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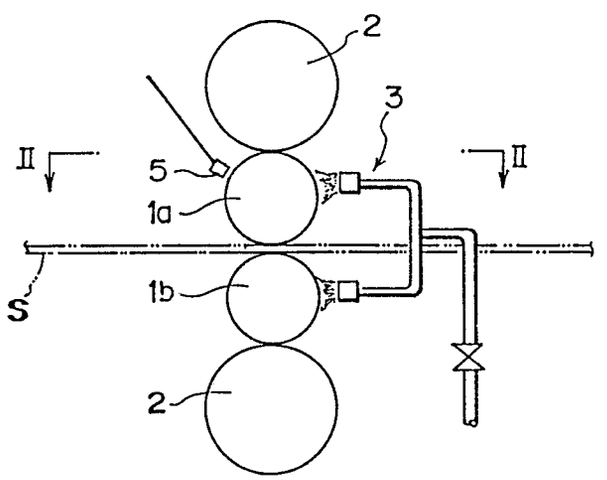
(54) HOT ROLLING METHOD AND EQUIPMENT FOR FRAGILE STRIP.

(57) This invention relates to a method of hot rolling a fragile strip, and equipment for practicing the method. During a hot rolling operation according to this method, both side portions of a roll body including the portions of the same which are in the vicinity of the strip edge-contacting portions thereof are heated so as to control the heat crown of the roll. The rolling equipment has a heating unit capable of varying a heating range in the lengthwise direction of a rolling roll, and a plurality of temperature sensors arranged in the lengthwise direction of the roll, and is capable of controlling the heating range of the heating unit according to temperature information from the temperature sensors.



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WARM ROLLING METHOD OF BRITTLE STEEL BAND AND FACILITY THEREFOR

TECHNICAL FIELD

The present invention relates to a warm rolling method of brittle steel bands such as high Si steels, and a facility therefor suitable to practising the method.

BACKGROUND OF THE INVENTION

Brittle materials such as high Si steel are known in difficulties of processings, e.g., rolling, but those materials may be subjected to rolling by increasing temperature.

In such rolling by increasing the temperature, since the temperature of a strip is higher than that of the roll, the working part of the roll is heated by the heated strip so that thermal expansion is repeated, and the roll is generated with a large convex crown. Due to such a crown, the roll is shaped like a bottom of pan or cauldron changing abruptly at the edges of the strip. Therefore, the strip under rolling is effected with extreme elongation at its center and with large tension stress at its edges. The brittle strip would be easily broken if receiving tension stress at the strip edges.

As a method of preventing the heat crown, the prior art cooled the rolls with a coolant, but in a case of the brittle material, this method could not be employed because the temperature of the strip should not be decreased.

Further, in the warm rolling of the steel band, the tempera-

ture of the roll should be necessarily high to a certain extent, otherwise the heat of the steel band would transfer to the roll and the steel band could not be performed with proper processing. Therefore, the roll must be preheated for entering the rolling of the steel band.

The present invention has been developed in view of problems involved with the prior art, and it is an object of the invention to provide a method of preventing the heat crown caused in the roll and carry out the warming roll without causing breakage of the brittle steel band.

It is another object of the invention to provide a rolling facility which preheats the rolls and is suited to practicing the above stated method.

DISCLOSURE OF THE INVENTION

For accomplishing the objects of the invention, during warm rolling of the brittle steel band, the inventive method heats both ends of roll bodies, including vicinities of the parts in length thereof, to which the edges of the steel band contact, in order to control heat crowns caused in the rolls under operation.

By controlling the heat crown, the thermal expansion may be uniformalized in the working part of the roll, and the steel band may be exactly prevented from elongation at its center.

The both sides of the roll is directly heated by means of burners or other heating instrument or indirectly heated via such as back-up rolls.

The inventive rolling facility has a heating apparatus which may change heating ranges in the length of the roll body, and a plurality of temperature sensors provided along the length of the

roll body, in order to change the heating ranges of the heating apparatus in accordance with temperature informations issued from the temperature sensors.

