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(54) ## SHEET HOT ROLLING MILL

(57) A finishing mill (30) included in a hot rolling mill system has a front stage (31) and a back stage (32). The front stage (31) is provided with two or more CVC rolling mills (31A, 31B) and the back stage (32) is provided with two or more different-diameter-roll mills (32A, 32B). When producing a thin sheet of 1.2 mm or below in thickness by rolling, the formation of crown and edge-drop can be suppressed and the formation of pincher in a tail end part of the sheet can be prevented, so that a rolled sheet can be smoothly manufactured.

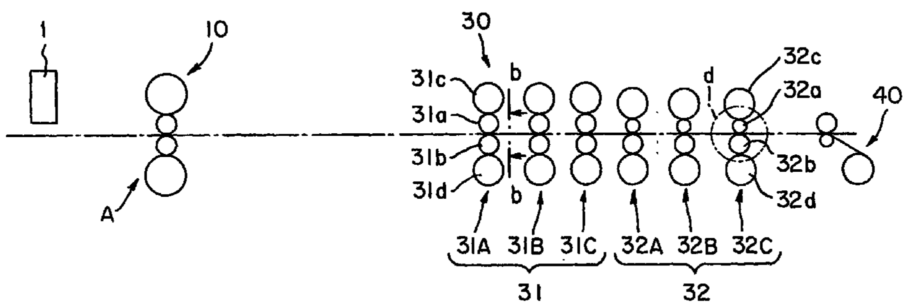

FIG. 1a

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Description

TECHNICAL FIELD

[0001] The present invention relates to a hot rolling mill system capable of smoothly producing a sheet (steel sheet) having a uniform thickness.

BACKGROUND ART

[0002] When producing a thin sheet by hot rolling, it is important to pass a tail end part of a sheet bar smoothly through each rolling mill as well as to form the sheet in a uniform thickness. When a sheet bar is rolled with rolls, the sheet bar is rolled in an irregular thickness due to body crowning that increases the thickness of a middle part of the sheet with respect to width and edge-drop that reduces the thickness of side edge parts of the sheet sharply. When a thin sheet is rolled, a trouble called pincher, i.e., rolling of folded tail end part of the sheet, is liable to occur. Crowning is an increase in the thickness of a sheet from side edges toward the middle of the sheet with respect to width due to the bending of rolls. Edge-drop is a sharp decrease in the thickness of side edge parts of a sheet in curved slopes caused by shoulders in rolls each formed at the boundary of a working part of the roll used for pressing the sheet and an idle part of the roll not used for pressing the sheet (a part of the roll corresponding to a space outside the edge of the sheet) and having the shape of a circular arc. Pincher is folding of the tail end part of a sheet bar that becomes unstable when a tension is not exerted on the sheet bar between rolling mills. The folding occurs due to collision of the unstable tail end part against a side guide or the like, and the folded tail end part enters the rolling mill as it is. The accuracy of the sheet is reduced if crowning or pincher occurs. The rolls are damaged and the rolls need grinding if pincher occurs, and thereby production is reduced greatly.

[0003] Pincher is more likely to occur as the sheets become thinner. When reducing the thickness of a sheet bar, the sheet bar is rolled at a large draft, a high rolling force is exerted on the sheet bar and force that moves the sheet bar laterally increases accordingly. If the sheet bar collides against a guide or the like disposed in front of the rolling mill, the tail end part of the sheet bar is bent easily. Therefore, the lower limit of the thickness of steel sheets that can be rolled by a hot rolling mill has been 1.2 mm.

[0004] Techniques for smoothly hot-roll steel sheets of about 1.2 mm or below in thickness, preventing pinchers are mentioned in "(280) Overview of endless rolling on Chiba 3 HOT", CAMP-ISIJ, Vol. 10 (1997)-1088, and JP-A 6-106207. The techniques mentioned in those publications join the leading end of a succeeding sheet bar to the tail end of a preceding sheet bar before the tail end part of the preceding sheet bar enters a finishing mill to reduce the number of tail end parts which are not tensioned. A part which is unavoidably a tail end part is rolled in a thickness of 1.6 mm or above to avoid pincher.

[0005] The cost of equipment necessary for smoothly manufacturing thin sheets by the techniques mentioned in those publications is considerably high as compared with that of the conventional hot rolling mills, because the equipment needs a special joining apparatus for joining together sheet bars in a short time and the general arrangement of the line of hot rolling mills must be changed. Therefore, great modification of the conventional hot rolling mills is necessary to practice the foregoing techniques. Modification work takes a long time and the operation must be stopped for a long time. Although the foregoing means are able to prevent pincher, it is difficult to suppress crowning and edge-drop by the foregoing means.

[0006] It is an object of the present invention to provide a sheet hot rolling mill system capable of suppressing crowning and edge-drop and of preventing pincher in the tail end part of a sheet bar, and having a simple construction.

DISCLOSURE OF THE INVENTION

[0007] A hot rolling mill system of the present invention has a finishing mill consisting of a front stage and a back stage, in which

① The front stage includes two or more stands of CVC rolling mills or pair-cross rolling mills, and
② The back stage includes two or more stands of different-diameter-roll mills.

