

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number:

0 584 642 A1

(12)

EUROPEAN PATENT APPLICATION(21) Application number: **93112820.1**(51) Int. Cl.⁵: **B21B 13/14, B21B 27/05,
B21B 29/00**(22) Date of filing: **10.08.93**

A request for addition of missing figures 4 and 16 has been filed pursuant to Rule 88 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 2.2).

(30) Priority: **12.08.92 JP 235146/92
12.08.92 JP 235147/92**(43) Date of publication of application:
02.03.94 Bulletin 94/09(84) Designated Contracting States:
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D-81675 München (DE)**(54) **Rolling mill.**

(57) A rolling mill including a split type backing-up roll, which can form a crown pattern most suitable for control of a sheet configuration of given strip to be rolled, is disclosed herein. Outer diameters of a center backing-up roll (3a), quarter backing-up rolls (3b) and side backing-up rolls (3c) are made identical, an axis of the center backing-up roll (3a) and axes of the both side backing up rolls (3c) are arranged as displaced from an axis of a roll shaft in the opposite directions to each other, axes of the both quarter backing-up rolls (3b) are displaced from the axis of the above-mentioned roll shaft in the

direction crossing at a desired angle with a straight line connecting the axis of the above-mentioned center backing-up roll (3a) and the axes of the above-mentioned side backing-up rolls (3c), and thereby it is made possible to obtain many kinds of crown patterns. Similar rolling mills including a split type backing-up roll having a number of different constructions are also disclosed.

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Fig. 1

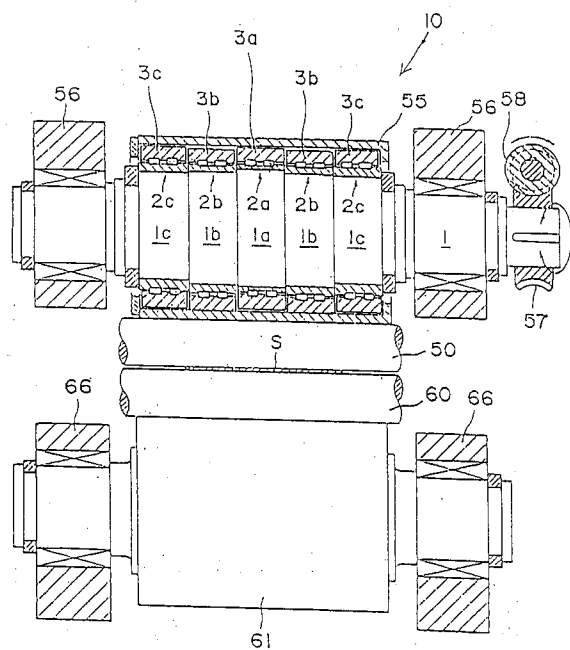
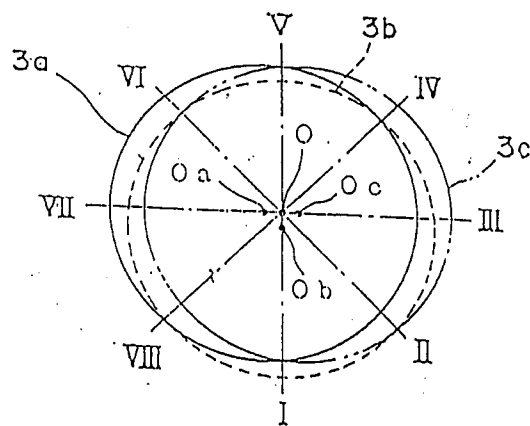


Fig. 2



BACKGROUND OF THE INVENTION:

1. Field of the Invention:

The present invention relates to a split type backing-up roll in a rolling mill which can change a roll crown.

2. Description of the Prior Art:

In the case of carrying out rolling of steel sheets, sometimes edge elongation and distortion would occur. In the event that edge elongation has occurred, it is dealt with by carrying out change and adjustment of a roll crown.

As to a rolling mill roll capable of changing its roll crown, a sleeve-system slit type backing-up roll used as an upper or lower backing-up roll of a four-stage rolling mill as shown in Fig. 16, has been known.