During heating by the above heating apparatus, the temperature on the roll surface is measured by the temperature sensors, and in accordance with the tempertaure information therefrom, the heating range, i.e., the heating widthes at the both ends of the rolls are controlled by an on-off control of each of heating elements composing the heating apparatus.

The roll is preheated by heating the full length of the roll body.

As the heating apparatus, the heating burners or other suitable means may be employed.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a view showing an embodiment of the inventive method;

Fig.2 is a view seen from II - II of Fig.1;

Fig.3 is a graph showing influences of the heating widthes at the both sides of of the roll bodies to an amount of heat crown in the warm rolling;

Fig.4 is a graph showing changes as time passes, of the heat crown amounts of the inventive and the comparative examples in the embodiment;

Fig.5 is a side view showing an embodiment of the inventive heating facility;

Fig.6 is a view seen from VI - VI of Fig.5; and

Fig.7 is a graph showing an amount of heat expansion in the length of the roll body in the warm rolling of the steel band.

MOST PREFERRED EMBODIMENTS FOR PRACTISING THE INVENTION

Figs.1 and 2 show one embodiment of the invention, where the rolls are directly heated by means of burners.

In the drawings, numerals 1a,1b are upper and lower rolls, 2 is back-up rolls, 3 is a burner, 4 is stands, 5 is a thermometer (contact type) for measuring temperatures of the roll, and (S) is a steel band.

The burner 3 is disposed against the rolls 1a,1b such that the both sides of the roll body may be heated, and has a plurality of burner portions (burner nozzles) along the length of the roll body such that the flames may be changed in width at the both sides of the roll body.

In the facility, the burner 3 directly heats the both sides of the roll bodies, including the vicinities of parts thereof to which the edge parts of the steel band (S) contact, so as to control the heat crown thereat.

Actually, the thermometer 5 measures the temperature in the length of the roll body, so that the heating width is controlled by the on-off control of the heating elements of the burner.

By preventing the heat crown, the heat expansion is made uniform in the working part of the roll so that the steel band may be prevented from elongation at its center.

The both sides of the roll body may be directly heated by the burners or other heating instruments, or may be indirectly heated via the back-up rolls.

Fig.3 is a graph showing influences of the heating widthes to an amount of heat crown in the warm rolling by the facility as seen in Fig.1, and it is seen that the crown may be controlled by the heating width, and especially if the heating width is broad-

ened gradually as time passes, ΔH can be checked exactly.

EXAMPLE

The same facility as shown in Figs.1 and 2 was used, and the rolls were, before rolling, preheated (200°C) by means of all of the burners disposed against the roll bodies, and subsequently the heating was made on a predetermined width in the roll from its part contacting the edges of the steel band to the ends of the roll, and the warm rolling was carried out on the steel band. For comparison, the warm rolling was done, but the roll was not heated under the same condition. The rolling conditions were as follows.

Steel band: 6.5% Si steel

Heating temperature of steel band: 350°C

Diameter of roll: 200 mmφ

Length of roll body: 500 mm

Width of steel band 200 mm

Roll heating conditions (the invention)

Heating width: 30 mm

Temperature of burner: 1000°C

Temperature of rolls: 200 to 250°C

Fig.4 is a graph showing changes as time passes, of the heat crown amounts ΔH (refer to Fig.3) during rolling in the inventive and the comparative examples. The comparative example did not heat the rolls, and a large crown was caused as the rolling progressed, while the invention checked the heat crown to the small amount. The invention could roll the steel band in thickness from 2.0 mm to 0.5 mm without causing breakages at the edge port-

ions. However, the comparative example generated breakages at the edge portions of the steel strip at beginning of rolling if the rolls were not preheated. Further, if the vicinities of the edge portions of the strip were not heated for rolling, the large elongation was generated at the center of the steel band, and the steel band was broken at last.

As the desired rolling could be performed if the rolls were maintained at the temperature between 200°C and 250°C, another example was carried out under a condition that the temperature was not below the above mentioned temperature, in that the heat crown was prevented by forcibly air-cooling the working parts of the rolls generating large heat expansion. Thus, as a result of combination of the burners heating the vicinities of the edges of the strip and the air cooling of the working parts of the rolls, the heat crown could be controlled satisfactorily until the strip was rolled to a desired thickness without causing extreme increasing of the temperature in the rolls.

