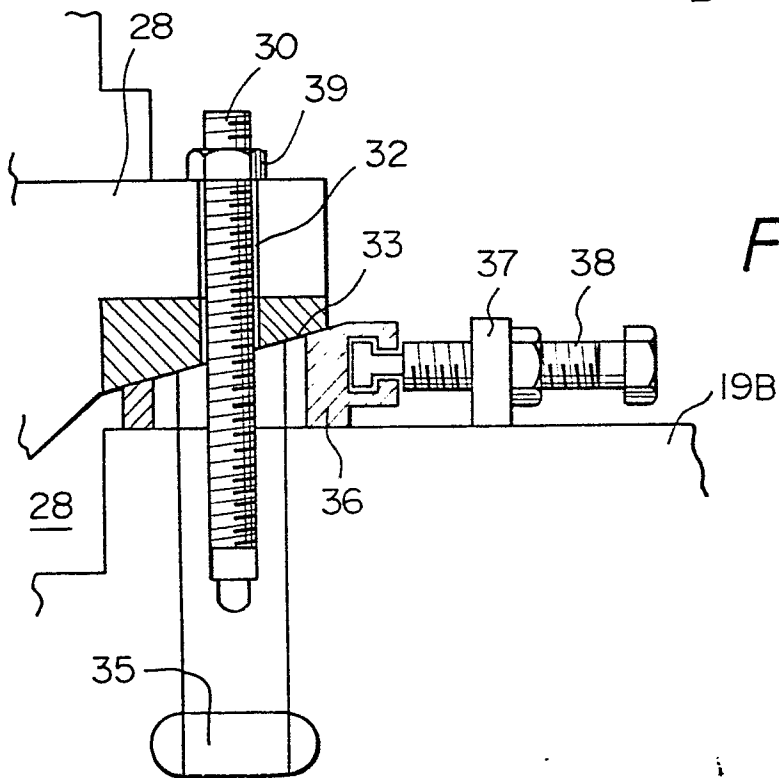
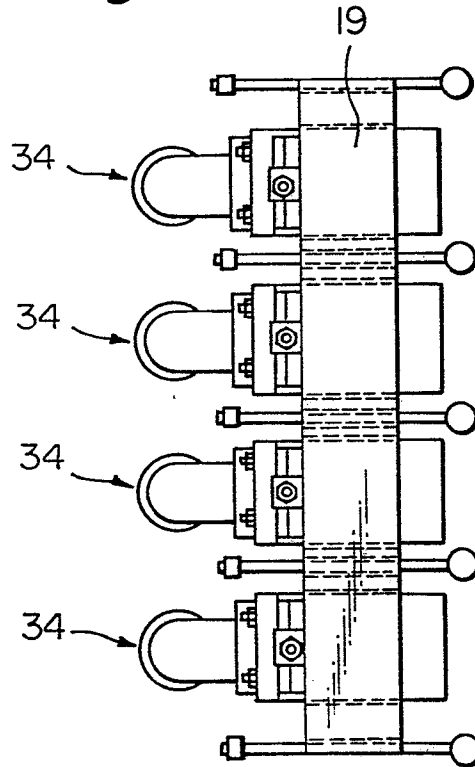
*Fig. 2**Fig. 5**Fig. 6*