In this backing-up roll, on a roll shaft 51 are formed a center eccentric shaft portion 51a, a pair of left and right quarter eccentric shaft portions 51b and a pair of left and right side eccentric shaft portions 51c, respectively, having different eccentric directions and different diameters, roll bearings 52a - 52c are respectively fitted around these eccentric shaft portions 51a - 51c, and the outer rings of these respective roll bearings 52a - 52c form a freely rotatable center backing-up roll 53a, a pair of left and right quarter backing-up rolls 53b and a pair of left and right side backing-up rolls 53c. Around these axially splitted backing-up rolls 53a - 53c is loosely fitted a cylindrical sleeve 55.

By means of the above-mentioned members, an upper split type backing-up roll 59 is constructed.

The opposite ends of the roll shaft 51 are supported by bearing boxes 56, and at one end of the roll shaft 51 are equipped a worm wheel 57 and a worm 58. It is to be noted that in Fig. 16, reference numeral 50 designates an upper work roll, numeral 60 designates a lower work roll, numeral 61 designates an integral type lower backing-up roll, and numeral 66 designates bearing boxes.

Fig. 17 is a schematic view showing an eccentric condition of the upper split type backing-up roll 59, in which axes Oa, Ob and Oc of the respective backing-up rolls 53a, 53b and 53c deviate from an axis O of the roll shaft 51, and the side backing-up roll 53c is smaller in diameter than the center backing-up roll 53a and the quarter backing-up rolls 53b.

At the time rolling a strip S by means of a rolling mill having the above-mentioned split type backing-up roll 59, the upper work roll 50 is supported by this upper split type backing-up roll 59

by forcibly lowering the bearing boxes 56, and starting from this condition by appropriately rotating the roll shaft 51 via the worm 58 and the worm wheel 57, a roll crown corresponding to a sheet configuration of the strip S is formed. In Fig. 18 is shown variation of a crown pattern at the depressing position.

In the case of the heretofore known split type backing-up roll, varieties of the crown patterns were few, also variation of the crown pattern by rotating the roll shaft was large, hence fine adjustment thereof was difficult, and therefore, in rolling of a strip, a sheet configuration of the strip could not be fully controlled.

On the other hand, when a sheet material is rolled, due to heat generation caused by this rolling, as shown in Fig. 19, a range of the sheet material width size W of the work rolls 50 and 60 is heated and raised in temperature by this rolling, and a thermal crown as shown by double-dot chain lines is created.

Fig. 20 is a front view showing a general concept of a rolling mill making use of a heretofore known sleeve-system split type backing-up roll on which a thermal crown was created, Fig. 21 is a schematic view showing an eccentric state and a depressing state of the same split type backing-up roll, and Fig. 22 is a diagram showing a crown pattern at a depressing position of the backing-up roll shown in Fig. 21.

Fig. 20 shows a rolling mill, in which working rolls 50 and 60 are pressed via backing-up roll chocks 75 and sleeve-system split type backing-up rolls 80 consisting of anti-friction bearings 73a, 73b and 73c rotatably mounted to a roll shaft 71 rotatable by desired angles and having their respective axes Oa, Ob and Oc displaced from an axis O of the roll shaft 71 as shown in Fig. 21, and a cylindrical sleeve 55 loosely fitted around the split type backing-up roll to form an outer shaft of the anti-friction bearings 73a, 73b and 73c.

If a sheet material S is rolled by pressing the work rolls 50 and 60 on which thermal crown were created in the above-described manner, then in quarter portions Sa, which are the places distant from the opposite edges of the sheet material S by 10 mm - 200 mm, would occur the so-called quarter elongations.

In order to prevent generation of such quarter elongations, in the prior art, a method of strongly depressing only the center and opposite edge portions of a sheet by rotating the roll shaft 71 so that the depressing position may be chosen at 315° as shown in Figs. 20, 21 and 22 to give a crown pattern of the shape shown in Fig. 22 to the sleeve-system split type backing-up roll 80, was employed, or else creation of the thermal crown was prevented through a method of cooling the work

rolls 50 and 60 by spraying liquid coolant to them.

However, through the above-described methods in the prior art, prevention of generation of quarter elongations as well as prevention of creation of a thermal crown were not always sufficient.

In addition, while the crown pattern of the shape shown in Fig. 22 is effective for a particular sheet width, that is, for particular positions of quarter elongations, if the sheet width is changed and the positions of quarter elongations are displaced from the splitted roll position 73b, the crown pattern becomes ineffective.

Also, since the temperature-rise of the work rolls 50 and 60 became large if a rolling speed was raised, there were various disadvantages such that speed-up of a rolling line was difficult.

