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EUROPEAN PATENT APPLICATION

⑲ Application number: **80301621.1**

⑤① Int. Cl.³: **B 21 B 1/26, B 21 D 1/02**

⑳ Date of filing: **16.05.80**

④③ Date of publication of application: **02.12.81**
Bulletin 81/48

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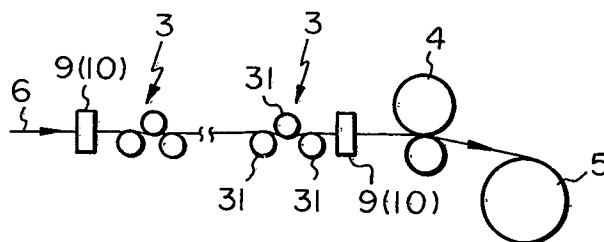
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⑧④ Designated Contracting States: **DE FR GB**

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⑤④ **Method for preventing wandering of strip under roller leveling in hot rolling line.**

⑤⑦ Wandering of a strip (6) in a hot rolling line is prevented by the provision of a hot roller leveler (3) and a side guide (9, 10) between a finishing mill and a coiler (5). At least one of the leveler rolls (31) is made adjustable in angle in a horizontal plane and/or in a vertical plane with respect to the strip (6).



- 1 -

METHOD FOR PREVENTING WANDERING OF STRIP UNDER
ROLLER LEVELING IN HOT ROLLING LINE

The present invention relates to a method for preventing wandering of a strip in a hot rolling line and, more particularly, to a method for correcting hot rolled strip in which shape defects of the hot rolled strip are corrected in the hot rolling line and the wandering of the strip during the correction is prevented.

Demands for increased flatness of hot rolled strip have recently become more and more severe, and now, if only the flatness is secured, hot rolled strips can be used in place of more expensive cold rolled strips.

In the manufacture of steel strips by a continuous hot rolling mill, the relatively large distance between the final mill stand of the finishing mill and the coiler presented a problem that the strip bottom having passed the final finishing stand, became under zero tension and fluttered. The fluttering of the strip bottom was a cause for such shape defects as out of flatness, edge defect, and edge break and defective appearance of coil.

For this reason, hot rolled strips were, after rolling in the continuous hot rolling mill, temper-rolled and simultaneously corrected in flatness. If the hot strip produced by such mill had satisfactory flatness it would have been possible to eliminate the temper rolling step. Heretofore, however, it was necessary to render the temper rolling to obtain the required flatness of the hot rolled strips.

As mentioned above, the insufficient flatness of the hot rolled steel strips caused defective appearance of coil which presented noticeable problems in the succeeding producing

steps such as, for example in the case of mother material for cold rolling, decrease in pickling efficiency resulted from decrease in passability of plates in the pickling line and wandering of the strip.

5 To overcome these problems, the inventors previously presented a method in which a hot roller leveler is provided between the final finishing mill and the coiler, so that the flatness of the hot rolled steel strip is corrected by the roll force of the hot roller leveler and the tension between
10 the finishing mill and the coiler (Japanese Patent Publication No. 48182/78 which issued as Japanese Patent No. 968053).

 We have confirmed that our previous method mentioned above sharply reduced the shape defects of strips such as center buckles and edge waves. However, in the cases where
15 the thickness distribution of the strip in the widthwise direction is not symmetrical, where the rolled shape is extremely asymmetrical, where the temperature distribution of the strip is asymmetrical (mainly due to unsatisfactory spray), and where the parallelism among the units of the
20 rolling line is not complete (it is difficult to maintain complete parallelism among the units throughout the long rolling line), the leveling of the strip by the hot roller leveler sometimes caused the strip to wander sideways so violently that the strip edge hit the support members (side
25 guide etc.) to thereby cause edge defects and, in the extreme case, make the coiling operation impossible.

 Accordingly, an object of the present invention is to prevent wandering of a strip under roller leveling in a hot rolling line, thereby stabilizing the flatness correction of
30 the strip and improving the coil appearance of the strip.

 In the method according to the present invention, in order to achieve the object, at least one hot roller leveler comprising a plurality of leveler rolls is provided between the finishing rolling mill and the coiler of the hot rolling
35 line to correct the flatness of the hot strip. The hot roller leveler is constructed as follows:

- a. At least one leveler roll is supported adjustably in angle in a horizontal plane with respect to the strip.

