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(71) Applicant:
Kawasaki Steel Corporation
Chuo-ku, Kobe-shi, Hyogo 651 (JP)

(72) Inventors:
- **TAKEDA, Ryo**
  Mizushima Iron Works of Kawasaki
  Kurashiki-shi Okayama 712 (JP)
- **KONDO, Hidenori**
  Mizushima Iron Works of Kawasaki
  Kurashiki-shi Okayama 712 (JP)
- **SAKURAI,Tomoyasu**
  Mizushima Iron Works of Kawasaki
  Kurashiki-shi Okayama 712 (JP)

(74) Representative:
Henkel, Feiler, Hänzel
Möhlstrasse 37
81675 München (DE)

(54) METHOD OF ROLLING DEFORMED BAR AND ROLL FOR DEFORMED BAR

(57) A steel bar for concrete reinforcement having knots and four ribs on its surface is produced by performing the final finish rolling by means of a two-roll rolling mill. Rolls R_1, R_2 of the two-roll rolling mill have a roll caliber (3), round calibers (2) and a bottom groove (1). The roll caliber (3) is substantially semi-circular in cross section, and is provided over the whole peripheral surface of the roll. The round calibers (2) are made in the groove surfaces of the roll caliber (3) and have a predetermined width so as to cross the roll caliber (3). The cross section of the bottom groove (1) is an isosceles trapezoid and the groove (1) is provided along the center line of the roll caliber (3) over the whole circumference of the roll caliber.

FIG. 1(a)

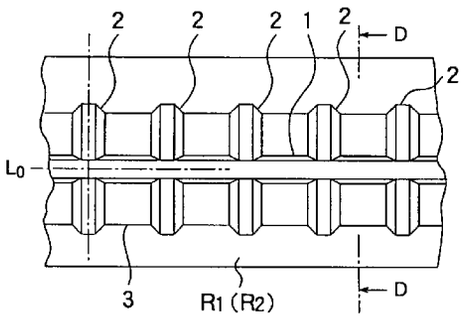
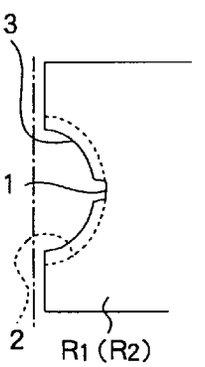


FIG. 1(b)



EP 0 853 988 A1

Description

Technical Field

The present invention concerns a rolling method for obtaining a steel bar for concrete reinforcement and, more in particular, it relates to a method capable of stably obtaining a steel bar for concrete reinforcement having four ribs extending in a longitudinal direction by a 2-roll rolling mill and to a roll used in this method.

Background Art

Fig. 6 shows a usual existent steel bar for concrete reinforcement. In Fig. 6, (a) is a side elevational view and (b) is a cross sectional view taken along line X-X in (a). The steel bar for concrete reinforcement 5 has a plurality of protrusions (knots) 12 formed on a circumferential surface of a round bar material along a circumferential direction substantially at an equal distance in a longitudinal direction. Further, two protrusions (ribs) 4 are formed along the longitudinal direction at positions spaced apart by 180° in the circumferential direction of a cross sectional circle.

Such a steel bar for concrete reinforcement 5 is produced by a final finish rolling mill of a continuous hot rolling facility in which a plurality of 2-roll rolling mills are arranged in tandem by rolling using finishing rolls R_1, R_2 as shown in Fig. 7 and Fig. 8.

Fig. 7 is a front elevational view illustrating an arrangement of both of finishing rolls and Fig 8(a) is a developed view for a roll circumferential surface, and (b) is a cross sectional view taken along line Y-Y in (a). As can be seen from the figures, a roll caliber 3 having a substantially semicircular cross sectional shape is formed over the entire circumferential direction to both of finishing rolls R_1 and R_2 for forming a pass for final finishing. Further, a caliber surface of the roll caliber 3 is provided with round calibers 2 in perpendicular to the roll caliber 3.

Then, by passing a material S rolled into an elliptic cross section by a row of upstream rolling mills through a pass defined with both of the finishing rolls R_1 and R_2, knots 12 corresponding to the round calibers 2 and ribs 4 formed by the material overfill from the gap between the rolls R_1 and R_2 are formed.

Further, the knots of the steel bar for concrete reinforcement are sometimes disposed obliquely to the longitudinal direction. In this case, as shown in Fig. 9, round calibers 2 of the finishing roll R are formed being inclined by a predetermined angle α relative to the circumferential direction. In Fig. 9, (a) is a developed view for a circumferential surface of the finishing roll R and (b) is a cross sectional view taken along line Z-Z thereof. Also in this case, ribs of the steel bar for concrete reinforcement obtained are only the two ribs formed by metal overfill from a gap between the finishing rolls R.