[0008] The CVC rolling mill in ① is a well-known rolling mill including rolls having axially varying outside diameter and capable of axial movement (CVC rolls). The pair-cross rolling mill is a well-known rolling mill including a pair of sets each of a work roll and a backup roll disposed so that the pair of sets are disposed not in parallel to each other, the pair of sets cross each other, middle parts of the work rolls of the pair of sets are closest to each other, and the positional relation between the pair of sets(angle between the pair of sets) can be changed. In those rolling mills, the shape of a roll gap can be changed. The roll gap can be changed in the CVC rolling mill by axially moving the CVC rolls having varying outside diameter and in the pair-cross rolling mill by changing the positional relation between the crossed rolls. The ability to change the roll gap of those rolling mills is higher than that of rolling mills that uses simple roll bending.

[0009] The different-diameter-roll mill in ② is a rolling mill including a pair of work rolls respectively having different diameters and only the work roll of a large diameter is driven for rotation. Since one of the pair of work rolls has a small diameter, the different-diameter-roll mill is able to roll a sheet bar in a large draft easily by a low rolling force. Since a shearing force is exerted on the sheet bar by driving only the work rolls of a large diameter, the different-diameter-roll mill is able to roll the sheet bar in a large draft more easily than a general rolling mill having work rolls of the same large diameter. Accordingly, the different-diameter-roll mill is able to roll a sheet bar in the same draft as that in which the general rolling mill or the rolling mill stated in ① and included in the front stage even if the rolling force of the different-diameter-roll mill is lower than those of the general rolling mill or the rolling mill stated in ① and included in the front stage. Therefore, even if the number of the stands of the different-diameter-roll mill is small and the different-diameter-roll mill has a compact arrangement, the different-diameter-roll mill is able to exercise the foregoing actions and to roll a sheet bar in a sufficient draft. The different-diameter-roll mill can be constructed by small-scale modification of a general rolling mill, such as replacing one of a pair of rolls having a large diameter with a roll of a small diameter. Thus, the hot rolling mill system of the present invention can be constructed simply at low cost if existing rolling mills are available for constructing the hot rolling mill system of the present invention.

[0010] The hot rolling mill system of the present invention having the arrangement stated in ① and ② is capable of suppressing crowning and formation of edge-drop and of reducing the frequency of formation of pinchers in the tail end parts of sheets owing to the following working operations a) to c).

a) Crowning in the sheet can be suppressed by changing and controlling the shape of the roll gap in the part ① of the front stage of the finishing mill. The crowning of the sheet is caused by irregularity in the roll gap with respect to the direction of amplitude, i.e., a direction along the axis of the roll, attributable to the bending of the rolls of the rolling mill. When the roll gap is properly changed and controlled by the rolling mill stated in ①, the crowning of the sheet can be reduced or a sheet having an optimum crown can be manufactured. The control of the crown through the change of the roll gap often deteriorates the flatness and the like of the sheet. Since such control is carried out by the front stage of the finishing mill, the flatness of the sheet can be improved by the middle or the back stage. When the crown is reduced by the front stage, the back stage needs only to maintain the small crown and hence the rolling operation of the different-diameter-roll mill can be stabilized.

b) The possibility of occurrence of pincher in the tail end part of the sheet bar can be reduced by rolling the sheet bar under a low rolling force by the part ② of the back stage of the finishing mill. Pincher is formed when the tail end part of the sheet bar to which any tension is not applied moves laterally (to the right or to the left of the pass line) and collides against a guide or the like included in the rolling mill. Results of an investigation into pincher showed that the tail end part of the sheet bar has difficulty in lateral movement when the rolling force is low. It is inferred that the lateral movement of the tail end part of the sheet bar occurs because the rolling means are not perfectly symmetrical; that is, the sheet bar is urged either to the right or to the left when the rolls of the rolling mill are not strictly symmetrical. Consequently, the lower the rolling force, the smaller is the force biasing the sheet bar to the right or to the left and the lesser the tendency of the tail end part to move laterally. Thus, this rolling mill has scarce possibility of forming pincher in the tail end part even in rolling a considerably thin sheet. Generally, the lateral movement (width of shift) of the tail end part of a sheet bar on a finishing mill is greater in the rolling mill of the back stage. Therefore, it is effective in preventing pincher to roll the sheet bar by a lower rolling force by the rolling mill of the back stage.

c) Occurrence of edge-drop can be suppressed by rolling a sheet bar with a low rolling force in the part ② of the back stage of the finishing mill. Since edge-drop is caused by shoulders in rolls each formed at the boundary of a working part of the roll used for pressing the sheet bar and a part of the roll corresponding to a space outside the edge of the sheet bar and having the shape of a circular arc, edge-drop can be reduced by pressing the roll with a low rolling force against the sheet bar so that a shallow depression is formed.