SUMMARY OF THE INVENTION:

It is therefore one object of the present invention to provide a rolling mill including a split type backing-up roll which can form a crown pattern most suitable for sheet configuration control of a strip.

Another object of the present invention is to provide a rolling mill including a novel split type backing-up roll, which makes it possible to easily perform sheet configuration control of a strip, and which can improve quality of products.

Still another object of the present invention is to provide a novel method of rolling sheet materials, which can fully prevent creation of a thermal crown.

According to one feature of the present invention, there is provided a rolling mill including work rolls and a split type backing-up roll constructed by rotatably fitting around a roll shaft a center backing-up roll, a pair of quarter backing-up rolls and a pair of side backing-up rolls splitted in the direction of the roll shaft, and loosely fitting a cylindrical sleeve around the outer circumferential surfaces of these respective backing-up rolls, improved in that an axis of either one of the above-mentioned center backing-up roll and the above-mentioned quarter backing-up roll and an axis of the aforementioned side backing-up rolls are positioned as displaced from an axis of the above-mentioned roll shaft in the opposite directions to each other, and that an axis of the other one of the aforementioned center backing-up roll and the above-mentioned quarter backing-up rolls is positioned as displaced from the axis of the above-mentioned roll shaft in the direction crossing at a desired angle with a straight line connecting the axis of the aforementioned side backing-up roll and the axis of the above-mentioned either one roll.

The above-described respective backing-up rolls can be formed in various modes of embodi-

ments such that they are formed, for instance, to have the same outer diameters, or the outer diameters of the above-mentioned either one backing-up roll and the aforementioned side backing-up roll are made smaller than the outer diameter of the above-mentioned the other backing-up roll.

In the case where the center backing-up roll, the quarter backing-up rolls and the side backing-up rolls have been arranged in an eccentric state shown in Fig. 2 according to the present invention described above, each time the roll shaft of this split type backing-up roll is rotated by 45° , a crown pattern of the backing-up roll at its depressed position would change as shown in Fig. 3, and a large variety of crown patterns can be formed.

Alternatively, in the case where the center backing-up roll, the quarter backing-up rolls and the side backing-up rolls have been arranged in the eccentric state shown according to the present invention, when a strip is rolled by a rolling mill including this split type backing-up roll, each time the roll shaft is rotated by 45° , the crown pattern at its depressed position would change smoothly and largely from a flat crown pattern at position I to crown patterns at positions III, V, VII and VIII shown in Fig. 6. Accordingly, during rolling of a strip, the roll shaft is rotated by an appropriate angle while observing the rolled sheet shape, and thereby an optimum crown pattern for control of the sheet configuration is formed.

Also, according to another feature of the present invention, there is provided a rolling mill including work rolls and a split type backing-up roll constructed by rotatably fitting around a roll shaft a center backing-up roll, a pair of quarter backing-up rolls and a pair of side backing-up rolls splitted in the direction of the roll shaft and loosely fitting a cylindrical sleeve around the outer circumferential surfaces of these respective backing-up rolls, improved in that axes of the above-mentioned both quarter backing-up rolls are positioned at the same place as an axis of the aforementioned roll shaft, an axis of the above-mentioned center backing-up roll is positioned as displaced from the axes of the above-mentioned roll shaft and the above-mentioned quarter backing-up rolls, and axes of the above-mentioned both side backing-up rolls are positioned as displaced from the axis of the aforementioned roll shaft in the direction crossing at a desired angle with a straight line connecting the axes of the aforementioned roll shaft and the aforementioned quarter backing-up rolls and the axis of the above-mentioned center backing-up roll.

In these respective backing-up rolls, for instance, the above-mentioned center backing-up roll and the above-mentioned both quarter backing-up rolls could be formed to have an identical outer

diameter and the outer diameters of the above-mentioned both side backing-up rolls could be made smaller than the outer diameters of the aforementioned center backing-up roll and the aforementioned quarter backing-up rolls.

In the case where the center backing-up roll, the quarter backing-up rolls and the side backing-up rolls have been arranged in an eccentric state shown in Fig. 8 according to the present invention, each time the roll shaft of this split type backing-up roll is rotated by 45° , a crown pattern of the backing-up roll at its depressing position, would change as shown in Fig. 9, and the pattern change is effected smoothly.

During a rolling operation of a strip, the roll shaft is rotated by an appropriate angle while observing the rolled sheet shape, and thereby the crown pattern is smoothly changed to an optimum crown pattern for control of the sheet configuration.