In recent years, such steel bar for concrete reinforcements have been bent by a fabrication machine. In this case, if there are only two ribs, it is difficult to stably support the surface of the steel bar for concrete reinforcement by a feeding device or a supporting device of the fabrication machine. Accordingly, it has been demanded a steel bar for concrete reinforcement having four ribs substantially at an equal distance in the circumferential direction. Further, if the ribs are present by four, they also provide a merit of increasing adhesion with concretes.

However, a technique for producing a steel bar for concrete reinforcement having four ribs has not yet been established. For instance, according to the technique filed previously by the present applicant and the like (refer to the publication of Japanese Patent Laid-Open Hei 7-32302), although a steel bar for concrete reinforcement with four ribs can be produced by using a 4-roll rolling mill as a final finishing rolling mill, this technique increases a cost. Further, forming four ribs by applying final finish rolling by a 2-roll rolling mill has not yet been put to practical use.

The present invention has been accomplished in view of the foregoings and it is an object to obtain a steel bar for concrete reinforcement provided with knots and four ribs by applying final finish rolling by a 2-roll rolling mill.

Disclosure of the Invention

A method of rolling a steel bar for concrete reinforcement according to the present invention has a feature, in a method of rolling a steel bar for concrete reinforcement of forming knots and ribs on a circumferential surface of a material supplied by a final finish rolling mill of a continuous hot rolling facility in which a plurality of 2-roll rolling mills are arranged in tandem, wherein final finish rolling is performed by means of a pair of two rolls each having a roll caliber having a substantially semi-circular cross sectional shape formed entirely in a circumferential direction on a circumferential surface of the roll, round calibers formed so as to cross the roll caliber on the surface of the roll caliber, and a bottom groove having a substantially trapezoidal cross sectional shape and having an opening width larger than a bottom width, and formed entirely over the circumferential direction to a central portion in the direction of the caliber width of the roll caliber, thereby forming four ribs by metal overfill from the gap between the rolls and metal flow to the bottom groove.

According to this method, two ribs are formed by metal flow to the bottom groove formed to each of the rolls in addition to the two ribs formed by metal overfill from the gap between the rolls. Since the ribs formed by the bottom groove are disposed in the central portion in the direction of the width of the caliber of the roll caliber, a steel bar for concrete reinforcement having four ribs formed at an equal distance or substantially equal distance in the circumferential direction is obtained.

Further, for example as shown in Fig. 1, the rolls are disposed such that the bottom surface of the bottom groove 1 and the bottom surface of the round calibers 2 are aligned, and the round calibers 2 and the roll caliber 3 are in perpendicular and, as shown in Fig. 2, it is preferred to perform rolling while setting such a condition that the width of H_1 between ribs 4a and 4b formed by metal overfill and metal flow is aligned or substantially aligned with the diameter A_1 of a cross sectional circle of the round caliber 2.

According to this method, the four ribs are formed each at an equal distance or at a substantially equal distance in the circumferential direction, as well as the outer circumferential surface of all of the ribs is aligned or substantially aligned with the outer circumferential surface of the knot, and the knot is formed at a right angle to the rib.

Further, as shown in Fig. 2, the roll is preferably adapted such that the depth of the bottom groove 1 is 10% or less of a mean diameter of a product, the bottom groove 1 has a substantially isosceles trapezoidal cross sectional shape, an angle made between not parallel two sides is 10° or more, and the bottom width b of the bottom groove 1 is 4% or more of the mean diameter.

Further, the substantially trapezoidal shape and the substantially isosceles trapezoidal shape mean shapes in which two parallel sides of the trapezoid (not including parallelogram) and isosceles trapezoid are not strictly linear but are coaxially arcuate. Then, a shorter one of arcs forms the bottom surface of the bottom groove, while the longer one forms the opening. Further, the mean diameter of the product means a mean diameter of a round bar portion excepting the knots and ribs of the steel bar for concrete reinforcement.

Then, as shown in Fig. 2, the advancing speed of the material S is aligned with a rotational speed of the rolls R_1, R_2 on the circumferential surface, but a corner a in the roll caliber 3 as an opening of the bottom wall 1 has a small radius of rotation, and the rotational speed at the corner a is slower than the advancing speed of the material S. Therefore, while a excess force exerts on the corner a and tends to cause a crack while rolling, a crack can be suppressed by defining the shape of the bottom groove 1 as described previously.

When it was actually examined whether a crack was caused at the corner a of the roll by varying the angle θ and the groove width b, a result as shown in the graph of Fig. 3 was obtained in a case of setting the depth of the bottom groove 1 to 10% of the mean diameter of the product, which is an upper limit according to JIS standards. From the graph, it can be seen that if the depth of the bottom groove 1 is 10% of the mean diameter of the product, no roll crack is caused if the angle θ is 10° or more and the groove width b is 4% or more of the mean diameter of the product. Further, since the roll crack is suppressed as the depth for the bottom groove 1 is smaller, roll crack is not caused also in a case where the depth of the bottom groove 1 is 10% or less for the mean diameter of the product, so long as the angle θ is 10° or more and the groove width b is 4% or more for the mean diameter of the product.