[0011] Since the rolling mill (the CVC rolling mill or the pair-cross rolling mill) of ① of this hot rolling mill system has two or more stands, the crowning of the sheet can be effectively suppressed. Since the rolling mill (the different-diameter-roll mill) of ② has two or more stands, the sheet bar can be rolled in a necessary draft by using a very low rolling force, effectively suppressing the occurrence of pincher and edge-drop.

[0012] The hot rolling mill system of the present invention may further comprise, in addition to the foregoing components, a temperature drop preventing means for preventing temperature drop in the sheet between the last stand of a roughing mill on the upstream side and the first stand of the finishing mill. The temperature top preventing means may be a tunnel furnace, a sheet bar coiler/uncoiler or a sheet bar heater.

[0013] The sheet before being rolled by the finishing mill moves at a low speed dependent on the rolling speed of the finishing mill. Therefore, the sheet stays for a long time in front of the finishing mill and the temperature decreases toward the tail end of the sheet bar. The temperature of the sheet in the back stage of the finishing mill is lower than that of the same in the front stage of the finishing mill. This hot rolling mill system maintains the temperature of the Sheet before being rolled by the finishing mill on a desired level or increases the temperature of the sheet by the temperature top preventing means. A rolling force necessary for finish rolling is low when the temperature of the sheet is sufficiently high as compared with that necessary when the temperature of the sheet is not sufficiently high. Therefore, this hot rolling mill system that prevents temperature drop of the sheet by the temperature drop preventing means can achieve finish rolling operation (particularly that of the back stage of the finishing mill) by using a low rolling force. Since the leading end part and the tail end part of the sheet bar can be maintained at the same temperature, rolling load does not vary and stable rolling can be achieved. Thus, the occurrence of edge-drop and pincher can be effectively suppressed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1a is a diagrammatic view of a hot rolling mill system in a first embodiment of the present invention;

Fig. 1b is a front elevation of an essential part of a CVC rolling mill taken on line b-b in Fig. 1a;

Fig. 1c is a front elevation similar to Fig. 1b in which work rolls are displaced axially relative to each other to change roll gap;

Fig. 1d is a side elevation of an essential part of a different-diameter-roll mill corresponding to a part indicated at d in Fig. 1a;

Fig. 2a is a diagrammatic view of a hot rolling mill system in a second embodiment of the present invention;

Fig. 2b is a diagrammatic view of a hot rolling mill system in a third embodiment of the present invention;

Fig. 2c is a diagrammatic view of a hot rolling mill system in a fourth embodiment of the present invention;

Fig. 3 is a view of a pair-cross rolling mill; and

Fig. 4 is a graph showing a temperature distribution in a sheet on the front side of a finishing mill.

BEST MODE FOR CARRYING OUT THE INVENTION

[0015] Preferred embodiments of the present invention will be described hereafter. Fig. 1a is a general view of a hot rolling mill system A in a fast embodiment of the present invention, Fig. 1b shows a pair of work rolls 31a and 31b included in a CVC rolling mill included in the hot rolling mill system A shown in Fig. 1a (a view taken on line b-b in Fig. 1a), Fig. 1c shows work rolls displaced axially relative to each other to change roll gap, and Fig. 1d shows a different-diameter-roll mill 32 included in the hot rolling mill system A shown in Fig. 1a (a part indicated at d in Fig. 1a).

[0016] The hot rolling mill system A is constructed by arranging the following components. A heating furnace 1 is disposed at an upstream end (left side as viewed in Fig. 1a) and a rough rolling mill 10 is disposed behind the heating furnace 1. The heating furnace 1 is a heating means for heating a slab, i.e., a material, at about 1200 °C. The rough rolling mill 10 rolls the heated slab to a plate of a thickness on the order of 30 mm. Fig. 1a typically represents the rough rolling mill 10 by a single stand. The rough rolling mill 10 may have a plurality of stands. A finishing mill 30 having six stands is disposed behind the rough rolling mill 10, and a coiler 40 for taking up a rolled sheet is disposed behind the finishing mill 30.

[0017] The hot rolling mill system A has the following arrangement to produce smoothly thin steel sheets of a thickness equal to 1.2 mm or below (particularly, 1.0 mm or below) in high dimensional accuracy.

[0018] The three stands 31A, 31B and 31C of the front stage of the finishing mill 30 are the so-called CVC rolling mills, i.e., rolling mills having rolls having diameter continuously varying from one to the other end of the rolls. As shown in Fig. 1a, the CVC rolling mills are four-high mills each having work rolls 31a and 31b and backup rolls 31c and 31d. As shown in Fig. 1b, the work rolls 31a and 31b of each stand have a crown (CVC, continuous variation of the diameter). As shown in Fig. 1c, the work rolls 31a and 31b can be simultaneously moved in the opposite axial directions, respectively. When the positional relation between the work rolls 31a and 31b is adjusted by thus axially moving the work rolls 31a and 31b, the shape of a roll gap between the work rolls 31a and 31b, i.e., gap between parts of the work rolls 31a and 31b in contact with a sheet x, can be changed. Know roll benders may be combined with the work rolls 31a and 31b.