Fig. 3

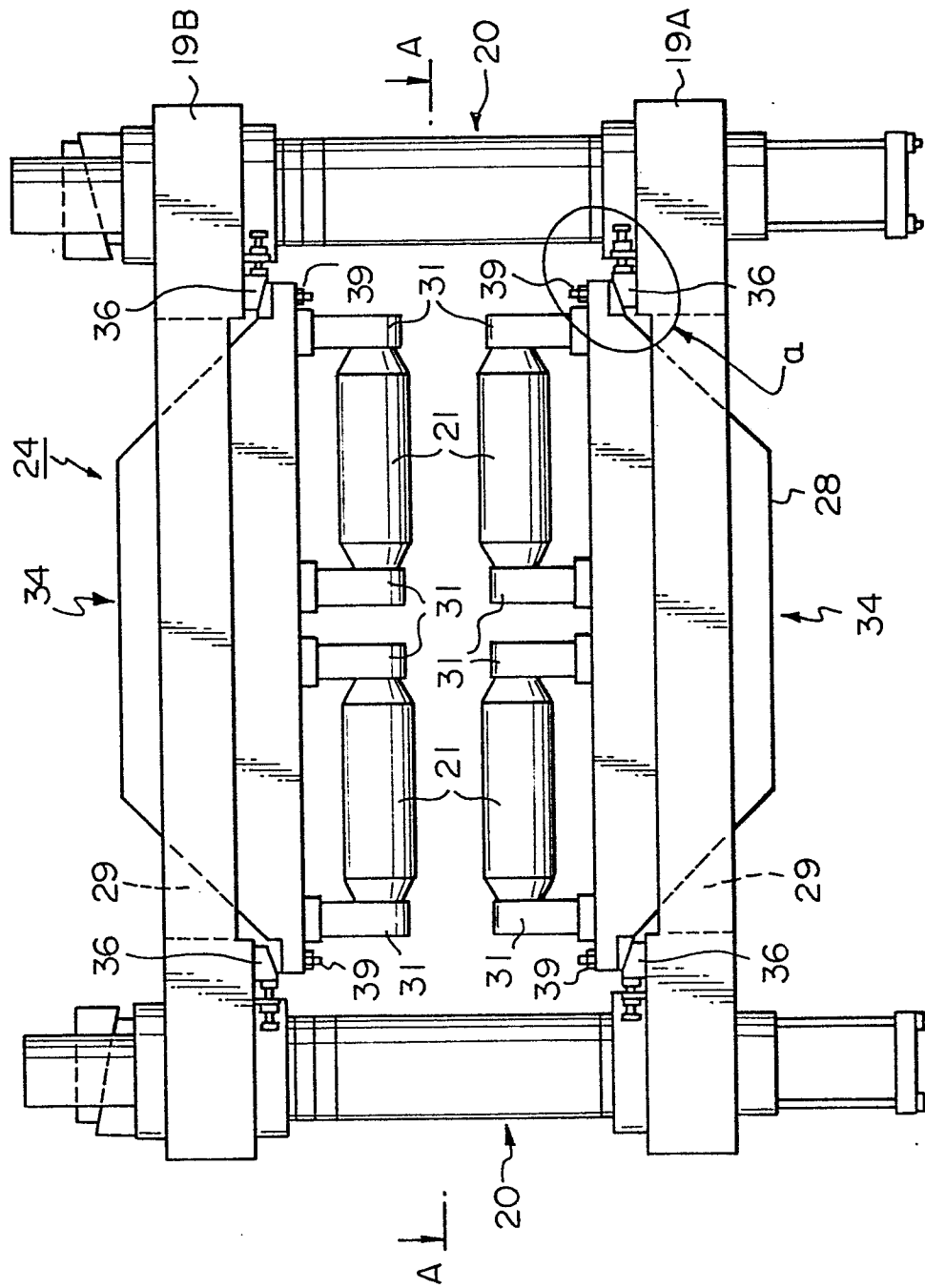
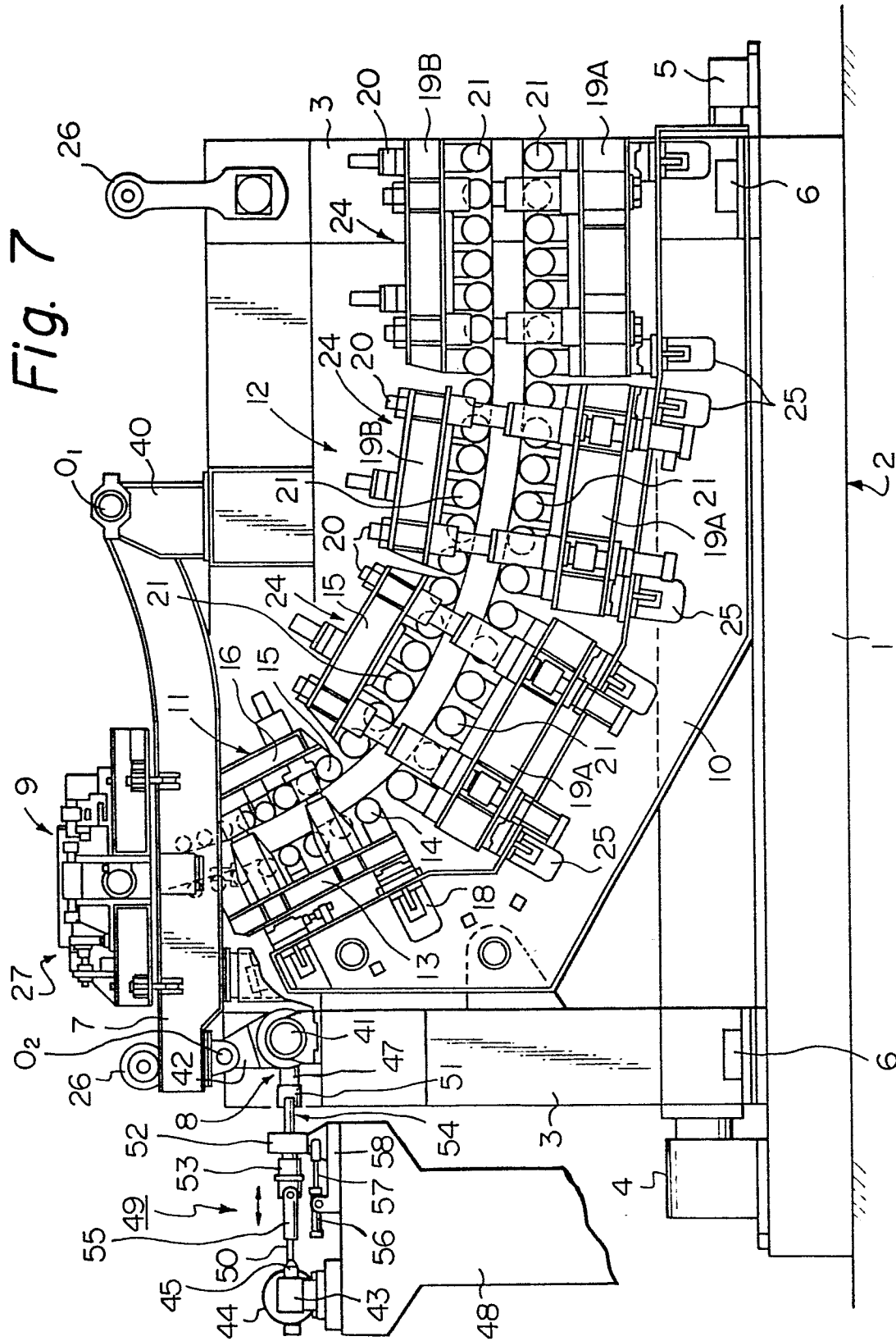