The roll crack is suppressed as the groove width b of the bottom groove 1 is larger and the angle θ is greater, and upper limit values for them are determined by product standards defined in accordance with JIS or the like.

The present invention further provides a roll for rolling a steel bar for concrete reinforcement having a roll caliber having a substantially semicircular cross sectional shape formed entirely in a circumferential direction on a circumferential surface of the roll, round calibers formed so as to cross the roll caliber on the surface of the roll caliber, and a bottom groove having a substantially trapezoidal cross sectional shape and having an opening width larger than a bottom width, and formed entirely over the circumferential direction to a central portion in the direction of the caliber width of the roll caliber.

The roll for rolling the steel bar for concrete reinforcement is preferably disposed such that the bottom surface of the bottom groove and the bottom surface of the round caliber are aligned, and the round calibers and the roll caliber are in perpendicular.

The roll for rolling the steel bar for concrete reinforcement is further preferably adapted such that the depth of the bottom groove is 10% or less of the mean diameter of the product, the bottom groove has a substantially isosceles trapezoidal cross sectional shape, the angle made between not parallel two sides thereof is 10° or more, and the bottom width of the bottom groove is 4% or more of the mean diameter.

Brief Explanation of the Drawings

Fig. 1 is a view illustrating a preferred roll of a 2-roll rolling mill for final finishing, in which (a) is a developed view of a roll circumferential surface and (b) corresponds to a cross sectional view taking along line D-D in (a).

Fig. 2 is a front elevational view illustrating a roll arrangement of a 2-roll rolling mill for final finishing to perform a preferred method of the present invention.

Fig. 3 is a graph for explaining the operation of the preset invention.

Fig. 4 is a front elevational view illustrating a roll pass of a 2-roll rolling mill for final finishing in one embodiment according to the present invention.

Fig. 5 is a illustrating a state in a feed roller for a steel bar for concrete reinforcement obtained by a preferred embodiment according to the present invention in which (a)- (c) represent different states respectively.

Fig. 6 is a view illustrating an example of an existent steel bar for concrete reinforcement in which (a) is a side elevational view and (b) corresponds to a cross sectional view taken along line X-X thereof.

Fig. 7 is a schematic view illustrating a roll arrange-

ment in a 2-rolling mill for final finishing for obtaining a steel bar for concrete reinforcement shown in Fig. 6.

Fig. 8 is a developed view (a) illustrating the roll of Fig. 7 and a cross sectional view (b) taken along line Y-Y thereof.

Fig. 9 is a view illustrating a roll of a 2-roll rolling mill for final finishing used in existent steel bar for concrete reinforcement rolling, in which (a) is a developed view of a roll circumferential surface and (b) corresponds to a cross sectional view taken along line Z-Z in (a).

Best Mode for Practicing the Invention

For explaining the present invention in more details, one embodiment will be explained in accordance with appended drawings.

Fig. 1 is a view illustrating a roll of a 2-roll rolling mill for final finishing used in this embodiment, in which (a) is a developed view for a roll circumferential surface and (b) corresponds to a cross sectional view along line D-D in (a). Further, Fig. 4 is a front elevational view illustrating a roll pass of a 2-roll rolling mill for final finishing formed by the roll in Fig. 1.

As shown in Fig. 1, roll R_1 (R_2) has a roll caliber 3 of a substantially semicircular cross sectional shape formed over the entire circumferential direction at a roll circumferential surface. Further, round calibers 2 each of a predetermined width are engraved to the roll caliber 3 so as to cross the center line L_0 in the direction of the caliber width of the roll caliber 3. The round calibers 2 are formed each at an equal distance along the circumferential direction of the roll caliber 3 (that is center line L_0 in the direction of the caliber width). Further, a bottom groove 1 having a substantially isosceles trapezoidal cross sectional shape and having an opening width greater than the bottom width is formed to the central portion in the direction of the caliber width of the roll caliber 3 over the entire circumferential direction.

As shown in Fig 4, the bottom surface of the bottom groove 1 is aligned with the bottom surface of the round caliber 2. Further, the depth c for the bottom groove 1 and the round caliber 2 is 0.85 mm, the diameter of the pass (mean diameter of the product) A_2 is 15.9 mm, the angle made between the not parallel two sides of the isosceles trapezoid constituting the cross section of the bottom groove 1 is 60° , and the bottom width b of the bottom groove 1 is 2.0 mm.

Further, an inclined portion 3a is formed to a boundary portion of the circumferential surfaces of rolls R_1, R_3 relative to the roll caliber 3. The roll distance d is set to 2.0 mm, and the angle made between the inclined portions 3a of both of the rolls R_1 and R_2 is set to 60° . The depth c of the bottom groove 1 corresponds to 5.3% of the mean diameter A_2 of the product, while the groove width b on the bottom of the bottom groove 1 corresponds to 13% of the mean diameter A_2 of the product respectively.