[0019] The three stands 32A, 32B and 32C of the back stage of the finishing mill 30 are the so-called different-diameter-roll mills. As shown in Fig. 1a, the different-diameter-roll mills are four-high mills each having work rolls 32a and 32b and backup rolls 32c and 32d. As shown in Fig. 1d, the work rolls 32a and 32b have different diameters, respectively. Only the lower large-diameter work roll 32b is driven for rotation by a motor, not shown, or the like, and the upper small-diameter work roll 32a is a free roller to which any driving force is not applied. Each stand is provided with well-known work roll benders, not shown, to bend the work rolls 32a and 32b. In each of the three stands 32A, 32B and 32C as different-diameter-roll mills, the top work roller 32a has a small diameter and only the lower work roll 32b is driven. Therefore, a shearing force is applied to the sheet x. Since the upper work roll has a small diameter, the sheet can be rolled in a sufficient draft even if the rolling force is relatively low.

[0020] In the hot rolling mill system A, the work rolls 31a and 31b of the three stands 31A, 31B and 31C of the front stage are displaced axially as shown in Fig. 1c to correct the crown of the sheet x regardless of thickness and width so that an optimum crown is formed. Edge-drop in the sheet x can be reduced by using a low rolling force by the three stands 32A, 32B and 32C, i.e., the different-diameter-roll mills, of the back stage 32. The hot rolling mill system A provided with the six-stand finishing mill 30 is capable of suppressing the formation of crown and edge-drop and of producing sheets of high dimensional accuracy. When a steel sheet is rolled by the conventional hot rolling mill system to produce a 1.2 mm thick, 1220 mm wide steel sheet, a crown of about 50 μm in an average is formed in a part at 25 mm from the edge of the steel sheet. Studies made by the inventors of the present invention proved that the crowns can be limited to about 15 μm in average and about 30 μm in maximum when producing either a 1.2 mm thick, 1220 mm wide steel sheet or a 1.0 mm thick, 1000 mm wide steel sheet by this hot rolling mill system A.

[0021] The formation of pincher in the tail end part of the sheet x can be effectively prevented by using a low rolling force by the three stands 32A, 32B and 32C of the back stage 32 when rolling the sheet by this hot rolling mill system A. When the sheet x is rolled by using such a low rolling force, the application of an asymmetrical force (application of different forces toward the right and the left) to the sheet x can be suppressed to reduce the dislocation of the sheet to the right or to the left. Even if the thickness of the sheet x is as small as 1.2 mm or below, the hot rolling mill system A is able to reduce the frequency of occurrence of pincher and to continue smooth production. When producing 1.2 mm thick, 1220 mm steel sheets by the conventional hot rolling mill system, the pincher forming frequency ratio is about 3% (three pinchers per 100 sheets). The pincher forming frequency ratio can be limited to values on the order of 0.5% when producing the same steel sheets by the hot rolling mill system A of the present invention, and can be limited to values on the order of 3% when producing 1.0 mm thick, 1220 mm wide steel sheets by the hot rolling mill system A.

[0022] Figs. 2a, 2b and 2c show other embodiments of the present invention. A hot rolling mill system B shown in Fig. 2a is provided with a tunnel furnace 21 disposed between the last stand of a rough rolling mill 10 and the first stand 31A of the finishing mill 30. The tunnel furnace 21 is a tunnel-shaped furnace extended along a pass line and is able to heat a sheet with a heating means, such as a burner or the like, provided therein. The last stand of the rough rolling mill 10 and the first stand 31A of the finishing mill 30 are different from each other in sheet feed speed (the sheet feed speed of the former is higher than that of the latter). Since the sheet delivered from the former is rolled at a low speed dependent on the delivery speed of the finishing mill 30, the temperature of the sheet at the entrance of the finishing mill 30 decreases from the leading end to the tail end of the sheet. The tunnel furnace 21 prevents such a temperature decrease. A rolling force necessary for rolling a sheet that is heated to prevent the temperature decrease is lower than that necessary for rolling a sheet that is not heated. Since the leading end part and the tail end part can be rolled by substantially the same rolling force, the stands of the finishing mill 30, particularly, the different-diameter-roll mills 32A, 32B and 32C of the back stage 32 may be considerably low, which enhances the effect of suppressing edge-drop and pincher. Generally, temperature decrease at the tail end part of the sheet is the greatest. Therefore, the effect of the tunnel furnace 21 in suppressing the formation of pincher is significant. Thus, the hot rolling mill system B (similarly, hot rolling mill systems C and D, which will be described later) is capable of reducing the frequency of forming pinchers more effectively than the hot rolling mill system A.