- b. At least one leveler roll is supported adjustably in angle in a vertical plane with respect to the strip.
- c. At least one leveler roll is supported adjustably in angle in a horizontal plane and in a vertical plane, respectively, with respect to the strip.
- d. At least one leveler roll is supported adjustably in angle in a horizontal plane with respect to the strip and at least one other leveler roll is supported adjustably in angle in a vertical plane with respect to the strip.

Further, a side guide is provided on an entrance side, or on an exit side, or on both sides of one or more hot roller levelers constructed as described above, to prevent the wandering of the strip.

The invention will be better understood from the following description taken in connection with the accompanying drawings in which:

Figs. 1 and 2 are illustrations of the finishing mill and subsequent steps of a hot rolling line in which the method according to the present invention is applied;

Fig. 3 is a plan view of a leveler roll arranged adjustably in angle in a horizontal plane with respect to the strip;

Fig. 4 is a plan view of a leveler roll arranged adjustably in angle in a vertical plane with respect to the strip;

Fig. 5 is a side view taken from the line V-V of Fig. 4;

Fig. 6 is a plan view of a leveler roll arranged adjustably in angle in a horizontal plane and in a vertical plane with respect to the strip;

Fig. 7 is a graph showing the wandering correcting effect by the method according to the present invention;

Fig. 8 is a schematic side view of another embodiment of the hot roller leveler used in the method according to the present invention;

Fig. 9 is a graph similar to that of Fig. 7, showing other wandering correcting effect;

Fig. 10 is a plan view of a roller type side guide

adjustable in position, used in the method according to the present invention;

Fig. 11 is a front view taken from the line XI-XI of Fig. 10;

5 Fig. 12 is a plan view of a plate type side guide adjustable in position, used in the method according to the present invention;

Fig. 13 is a front view taken from the line XIII-XIII of Fig. 12;

10 Figs. 14 to 16 are illustrations of examples of arrangements in which a roller leveler is provided with one or more side guides; and

Figs. 17 to 19 are illustrations of examples of arrangements in which a plurality of roller levelers are provided
15 with one or more side guides.

With reference now to the drawings and more particularly to Figs. 1 and 2 thereof, there are schematically illustrated examples of a final mill stand and subsequent steps in the hot rolling line. In the method according to the present
20 invention, as shown, one or more hot roller levelers 3 are provided between a final mill stand 1 of a finishing mill and a coiler 5 in the hot rolling line. A strip 6 having emerged from the final stand 1 of the finishing mill passes a cooling water spray zone 2, is leveled by the hot roller
25 leveler 3, passes through pinch rolls 4, and is coiled by the coiler 5. In this hot rolling line, the hot roller leveler 3 is provided in the neighborhood of the coiler 5 and preferably immediately before the pinch rolls 4.

The hot roller leveler 3 comprising a plurality of
30 (three in the illustrated examples) leveler rolls 31 is provided in a single unit (Fig. 1) or in a plurality of units (Fig. 2).

In the method according to the present invention, the hot roller leveler 3 is constructed as follows:

- 35 a. At least one leveler roll 31 is supported adjustably in angle in a horizontal plane with respect to the strip 6 (Fig. 3).
b. At least one leveler roll 31 is supported adjustably

in angle in a vertical plane with respect to the strip 6 (Fig. 4).

c. At least one leveler roll 31 is supported adjustably in angle in a horizontal plane and in a vertical plane, respectively, with respect to the strip 6 (Fig. 6).

d. At least one leveler roll 31 is supported adjustably in angle in a horizontal plane with respect to the strip 6 and at least one other leveler roll 31 is supported adjustably in angle in a vertical plane with respect to the strip 6 (Fig. 6).

Adjustment of angle of the leveler roll 31 in the horizontal plane is accomplished by, for example, the construction shown in Fig. 3, in which one bearing 7a of the leveler roll 31 is a pivot bearing and the other bearing 7b thereof is so constructed as to be slidably movable in the horizontal direction and is connected to a hydraulic cylinder 8 maintained horizontal.