The rolling facility of the invention will be referred to.

Figs.5 and 6 show one embodiment of the present facility. Numerals 1a,1b are upper and lower rolls, 2 is back-up rolls, 3 is a burner, 4 is stands, 5 is a thermometer, 6 is a heat control apparatus, and 7 is a valve operating device.

The burner 3 is disposed against the rolls 1a,1b, and has a plurality of burner portions 31 (burner nozzles) along the length of the roll body such that the flames may be changed in width at the both sides of the roll body by the on-off of the burner portions 31. Gas supply pipes 8 to burner portions 31 of the burner 3 are provided with valves 9 which are operated by the valve operating device 7.

The temperature sensors 5 are provided with spaces along the length of the roll body. The temperature information from the temperature sensor 5 is sent to the heat control apparatus 6, and in accordance with the temperature information, the heating range of the burner 3 is controlled. Actually, the on-off control is made to each of the burner portions 31 by operating the valve.

The numeral 10 designates the air nozzles disposed against the center parts of the roll bodies, and each of them is supplied with the air from an air pipe 11.

In the above mentioned rolling facility, the rolls are pre-heated over almost the full lengthes of the rolls 1a,1b by means of all the heating burners disposed along the length of the roll body. Further, during rolling the brittle steel band (S), the burner 3 heats only the both sides of the roll including the vicinity of its part to which the edges of the steel band (S) contact, during which the temperature sensors 5 measure the temperature on the roll surface in the length of the roll body. The heating position and width of the roll are adjusted by the on-off control of each of the burner portions 31 such that the thermal expansion is made uniform in the working part of the roll in accordance with the temperature information.

The both sides of the roll bodies are heated by the burners as mentioned above, while the center parts of the roll bodies are forcibly cooled with the air supplied from the air nozzles 10, whereby the heat crown is positively prevented.

INDUSTRIAL APPLICABILITY

The method and facility of the invention may be applied to the rolling of the brittle steel bands such as high Si steels.

WHAT IS CLAIMED IS

1. A method for warm rolling of brittle steel bands, comprising heating, during warm rolling, both ends of roll bodies including vicinities of parts of the roll bodies to which the edges of the steel band contact, thereby to prevent heat crown caused in the rolls.

2. The method as claimed in claim 1, directly heating both sides of the roll body by means of heating means.

3. The method as claimed in claim 1, heating the both sides of the roll bodies of back-up rolls by measn of the heating means, and heating both sides of the roll bodies by heat conductivity from the back-up rolls.

4. The method as claimed in claim 1, 2 or 3, wherein the heating means is a burner.

5. The method as claimed in claim 1, 2 or 3, wherein the heating means is other than the burner.

6. The method as claimed in claim 1, 2 or 3, wherein the heating ranges at the both sides of the roll bodies are broadened as time passes.

7. A warm rolling facility for brittle steel bands, provided with a heating apparatus which may change heating ranges in length of roll bodies, and a plurality of temperature sensors along the length of the roll bodies, thereby to change heating

ranges of the heating apparatus in accordance with temperature informations issued from the temperature sensors.

8. The facility as claimed in claim 7, wherein the heating apparatus is provided with a plurality of burners along the length of the roll bodies.

9. The facility as claimed in claim 8, wherein the heating apparatus is provided with heating means other than the burners.