Such a 2-roll rolling mill was installed as a final finish rolling mill, and a round bar material rolled to a predetermined outer diametrical size by a row of ordinary 2-roll mills was put to finish rolling. In this case, as shown in Fig. 2 described above, a roll gap of a roll mill disposed just before the final finish rolling mill was adjusted such that the width H_1 of the ribs 4a, 4b formed by the material S overfill and flow going out of the final finish rolling mill was aligned with the diameter A_1 of the cross sectional circle of the round caliber 2.

As a result, a steel bar for concrete reinforcement in which four ribs were formed in the circumferential direction substantially at an equal distance, the outer circumferential surface of all of the ribs was aligned with the outer circumferential surface of the knot and the knots were formed in perpendicular to the ribs was obtained with no roll crack trouble.

Accordingly, when the thus obtained steel bar for concrete reinforcement 5 is rotated, as shown in Fig. 5(a)-(c), in a feed roller 6 as a feeding device of a fabrication machine, at least one rib 4 always abuts against each groove surface 6a of the feed roller 6. Therefore, the steel bar for concrete reinforcement is fed accurately while being supported securely on the feed roller 6.

Further, since the knots 12 are in perpendicular to the rib 4, there is also a merit that twist is not caused upon bending fabrication.

Further, in the embodiment described above, since the depth c of the bottom groove 1 is made to 5.3% of mean diameter A_2 of the product and the groove width b on the bottom of the bottom groove 1 is made to 13% of the means diameter A_2 of the product, a steel bar for concrete reinforcement 5 having four ribs 4 was obtained stably with no occurrence of roll cracking trouble.

Industrial Applicability

As described above, in the method of the present invention, a steel bar for concrete reinforcement provided with knots and four ribs can be obtained stably by performing final finish rolling by means of a 2-roll rolling mill.

This enables to obtain a steel bar for concrete reinforcement with four ribs by applying a rolling facility for producing existent 2-ribbed steel bar for concrete reinforcements and merely changing the roll of the 2-roll rolling mill for final finishing. Accordingly, the method and the roll according to the present invention can be utilized suitably as a method of producing a steel bar for concrete reinforcement having four ribs at a reduced cost and a roll used therefor.

Claims

1. A method of rolling a steel bar for concrete reinforcement of forming knots and ribs to the circumferential surface of a material supplied by a final

finish rolling mill of a continuous hot rolling facility in which a plurality of 2-roll rolling mills are arranged in tandem, wherein final finish rolling is performed by a pair of two rolls having a roll caliber having a substantially semicircular cross sectional shape formed entirely in a circumferential direction on a circumferential surface of the roll, round calibers formed so as to cross the roll caliber on the surface of the roll caliber, and a bottom groove having a substantially trapezoidal cross sectional shape and having an opening width larger than a bottom width, and formed entirely over the circumferential direction to a central portion in the direction of the caliber width of the roll caliber, thereby forming four ribs by metal overfill from the gap between the rolls and metal flow to the bottom groove.

2. A method of rolling a steel bar for concrete reinforcement as defined in claim 1, wherein the roll is disposed such that the bottom surface of the bottom groove (1) and the bottom surface of the round caliber (2) are aligned, the round calibers and the roll caliber (3) are disposed in perpendicular, and rolling is performed by setting conditions such that the width (H_1) between the ribs (4a, 4b) formed by the metal overfill and metal flow is aligned with or substantially aligned with the diameter (A_1) of a cross sectional circle of the round caliber.

3. A method of rolling a steel bar for concrete reinforcement as defined in claim 2, wherein the roll is adapted such that the depth of the bottom groove is 10% or less of the mean diameter of a product, the bottom groove has a substantially isosceles trapezoidal cross sectional shape and an angle (θ) made between not parallel two sides thereof is 10° or more, and the bottom width (b) of the bottom groove is 4% or more of the mean diameter.

4. A steel bar for concrete reinforcement rolling roll having a roll caliber having a substantially semicircular cross sectional shape over the entire circumferential direction on a circumferential surface of the roll, round calibers disposed to the surface of the roll calibers so as to cross the roll caliber, and a bottom groove having a substantially trapezoidal cross sectional shape and having an opening width greater than the a bottom width disposed over the entire circumferential direction to a central portion in the direction of the caliber width of the roll caliber.

5. A rolling roll for a steel bar for concrete reinforcement as defined in claim 4, wherein the bottom surface of the bottom groove and the bottom surface of the round caliber are aligned and the round calibers and the roll caliber are arranged so as to be in perpendicular.

6. A rolling roll for a steel bar for concrete reinforcement as defined in claim 5, wherein the depth of the bottom groove is 10% or less of the mean diameter of a product, the bottom groove has a substantially isosceles trapezoidal cross sectional shape, the angle made between not parallel two sides thereof is 10° or more, and the bottom width of the bottom groove is 4% or more of the mean diameter.