The adjustment of angle of the leveler roll 31 in the vertical plane is accomplished by, for example, the construction shown in Figs. 4 and 5, in which one bearing 7c of the leveler roll 31 is so supported as to be pivotally movable in the vertical plane and the other bearing 7d is connected to the hydraulic cylinder 8 maintained vertical.

The adjustment of angle of the leveler roll 31 in the horizontal plane and in the vertical plane, respectively, is accomplished by, for example, the construction shown in Fig. 6, in which the bearings 7a and 7b shown in Fig. 3 are combined with the bearings 7c and 7d shown in Fig. 4 respectively.

The construction shown in Fig. 1 in which one unit of the roller leveler 3 comprising the three leveler rolls 31 is provided between the finishing mill 1 and the coiler 5, will now be described in detail for the purpose of confirming the effects of each of the rolls. From an idealistic viewpoints, however, use of a hot roller leveler having more rolls is preferable since the more the number of the rolls is, the higher effects are obtained thereby in flatness correction and descaling of the strip. The roller leveler may be of a four-high type having back-up rolls for supporting deflection

of the work rolls or may be of a two-high type having only the work rolls.

In the hot roller leveler 3 shown in Fig. 1, the wandering of the strip 6 traveling on the line can be corrected by adjusting the angle of the leveler roll 31 positioned on the upper side of the strip in combination with one or two of the two leveler rolls 31, 31 positioned on the under side of the strip.

Fig. 7 shows the results of test on the relation between an angle of inclination θ in a horizontal plane of the leveler roll 31 and an amount of wandering Δx of the strip 6. In Fig. 7, the horizontal axis denotes the angle of inclination θ of the roll and the vertical axis denotes the amount of wandering per unit time $\Delta x/\Delta t$.

The strip used in this test was a common hot-rolled steel strip of thickness of 1.6 - 3.2 mm and width of 900 - 1300 mm. In Fig. 7, A indicates the case in which only the leveler roll 31 positioned at the left on the under side of the strip 6 was adjusted in angle, B indicates the case in which only the leveler roll 31 positioned on the upper side of the strip 6 was adjusted in angle, and C denotes the case in which all the three leveler rolls 31, 31, 31 were adjusted in angle.

Fig. 7 shows that in any of the cases, the greater the angle of inclination θ of the roll is, the greater becomes the amount of wandering Δx of the strip 6 and that when the angle of inclination θ of the roll varies in the reverse direction, the amount of wandering Δx of the strip also varies in the reverse direction. Fig. 7 shows further that the effect by adjustment of the angle of the leveler roll is greater in the intermediate roll than in the roll on the entrance or exit side and that the greatest effect is achieved by adjusting the angles of all the rolls.

Accordingly, in the method according to the present invention, the wandering of the strip can be canceled and prevented by adjusting the angle of at least one of the three leveler rolls 31 with the strip 6 in the horizontal plane.

Fig. 9 shows the results of test on the relation bet-

ween the angle of inclination θ of the roll and the amount of wandering Δx of the strip 6 in the hot roller leveler having five leveler rolls 31 as shown in Fig. 8. In Fig. 9, the vertical and the horizontal axes denote the same items as in Fig. 7. In Fig. 9, D denotes the case in which one leveler roll 31 positioned at the left on the under side of the strip 6 is inclined in the vertical plane, E denotes the case in which one leveler roll 31 positioned at the left on the upper side of the strip 6 is inclined in the vertical plane, F denotes the case in which both said leveler rolls 31, 31 are inclined simultaneously in the vertical plane, and G denotes the case in which one leveler roll 31 positioned at the left on the upper side of the strip 6 is inclined in the vertical plane and one leveler roll 31 positioned at the right on the under side of the strip 6 is simultaneously inclined in the horizontal plane.

The strip used in this test was a common hot-rolled steel strip of thickness of 1.2 - 3.2 mm and width of 900 - 1300 mm.

Fig. 9 shows that in any of the cases, the greater the angle of inclination θ of the roll is, the greater becomes the amount of wandering Δx of the strip and that when the angle of inclination θ of the roll varies in the reverse direction, the amount of wandering Δx of the strip also varies in the reverse direction. Fig. 9 shows further that the effect by adjustment of the angle of the leveler roll is greater in the intermediate roll than in the roll on the entrance or exit side and that the effect is enhanced by combining the adjustment of the angle of inclination of the roll in the vertical plane with the adjustment of the angle of inclination of the roll in the horizontal plane.