Fig. 7





European Patent  
Office

# EUROPEAN SEARCH REPORT

0074247

Application number

EP 82 30 4600.8

| DOCUMENTS CONSIDERED TO BE RELEVANT                          |                                                                                                                                      |                   | CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Category                                                     | Citation of document with indication, where appropriate, of relevant passages                                                        | Relevant to claim |                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Y,A                                                          | DE - B - 1 458 123 (AG DER VON MOOS' SCHEN EISENWERKE)<br>* claims 9 to 13; fig. 1, reference no. 22 *<br>& US - A - 3 483 915<br>-- | 1,2               | B 22 D 11/128<br>B 22 D 11/14                                                                                                                                                                                                                                                                                                                                                                                                  |
| Y                                                            | US - A - 3 707 184 (BURKHARDT et al.)<br>* claims 1 to 3 *<br>--                                                                     | 1                 |                                                                                                                                                                                                                                                                                                                                                                                                                                |
| A                                                            | DE - A - 2 264 330 (SCHLOEMANN AG)<br>* claim 1; fig. 1 *<br>--                                                                      | 1                 | TECHNICAL FIELDS SEARCHED (Int.Cl. 3)                                                                                                                                                                                                                                                                                                                                                                                          |
| A                                                            | DE - B1 - 2 636 667 (DEMAG AG)<br>* claims 1 to 3 *<br>& US - A - 4 132 261<br>--                                                    | 1                 | B 22 D 11/00                                                                                                                                                                                                                                                                                                                                                                                                                   |
| A                                                            | US - A - 3 722 576 (GALLUCCI)<br>* abstract; fig. *<br>& FR - A - 2 149 474<br>----                                                  | 3                 |                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                              |                                                                                                                                      |                   | CATEGORY OF CITED DOCUMENTS                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                                              |                                                                                                                                      |                   | X: particularly relevant if taken alone<br>Y: particularly relevant if combined with another document of the same category<br>A: technological background<br>O: non-written disclosure<br>P: intermediate document<br>T: theory or principle underlying the invention<br>E: earlier patent document, but published on, or after the filing date<br>D: document cited in the application<br>L: document cited for other reasons |
|                                                              |                                                                                                                                      |                   | &: member of the same patent family, corresponding document                                                                                                                                                                                                                                                                                                                                                                    |
| X The present search report has been drawn up for all claims |                                                                                                                                      |                   |                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Place of search                                              | Date of completion of the search                                                                                                     | Examiner          |                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Berlin                                                       | 12-11-1982                                                                                                                           | GOLDSCHMIDT       |                                                                                                                                                                                                                                                                                                                                                                                                                                |