FIG. 1(a)

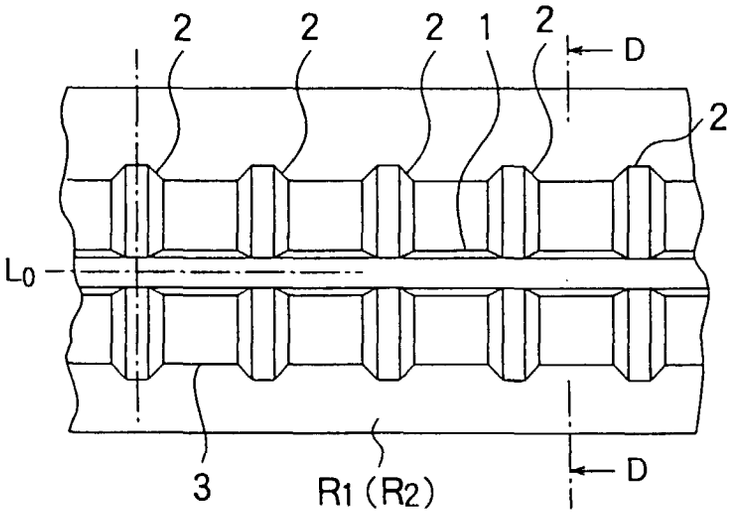


FIG. 1(b)