One reason for combining the adjustment of angle of inclination of the roll in the vertical plane with that in the horizontal plane is that when the roll to be adjusted in the vertical plane is inclined at a large angle in the vertical plane the intermesh of the leveler roll varies from an edge of the strip to the other, and if the angle of inclination of the roll in the vertical plane is made large

when the amount of wandering of the strip is large the shape of the strip at one edge will be changed into, for example, edge wave to cause shape defects. For this reason, the angle of inclination of the roll in the vertical plane is preferably made small and the adjustment thereof is preferably combined with the adjustment of the angle of inclination of the roll in the horizontal plane.

Practically, it is simplest and most effective to incline the entire leveler unit in the horizontal and/or the vertical planes.

In the method according to the present invention described hereinabove, by adjusting the angle of inclination of the leveler roll so as to cancel the wandering of the steel strip during hot rolling thereof, it is made possible to move the strip centrally of the line to thereby prevent the edges of the strip from hitting against the guides to cause edge defect and to thereby enable the strip to be leveled stably.

While the foregoing description is made with reference to the example in which the hydraulic cylinder 8 is used as the means for inclining the leveler rolls 31, it will be obvious to those skilled in the art that the hydraulic cylinder 8 may be replaced by any other suitable inclining means such, for example, as a rack and pinion mechanism and a link and lever mechanism.

For safer and securer prevention of wandering of the steel strip, it is preferable to use a position-adjustable roller type side guide 9 as shown in Figs. 10 and 11 or a position-adjustable plate type side guide 10 as shown in Figs. 12 and 13.

In the construction including only one unit of the hot roller leveler 3, the side guide 9 or 10 is provided either on the entrance side of the leveler 3 (Fig. 14) or on the exit side thereof (Fig. 15) or on each of the entrance and exit sides thereof (Fig. 16).

In the construction including a plurality of the roller levelers 3, the side guide 9 or 10 is provided only on the entrance or on the exit side of each leveler or on each of said sides thereof as necessary. Alternatively, the side

guide 9 or 10 may be effectively provided in the manner as shown in any of Figs. 17 to 19.

5 In the method according to the present invention, as described hereinabove, severe wandering of the steel strip is forcibly restrained by adjusting the angle of inclination of the leveler roll 31 and shifting the strip quickly to the central zone of the line while holding the edges of the strip 6 with the side guide 9 or 10. Accordingly, it is made possible to render stable leveling of the hot rolled steel strip and to sharply increase the grade of the strip flatness in the hot rolling line.

10 By increasing the intermesh of the leveler rolls and effectively utilizing the leveler as back tension means for coiling after the coil end passes through the final mill stand, it is made possible to obtain effects such as prevention of edge break and other edge defects resulted from the zero tension state after the passing of the coil end through the final mill stand and as grade up of the coiling form.

15 The leveling operation according to the present invention can be easily automated by providing a sensor of the amount of wandering of the strip and connecting the output of the sensor to the means for adjusting the angle of the leveler roll.

20 Further, the method according to the present invention provides additional advantages such as increase in descaling effect leading to increase in efficiency of the pickling line because the scale on the surface of the hot rolled strip is easily cracked by repeat bendings under tension width leveler rolls.

30 While we have described and illustrated a present preferred method of practicing the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously practiced within the scope of the following claims.

CLAIMS :