FIG_1

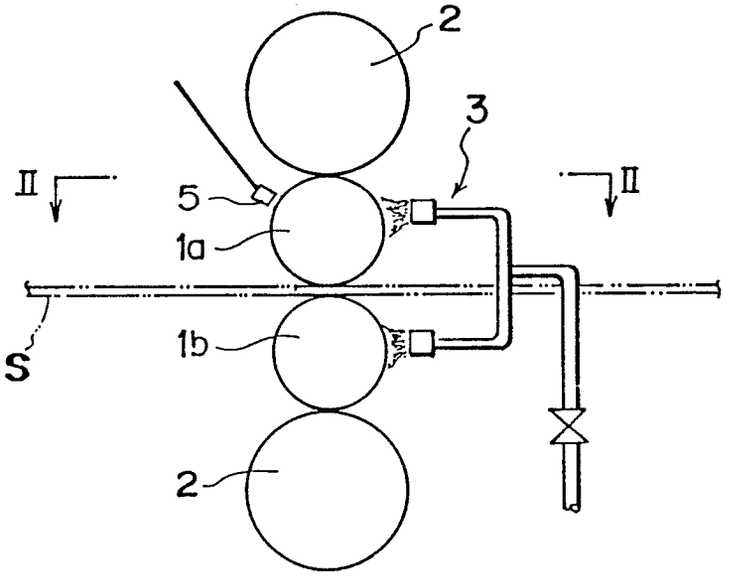

FIG_2

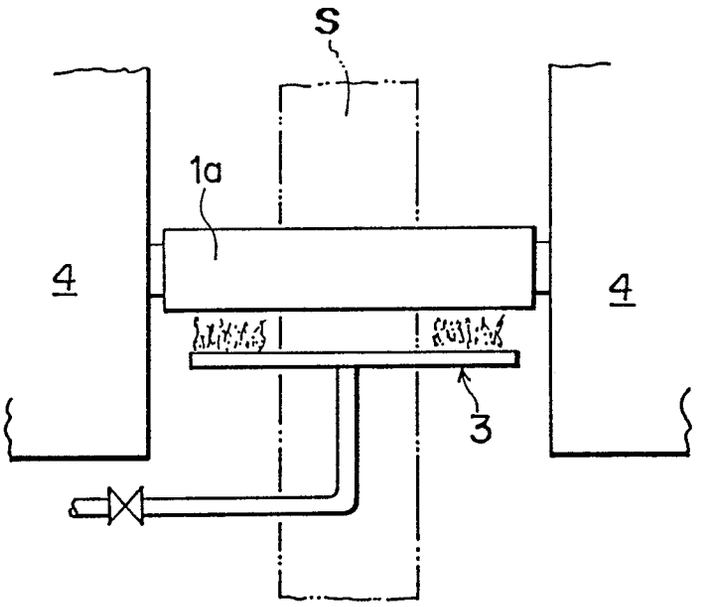

FIG_3

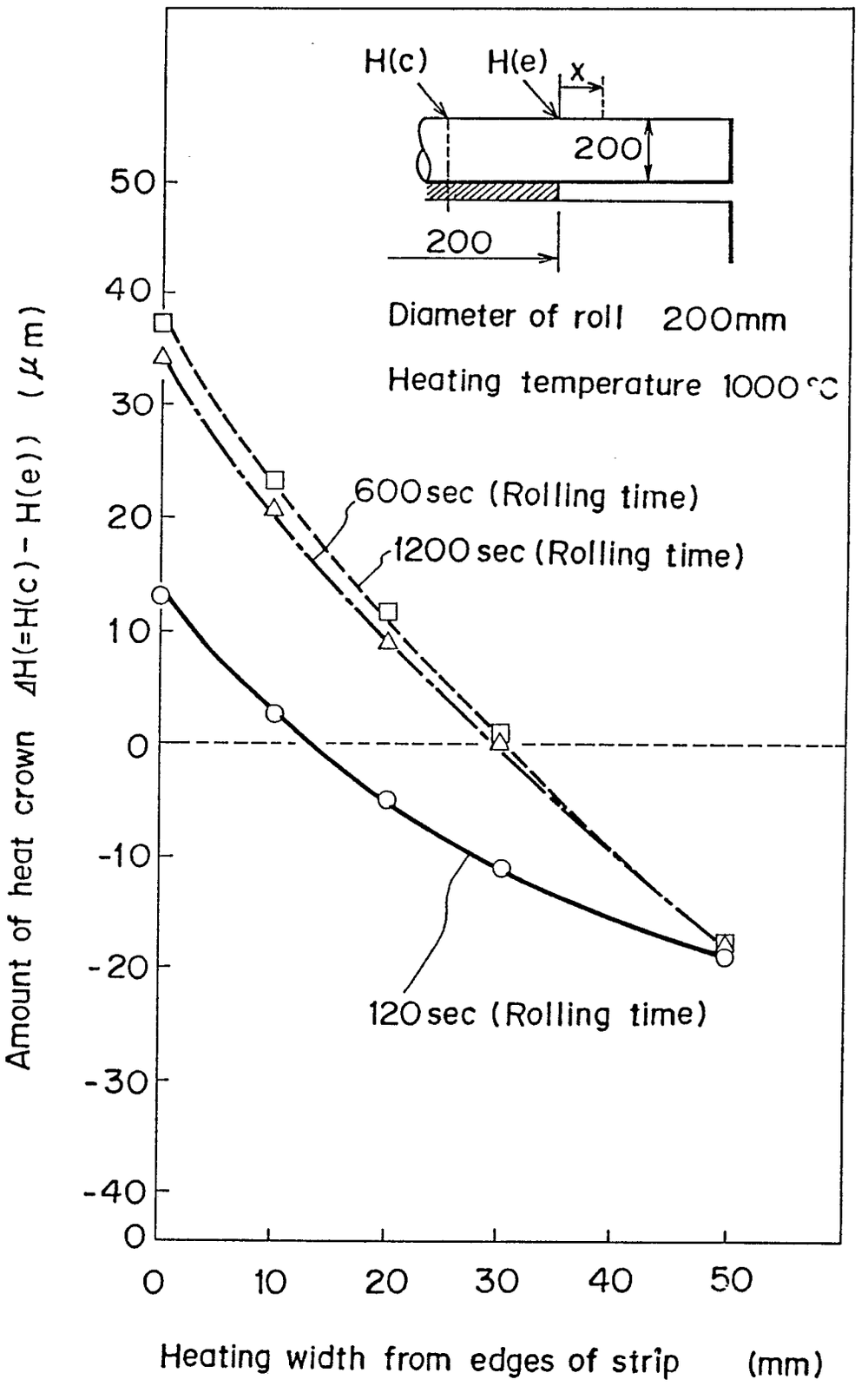
H(c)
H(e)
x
200
200
Diameter of roll 200mm
Heating temperature 1000°C
600sec (Rolling time)
1200sec (Rolling time)
120sec (Rolling time)
Amount of heat crown ΔH(=H(c)-H(e)) (μm)
50
40
30
20
10
0
-10
-20
-30
-40
0
10
20
30
40
50
Heating width from edges of strip (mm)