[0023] As shown in Fig. 2a, the finishing mill 30 of the hot rolling mill system B has seven stands. The three stands 32A, 32B and 32C of the back stage 32, similarly to those of the hot rolling mill system A shown in Fig. 1a, are different-diameter-roll mills. The hot rolling mill system B differs from the hot rolling mill system A shown in Fig. 1a in providing a front stage with four stands 31A, 31B, 31C and 31D provided with CVC rolls. The number of the rolling mills (stands) of the finishing mill 30, similarly to that of the stands of the rough rolling mill 10, may be properly determined according to the thickness and grade of sheet and the speed of production. At least some of the stands of the front stage 31 of the finishing mill 30 may be a well-known pair-cross rolling mill 36 capable of changing the shape of a roll gap as shown in Fig. 3. The pair-cross rolling mill 36 is a well-known rolling mill including a pair of sets of a work roll 36a and a backup roll 36c, and of a work roll 36b and a backup roll 36d, disposed so that the pair of sets are not parallel to each other, the pair of sets cross each other, middle parts of the work rolls 36a and 36b closest to each other, and the positional relation between the pair of sets (angle between the pair of sets) can be changed. The design of the hot rolling mill system may be changed without departing from the scope of the present invention. For example, the stands of the back stage 32 may be different-diameter-roll mills provided with CVC rolls. Similarly, such changes may be made in the hot rolling mill systems C and D shown in Figs. 2b and 2c and the hot rolling mill system A shown in Fig. 1a.

[0024] The hot rolling mill system C shown in Fig. 2b is provided with a sheet bar coiler/uncoiler 22 between the last stand of a rough rolling mill 10 and the first stand 31A of the finishing mill 30. The coiler/uncoiler 22 is an apparatus for coiling and uncoiling a sheet (sheet bar), such as Coilbox® commercially available from Steltech Ltd. (Canada). Since the temperature of the sheet is liable to drop before the sheet is fed to the finishing mill 30 as mentioned above, the drop of the temperature of the long sheet is suppressed by coiling the long sheet in a coil, and then the sheet is uncoiled from the coil and is fed to the finishing mill 30 to reduce the drop of the temperature of the sheet. Consequently, the sheet can be rolled for finish rolling by a low rolling force, which is effective in preventing the formation of edge-drop and pincher.

[0025] The hot rolling mill system D shown in Fig. 2c is provided a coiler/uncoiler 22 similar to that shown in Fig. 1b, and a sheet bar heater 23 disposed behind the coiler/uncoiler 22 and in front of the finishing mill 30. The sheet bar heater 23 heats the leading end part and the tail end part of a sheet with a heating means, such as a burner or the like to raise the temperature of the front and the tail end part of the sheet coiled by the coiler/uncoiler 22 because the temperature of the front and the tail end part is liable to drop. Pincher occurs in the tail end part of the sheet. Therefore, when the tail end part of the sheet is heated by the sheet bar heater 23, the tail end part of the sheet can be rolled by a reduced rolling force, so that the rate of occurrence of pincher can be effectively reduced.

[0026] The hot rolling mill system according to the present invention exercises the following effects.

1) Formation of a crown and edge-drop in the sheet is suppressed and, at the same time, the frequency of formation of pincher in the tail end part of the sheet can be reduced. Since pincher is hardly formed even if the sheet is considerably thin, the stable production of thin sheets having, for example, a thickness of about 1.2 mm or below can be achieved and the sheets can be rolled in a highly accurate thickness.
2) Since special devices and apparatus are not essential, the equipment cost is low and the hot rolling mill according to the present invention can be constructed in a short period simply by modifying the existing hot rolling mill system.
3) The heating means interposed between the rough rolling mill and the finishing mill to prevent the drop of the temperature of the sheet further effectively suppressing the formation of edge-drop and pincher, because finish rolling can be achieved by using a reduced rolling farce when the drop of the temperature of the sheet before the sheet is fed to the finishing mill can be prevented.

Claims

1. A hot rolling mill system having a finishing mill including a front stage and a back stage;
wherein the front stage includes two or more stands of CVC rolling mills, and

the back stage includes two or more stands of different-diameter-roll mills.

2. The hot rolling mill system according to claim 1, wherein each of the different-diameter-roll mill includes a roll of a large diameter that is driven for rotation, and a free rotatable roll of a small diameter.

3. The hot rolling mill system according to claim 2, wherein the roll having a large diameter is a lower roll, and the roll having a small diameter is an upper roll.

4. The hot rolling mill system according to claim 1, further comprising a rough rolling mill disposed on an upstream side of the finishing mill, and a temperature drop preventing means for preventing temperature drop of a sheet, disposed between the rough rolling mill and the finishing mill.

5. The hot rolling mill system according to claim 4, wherein the temperature drop preventing means is a tunnel furnace provided with a heating means and permitting a sheet to pass therethrough.

6. The hot rolling mill system according to claim 4, wherein the temperature drop preventing means is a sheet coiler/uncoiler.

7. The hot rolling mill system according to claim 4, wherein the temperature drop preventing means is a heater for heating a leading end part and a tail end part of a sheet.

8. A hot rolling mill system having a finishing mill including a front stage and a back stage;
wherein the front stage includes two or more stands of pair-cross rolling mills, and

the back stage includes two or more stands of different-diameter-roll mills.