1. A method for preventing wandering of a strip under roller leveling in a hot rolling line, comprising the steps of:
providing at least one unit of a hot roller leveler
5 comprising a plurality of leveler rolls between a finishing mill and a coiler; and
supporting at least one leveler roll adjustably in angle in a horizontal plane or in a vertical plane with respect to the strip.
- 10 2. A method according to Claim 1 wherein at least one leveler roll is supported adjustably in angle in the horizontal plane and in the vertical plane with respect to the strip.
3. A method according to Claim 1 wherein at least one leveler roll is supported adjustably in angle in the horizontal
15 plane with respect to the strip and at least one other leveler roll is supported adjustably in angle in the vertical plane with respect to the strip.
4. A method according to claim 1 wherein a side guide is provided on an entrance side of said roller leveler.
- 20 5. A method according to Claim 1 wherein the side guide is provided on an exit side of said roller leveler.
6. A method according to Claim 1 wherein the side guide is provided on each of the entrance and the exit sides of said roller leveler.
- 25 7. A method according to Claim 2 wherein the side guide is provided on the entrance side of said roller leveler.
8. A method according to Claim 2 wherein the side guide is provided on the exit side of said roller leveler.
9. A method according to Claim 2 wherein the side guide
30 is provided on each of the entrance and the exit sides of said roller leveler.
10. A method according to Claim 3 wherein the side guide is provided on the entrance side of said roller leveler.
11. A method according to Claim 3 wherein the side guide
35 is provided on the exit side of said roller leveler.
12. A method according to Claim 3 wherein the side guide is provided on each of the entrance and the exit sides of said roller leveler.