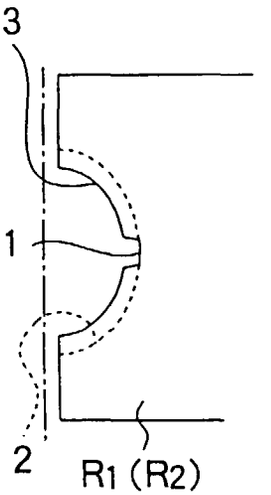


FIG. 2

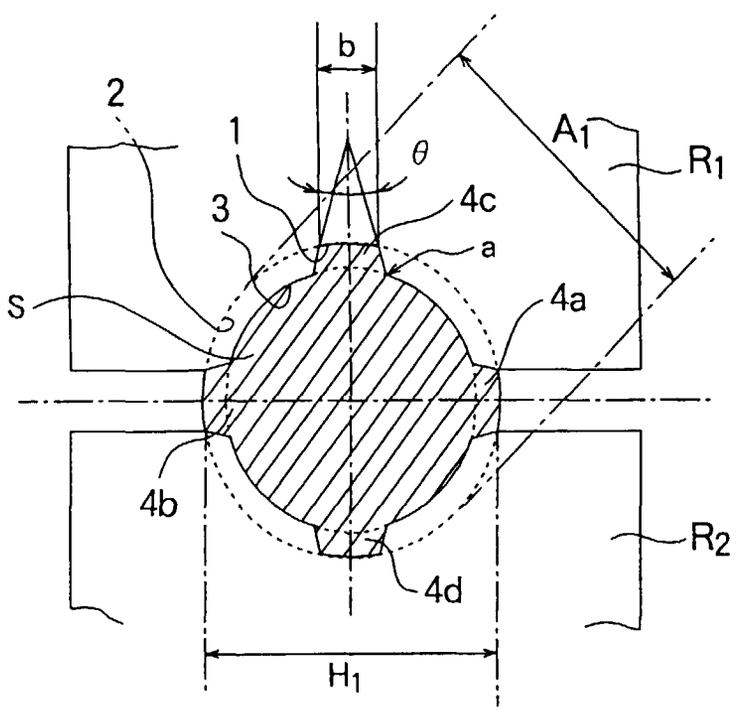


FIG. 3

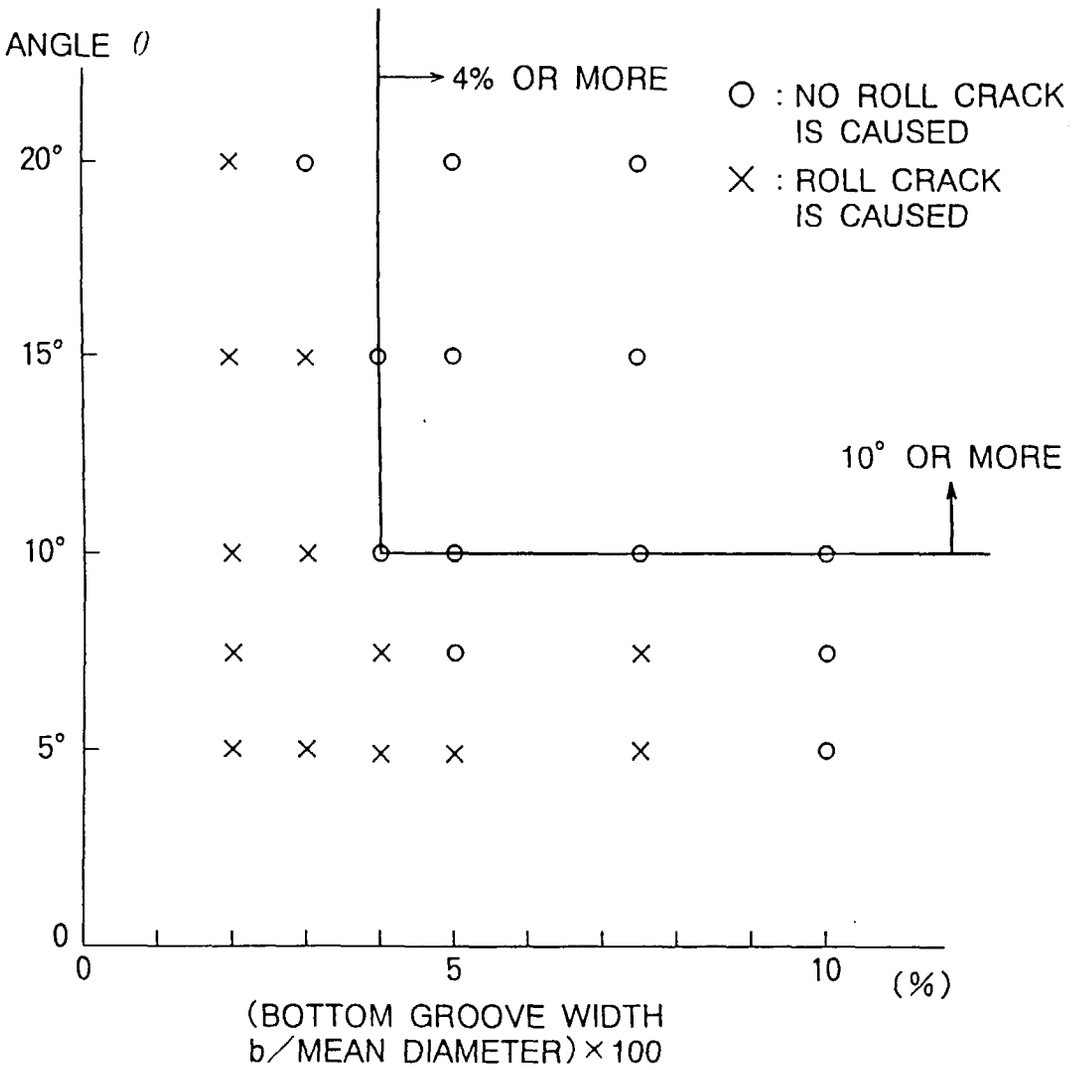

ANGLE θ
20°
15°
10°
5°
0
0
5
10
(%)
4% OR MORE
10° OR MORE
○ : NO ROLL CRACK IS CAUSED
× : ROLL CRACK IS CAUSED
(BOTTOM GROOVE WIDTH b/MEAN DIAMETER)×100