FIG_4

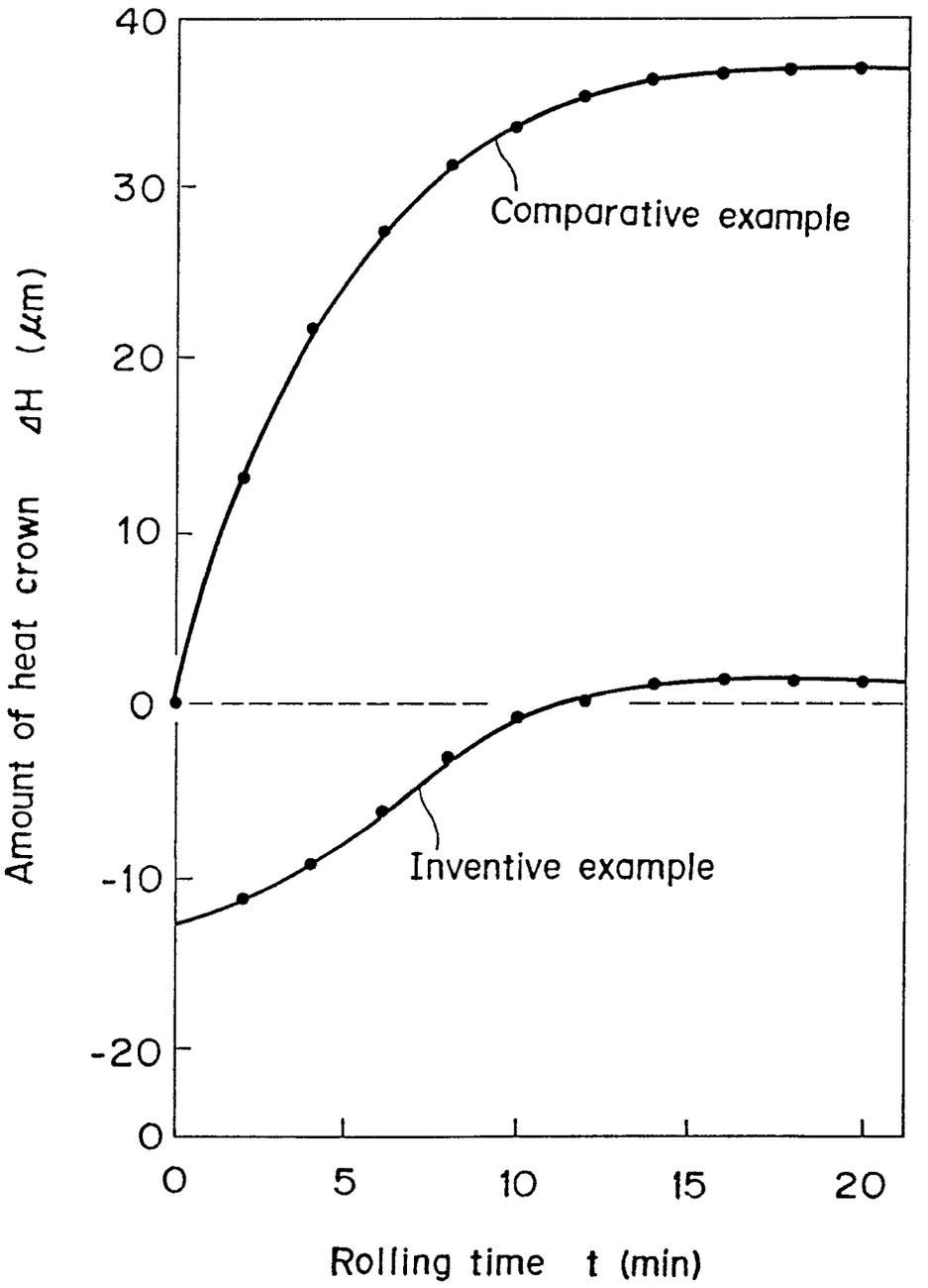
40
30
20
10
0
-10
-20
0
5
10
15
20
Comparative example
Inventive example
Amount of heat crown ΔH (μm)
Rolling time t (min)