Fig. 1

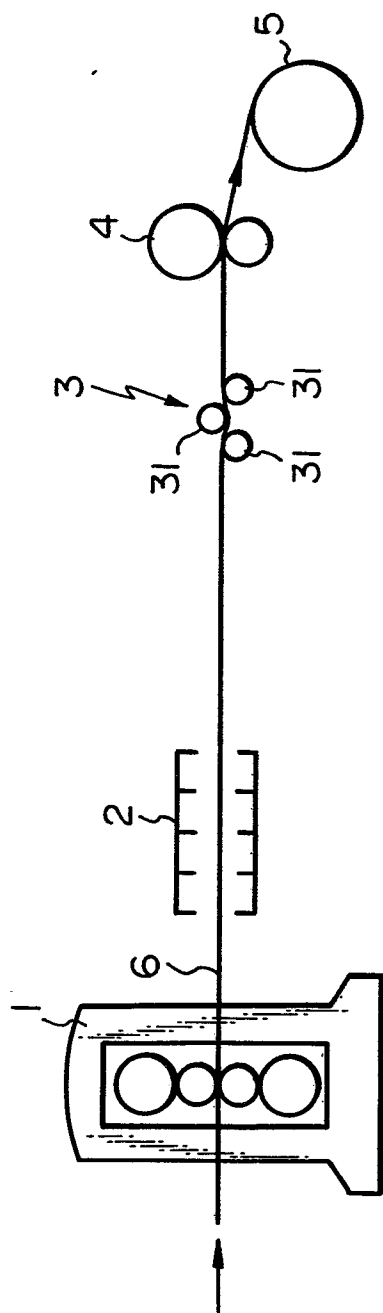


Fig. 2

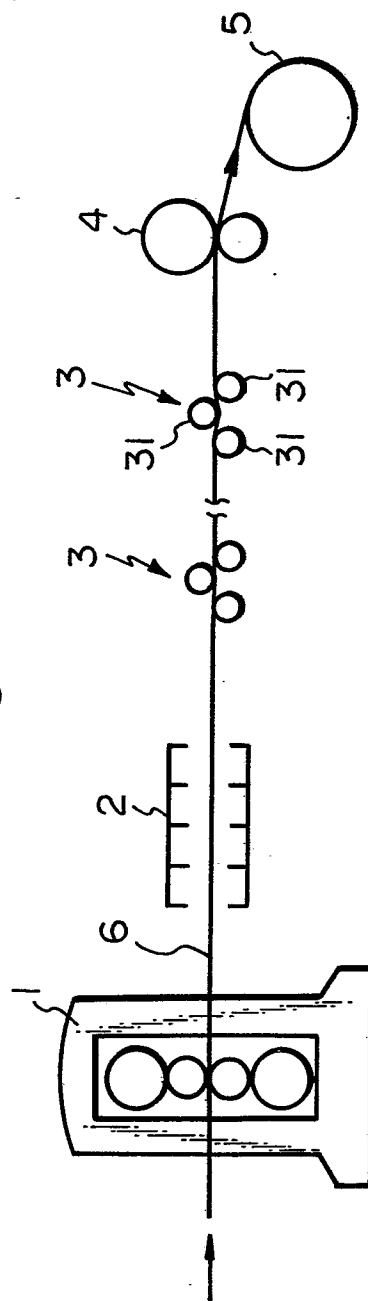


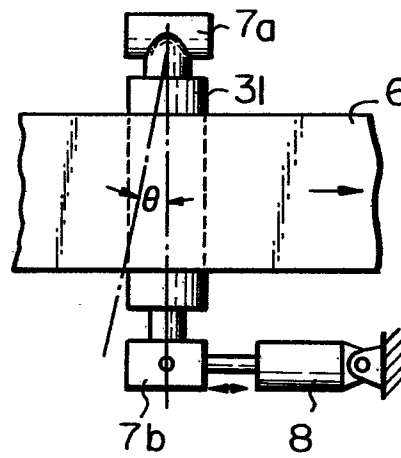
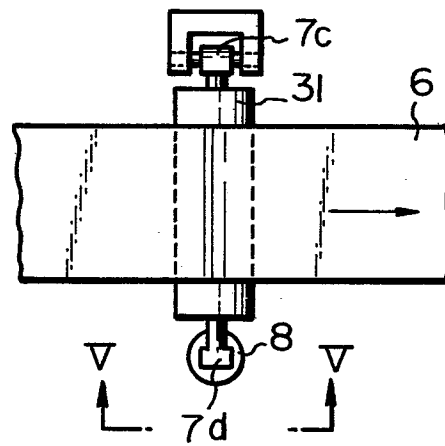
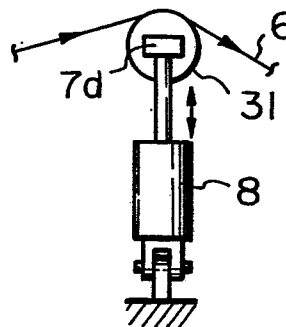
Fig. 3*Fig. 4**Fig. 5*