FIG. 4

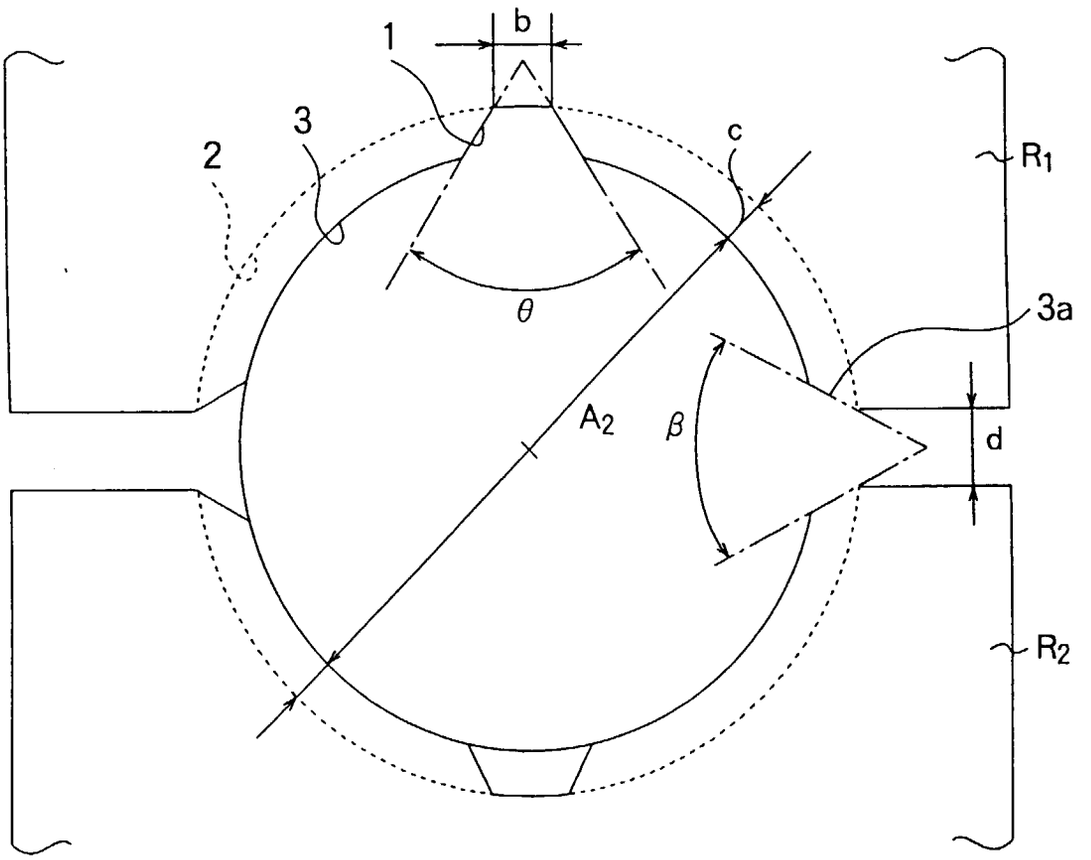


FIG. 5(c)

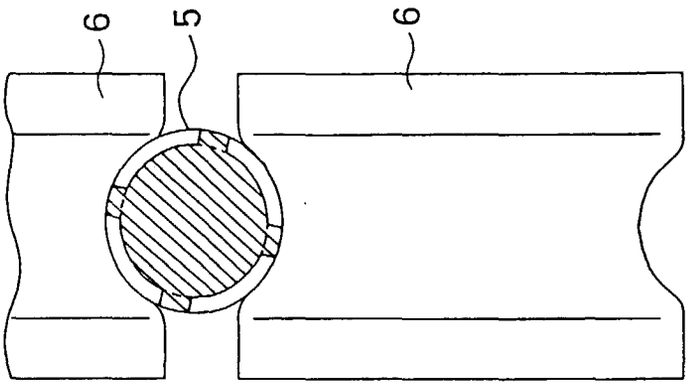


FIG. 5(b)

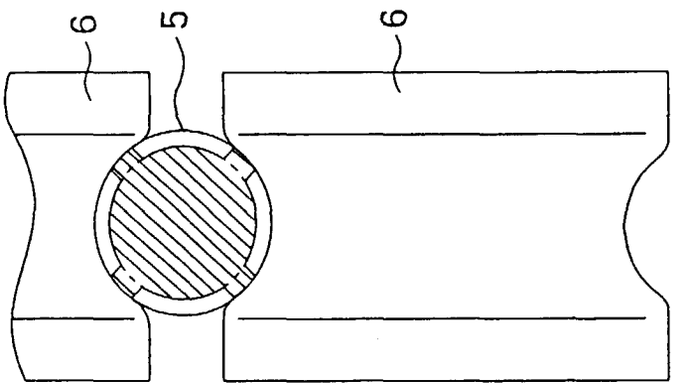


FIG. 5(a)

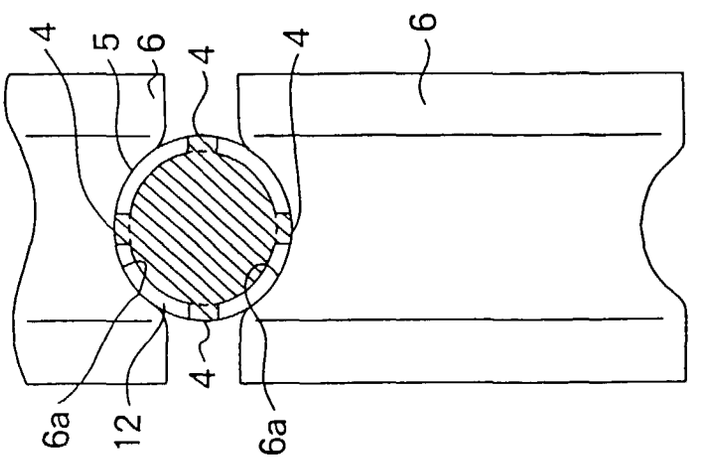


FIG. 6(a)

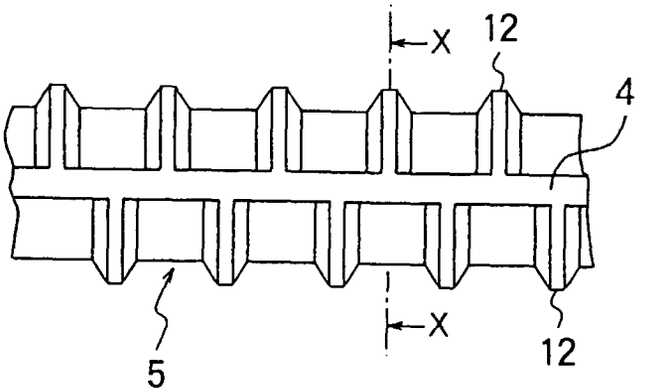


FIG. 6(b)