9. The hot rolling mill system according to claim 8, wherein each of the different-diameter-roll mills includes a roll of a large diameter that is driven for rotation, and a free rotatable roll of a small diameter.

10. The hot rolling mill system according to claim 9, wherein the roll having a large diameter is a lower roll, and the roll having a small diameter is an upper roll.

11. The hot rolling mill system according to claim 8, further comprising a rough rolling mill disposed on an upstream side of the finishing mill, and a temperature drop preventing means for preventing temperature drop of a sheet, disposed between the rough rolling mill and the finishing mill.

12. The hot rolling mill system according to claim 8, wherein the temperature drop preventing means is a tunnel furnace provided with a heating means and permitting a sheet to pass therethrough.

13. The hot rolling mill system according to claim 8, wherein the temperature drop preventing means is a sheet coiler/uncoiler.

14. The hot rolling mill system according to claim 8, wherein the temperature drop preventing means is a heater for heating a leading end part and a tail end part of a sheet.

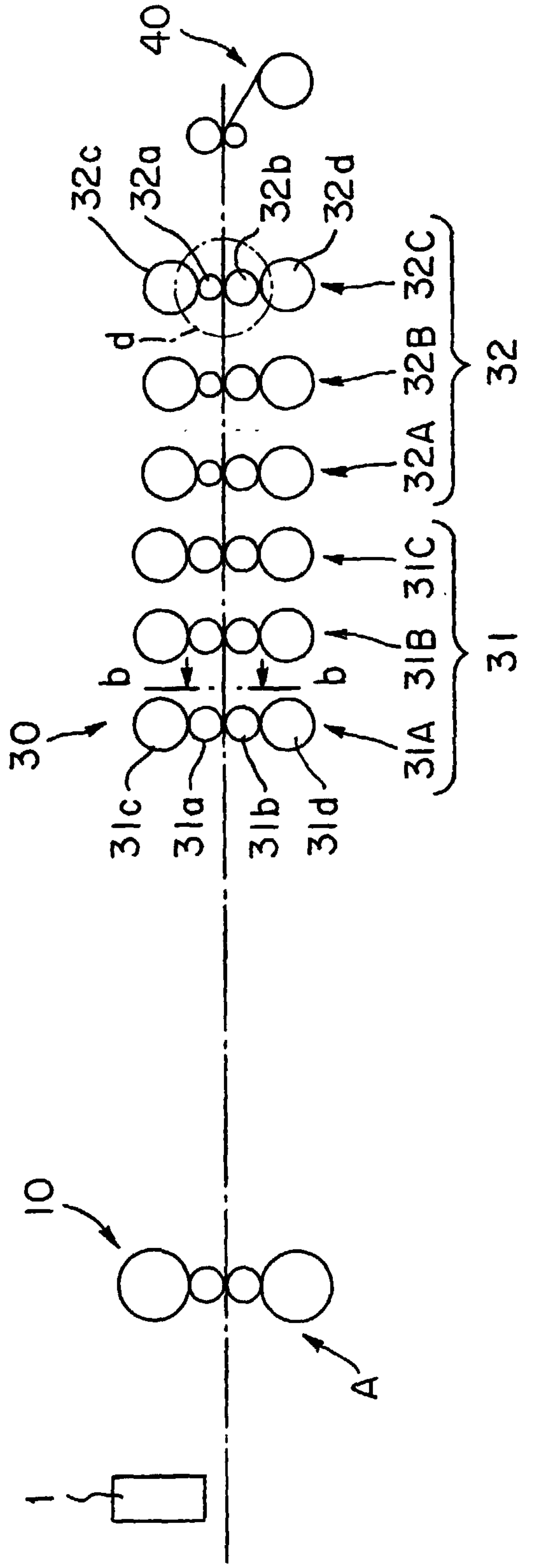
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FIG. 1a