Fig. 6

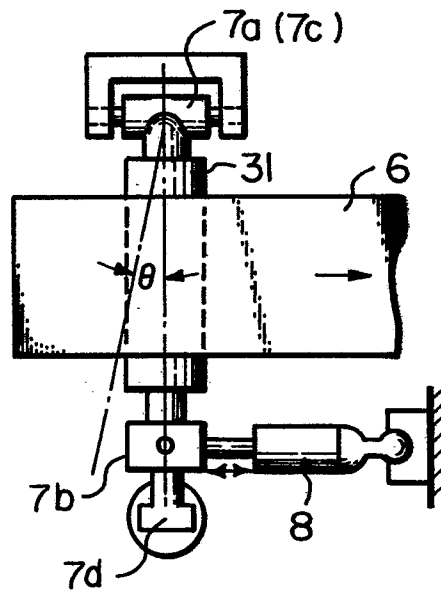


Fig. 7

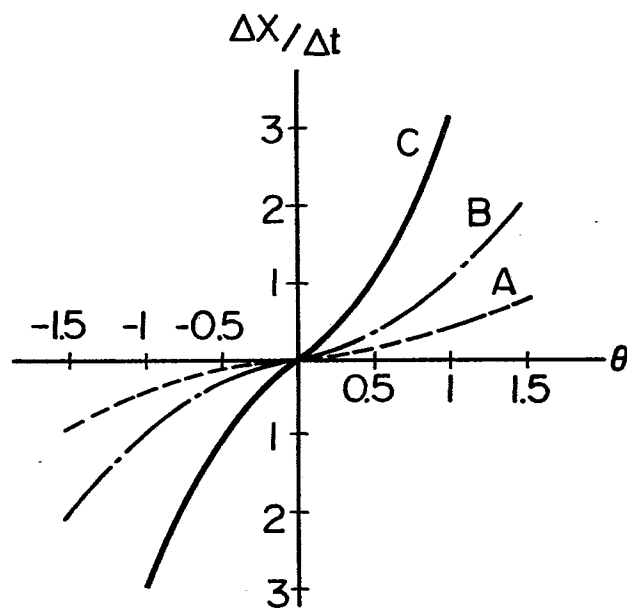


Fig. 8

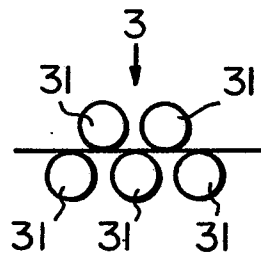


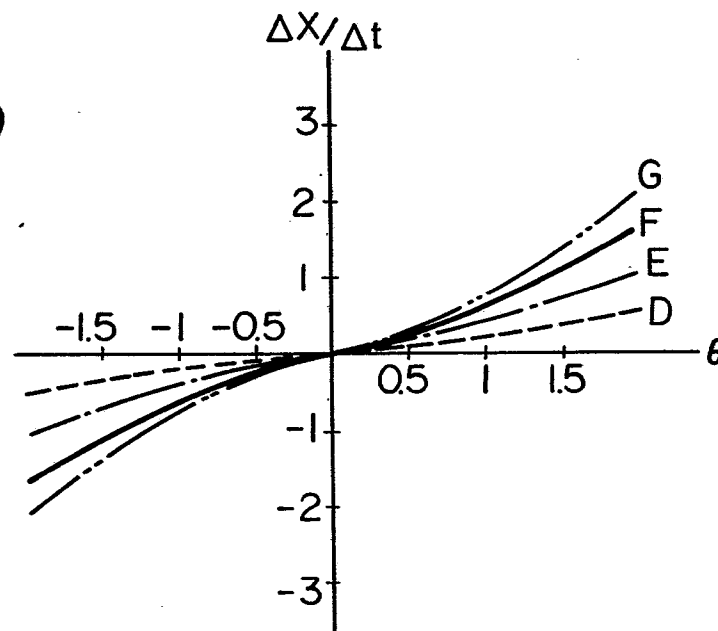
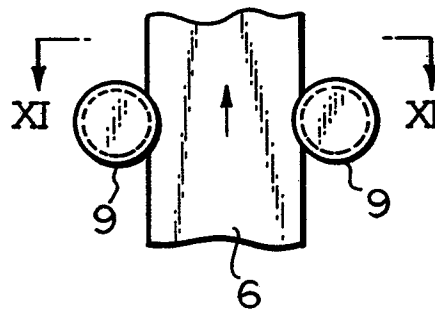
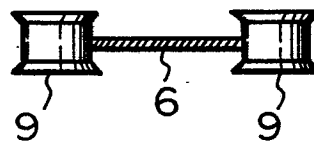
Fig. 9*Fig. 10**Fig. 11*