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FIG_5

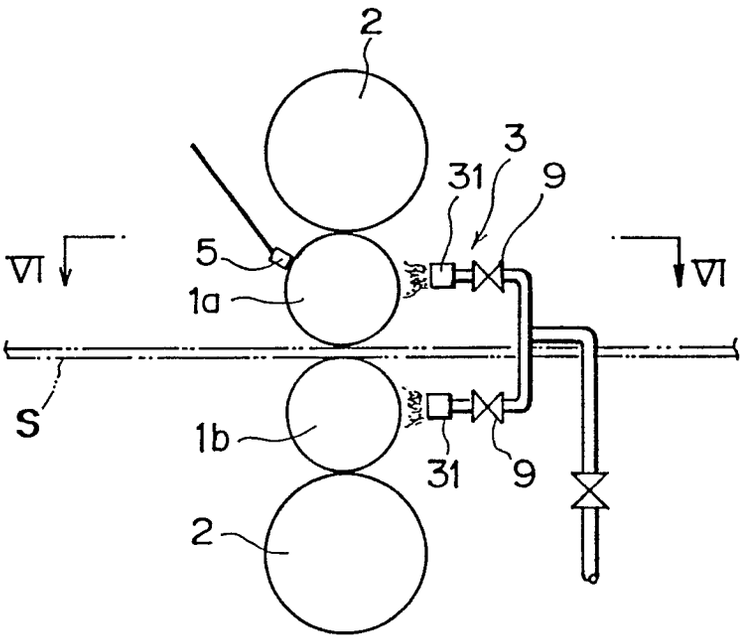

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FIG_6

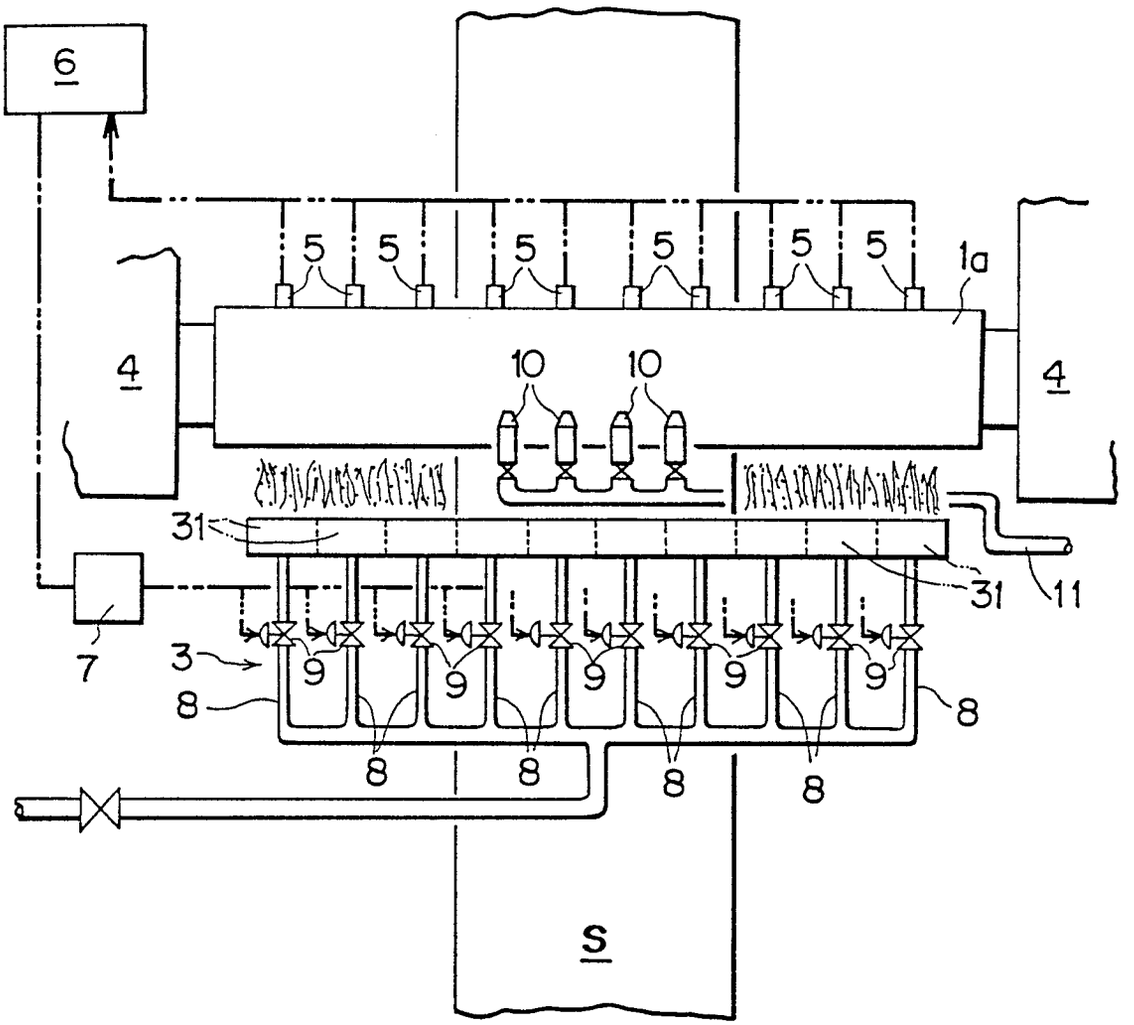
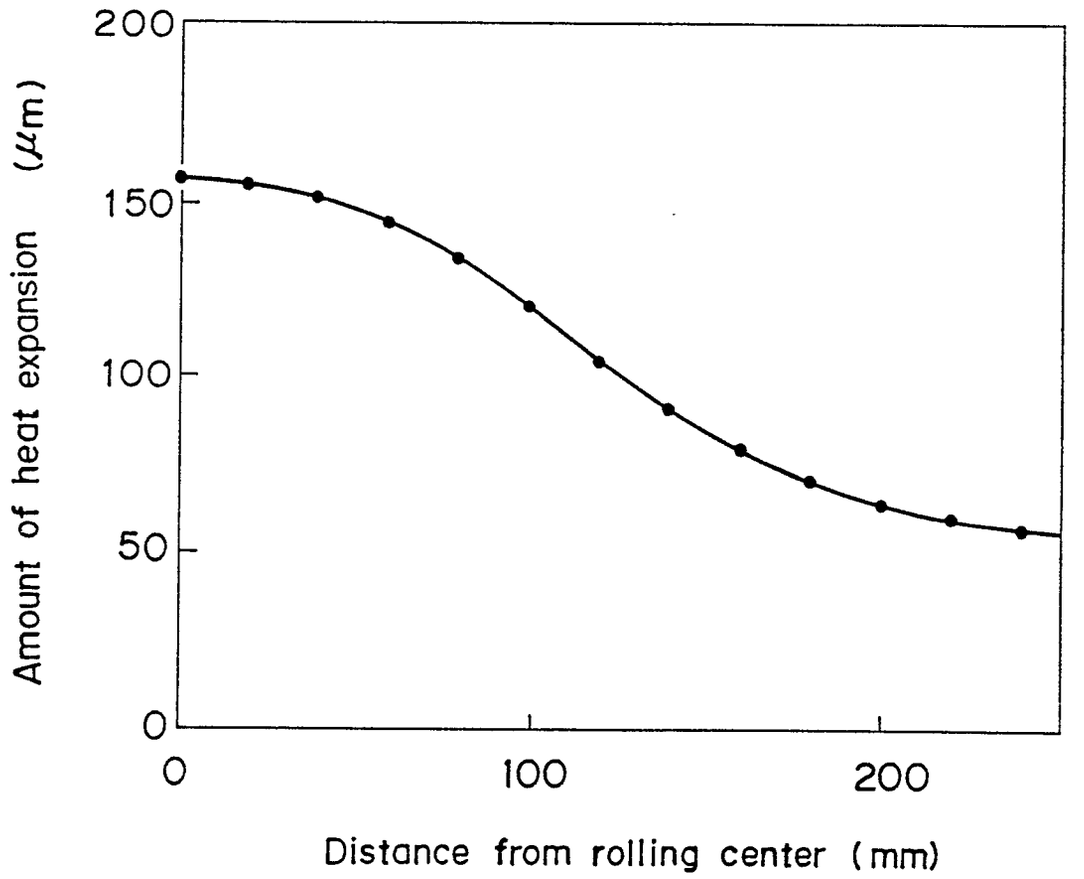


FIG_7


200
150
100
50
0
Amount of heat expansion (μm)
0
100
200
Distance from rolling center (mm)

INTERNATIONAL SEARCH REPORT 0031569 4

International Application No PCT/JP88/00492

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl[4] B21B1/22, B21B27/10

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	B21B1/22, B21B27/10, B21B37/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

Jitsuyo Shinan Koho	1926 - 1988
Kokai Jitsuyo Shinan Koho	1971 - 1988

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	JP, A, 60-238012 (Mitsubishi Electric Corporation) 26 November 1985 (26. 11. 85) Page 1, left column, lines 5 to 18 (Family: none)	1-9
X	JP, A, 60-180611 (Kobe Steel, Ltd.) 14 September 1985 (14. 09. 85) Page 1, left column, lines 5 to 9 (Family: none)	1-9

* Special categories of cited documents: [10]

"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)

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"P" document published prior to the international filing date but later than the priority date claimed

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"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

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
August 10, 1988 (10. 08. 88)	August 15, 1988 (15. 08. 88)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	