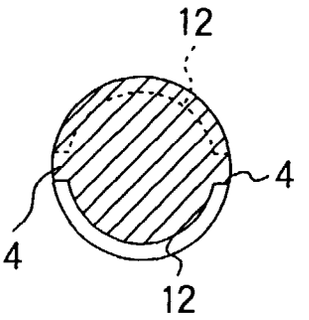


FIG. 7

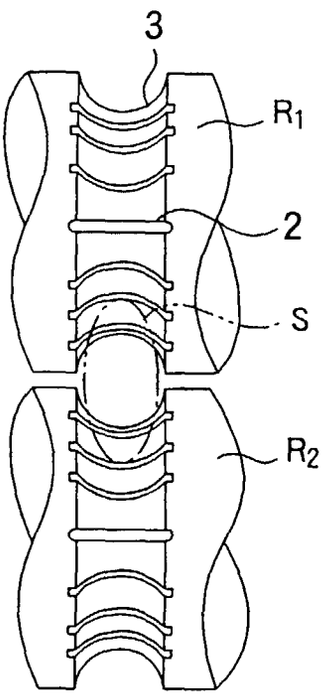


FIG. 8(a)

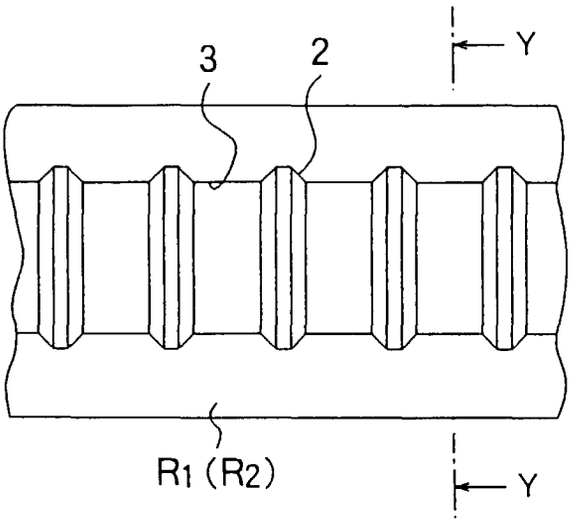


FIG. 8(b)

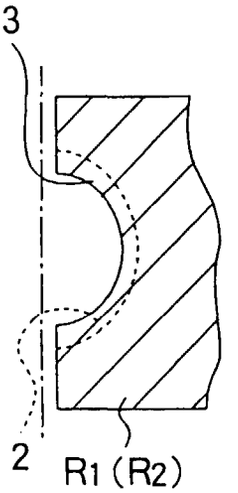


FIG. 9(a)

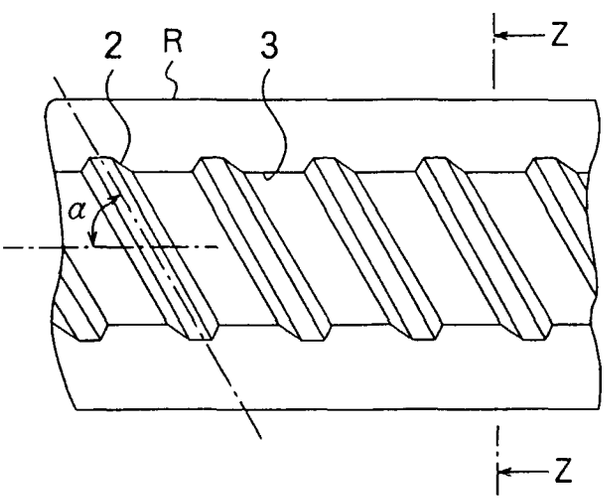
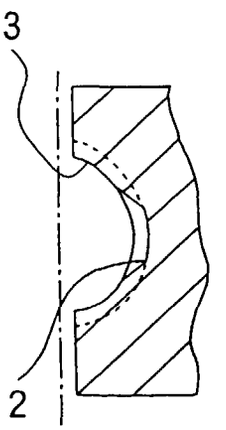


FIG. 9(b)



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP96/02783

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl^6 B21B27/02, B21B1/16

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 B21B1/16, B21B13/10, B21B27/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926 - 1996 Jitsuyo Shinan Toroku Koho 1996
Kokai Jitsuyo Shinan Koho 1971 - 1996
Toroku Jitsuyo Shinan Koho 1994 - 1996

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.
X A	JP, 4-3700, Y (Mitsubishi Materials Corp.), February 5, 1992 (05. 02. 92), Page 2, left column, line 43 to right column, line 31; Fig. 1 (Family: none)	1, 2, 4, 5 3, 6

☐ 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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Date of the actual completion of the international search	Date of mailing of the international search report
December 20, 1996 (20. 12. 96)	January 8, 1997 (08. 01. 97)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)