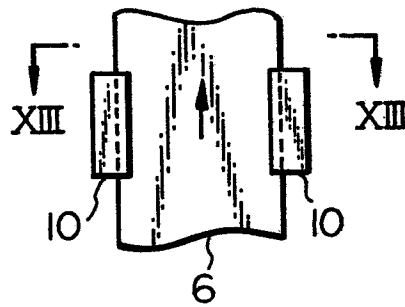
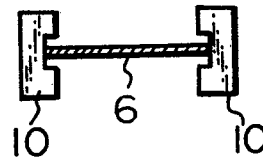
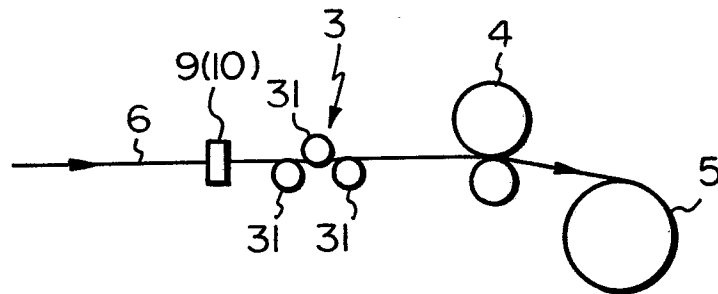
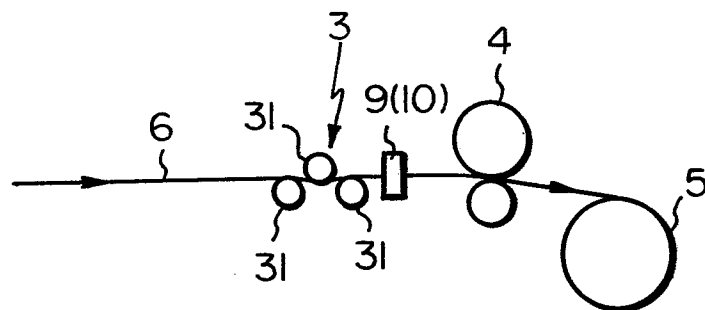
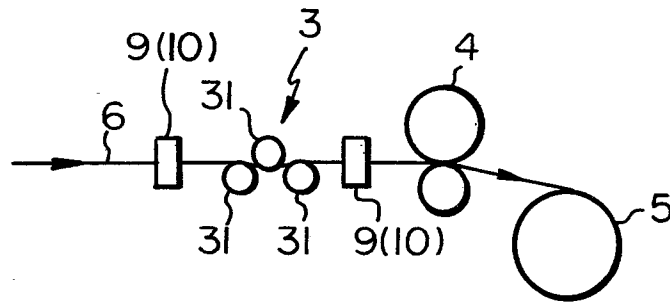
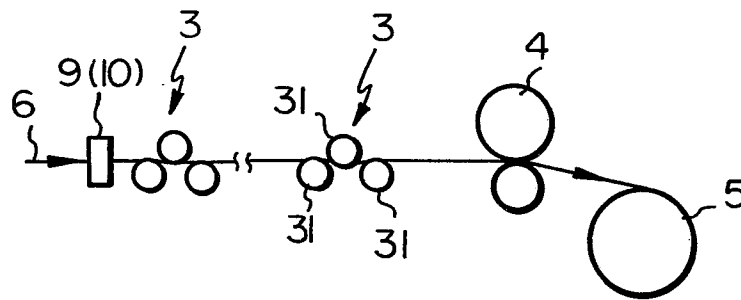
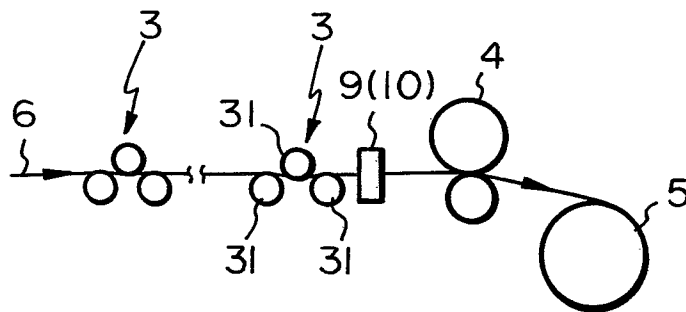
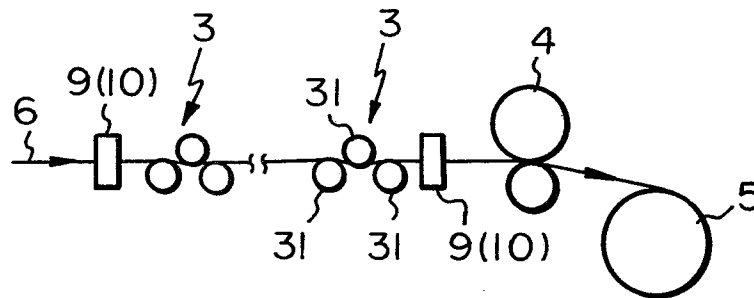
Fig. 12*Fig. 13**Fig. 14**Fig. 15*

Fig. 16*Fig. 17**Fig. 18**Fig. 19*



European Patent
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EUROPEAN SEARCH REPORT

0040653
Application number

EP 80 30 1621.1

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	DE - A1 - 2 461 496 (INTERLAKE) * claims 1 to 6 *	1,2, 4,6	B 21 B 1/26 B 21 D 1/02

	DE - A1 - 2 537 188 (BWG BERGWERK- UND WALZWERK-MASCHINENBAU) * claims 1, 9 *	1,2	

	DE - A1 - 2 742 043 (RHEINISCHE EISEN- GIESSEREI W. PULCH) * claim 1 *	1	

	DE - A1 - 2 706 943 (BWG BERGWERK- UND WALZWERK-MASCHINENBAU) * claim 6 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.)

	DE - A - 2 123 896 (VEREINIGTE ÖSTER- REICHISCHE EISEN- UND STAHLWERKE) * claims 1 to 3 *	1	B 21 B 1/00 B 21 B 15/00 B 21 B 37/00 B 21 B 39/00 B 21 D 1/00

	US - A - 3 438 231 (E.W. PETZSCHKE)		

			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
			&: member of the same patent family, corresponding document
☒ The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
Berlin	14-01-1981	SCHLAITZ	