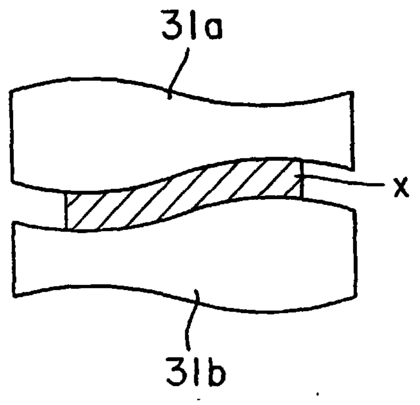


FIG. 1b

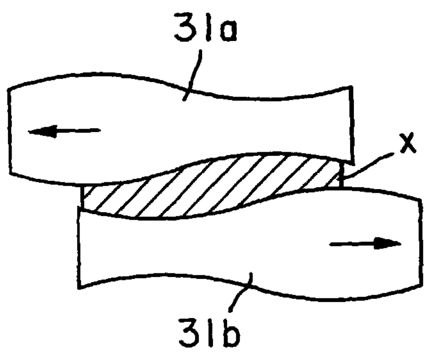


FIG. 1c

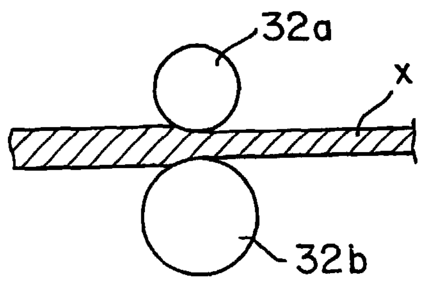


FIG. 1d

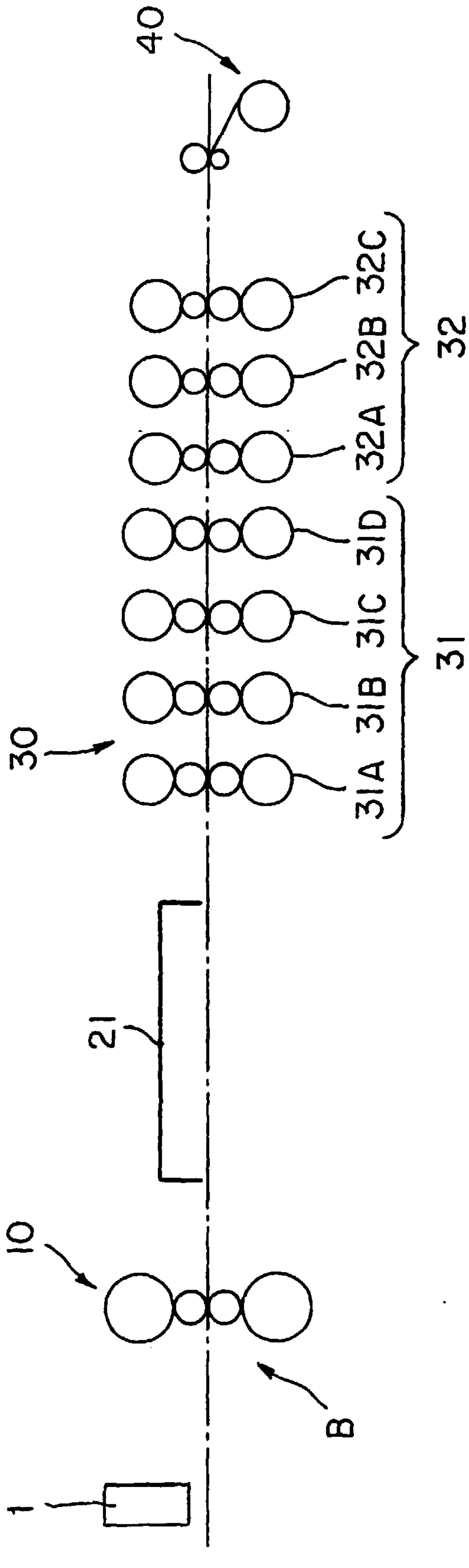


FIG. 2a

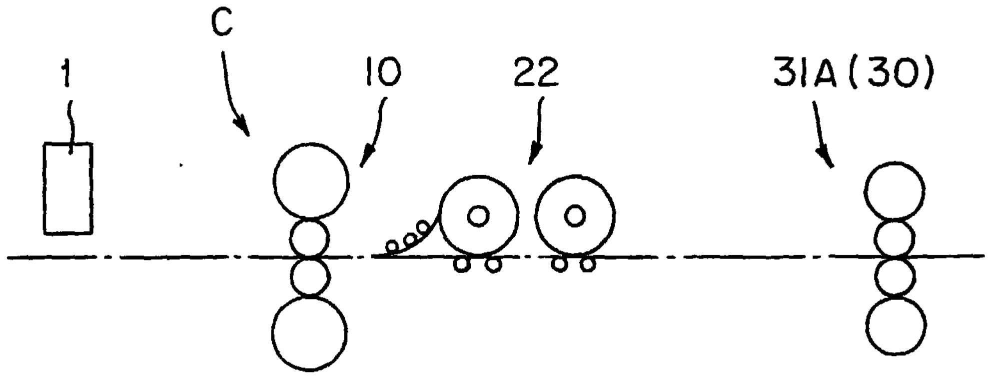


FIG. 2b

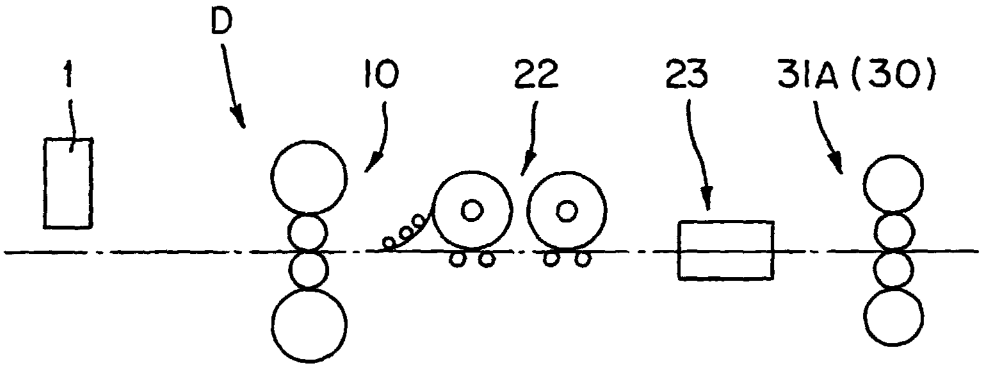


FIG. 2c

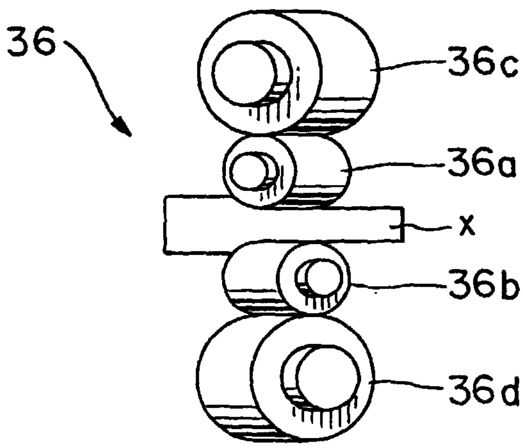
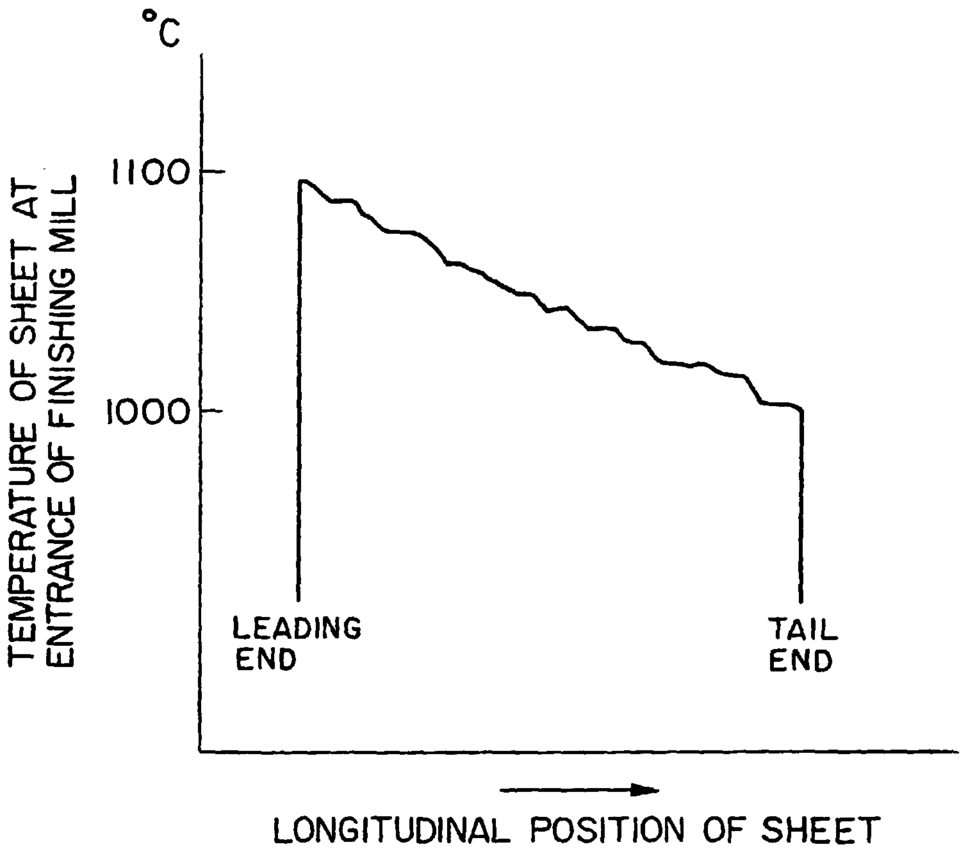


FIG. 3


°C
1100
1000
TEMPERATURE OF SHEET AT
ENTRANCE OF FINISHING MILL
LEADING
END
TAIL
END
LONGITUDINAL POSITION OF SHEET

F I G. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP99/04822

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl[6] B21B 1/26, 13/14, 45/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
Int. Cl[6] B21B 1/26, 13/14, 45/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926-1996	Toroku Jitsuyo Shinan Koho	1994-1999
Kokai Jitsuyo Shinan Koho	1971-1999	Jitsuyo Shinan Toroku Koho	1996-1999

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 62-137102, A (NIPPON STEEL CORPORATION), 20 June, 1987 (20.06.87), page 1, lower left column, lines 5 to 10; page 3, upper right column, line 11 to lower left column, line 4; Fig. 1 (Family: none)	1-14
A	JP, 4-11281, B2 (SMS Schloemann-Siemag AG.), 28 February, 1992 (28.02.92) & EP, 49798, A2	1-7
A	JP, 58-31242, B2 (Mitsubishi Heavy Industries, Ltd.), 05 July, 1983 (05.07.83) & EP, 72385, A1	8-14

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 November, 1999 (29.11.99)	07 December, 1999 (07.12.99)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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