It is to be noted that according to the present invention as featured above, the term "desired angle" means that the crossing angle could be arbitrarily chosen in the range of $20^\circ - 160^\circ$.

According to still another feature of the present invention, there is provided the above-featured rolling mill, further improved in that bending cylinders are provided in respective roll chocks of the above-mentioned backing-up rolls, and decrease bending is given to the work rolls by pushing the roll chocks of the above-mentioned work rolls by means of the same bending cylinders.

In this way, quarter elongations of sheets can be eliminated by giving decrease bending to the work rolls owing to employment of the bending cylinders.

According to yet another feature of the present invention, there is provided a method of rolling sheet materials, consisting of the steps of supporting work rolls by means of a split eccentric roll type backing-up roll splitted into three or more along the direction of a roll shaft, forming a crown pattern of the backing-up roll in a dish-shape or in a V-shape to depress one or both of the upper and lower work rolls, thereby giving a dish-shaped or V-shaped roll crown pattern to the above-mentioned work rolls, and giving decrease bending to the work rolls by pressing a work roll chocks by means of the respective bending cylinders provided in the backing-up roll chocks.

If the above-featured method of rolling sheet materials according to the present invention is practiced, when a thermal crown has been created on a work roll by heat-generation and temperature-rise due to rolling of the sheet materials, in the case where a width of the sheet material to be rolled is broad, a dish-shaped crown pattern is given to a work roll by forming the crown pattern of the split eccentric roll type backing-up roll support-

ing the work roll in a dish shape, and further, a work roll profile is made to be a flat shape having swelled portions at its opposite ends by applying decrease bending to this work roll by means of the bending cylinders.

Otherwise, in the case where a width of the sheet material to be rolled is narrow, a V-shaped crown pattern is given to the work roll by forming the crown pattern of the split eccentric roll type backing-up roll supporting the work roll in a V-shape, and further, the work roll profile is made to be a wave shape by applying decrease bending to this work rolls by means of the bending cylinders.

In this way, a flatness of sheet materials is improved by releasing the portion liable to be strongly rolled due to a thermal crown.

The above-mentioned and other objects, features and advantages of the present invention will become more apparent by reference to the following description of preferred embodiments of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

In the accompanying drawings:

Fig. 1 is a cross-section front view of an essential part of a rolling mill making use of a sleeve-system split type backing-up roll according to a first preferred embodiment of the present invention;

Fig. 2 is a schematic view showing outer diameters and eccentric states of the respective splitted backing-up rolls in Fig. 1;

Fig. 3 is a diagram showing crown patterns at respective depressing positions of the split type backing-up roll shown in Fig. 1;

Fig. 4 is a cross-section front view of an essential part of a rolling mill making use of a sleeve-system split type backing-up roll according to a second preferred embodiment of the present invention;

Fig. 5 is a schematic view showing outer diameters and eccentric states of the respective splitted backing-up rolls in Fig. 4;

Fig. 6 is a diagram showing crown patterns at respective depressing positions of the split type backing-up roll shown in Fig. 4;

Fig. 7 is a cross-section front view of an essential part of a rolling mill making use of a sleeve-system split type backing-up roll according to a third preferred embodiment of the present invention;

Fig. 8 is a schematic view showing outer diameters and eccentric states of the respective splitted backing-up rolls in Fig. 7;

Fig. 9 is a diagram showing crown patterns at respective depressing positions of the split type

backing-up roll shown in Fig. 7;

Fig. 10 is a cross-section front view of an essential part of a rolling mill making use of sleeve-system split type backing-up rolls for both the upper and lower backing-up rolls according to a fourth preferred embodiment of the present invention;

Fig. 11 is a schematic view showing outer diameters, eccentric states and depressing positions of the respective splitted backing-up rolls in Fig. 10;

Fig. 12 is a diagram showing crown patterns at respective depressing positions of the split type backing-up rolls shown in Fig. 10;

Fig. 13 is a cross-section front view of an essential part of a rolling mill making use of a sleeve-system split type backing-up roll for only the upper backing-up roll according to a fifth preferred embodiment of the present invention;

Fig. 14 is a schematic view showing outer diameters, eccentric states and depressing positions of the respective splitted backing-up roll in Fig. 13;

Fig. 15 is a diagram showing crown patterns at respective depressing positions of the split type backing-up roll shown in Fig. 13;

Fig. 16 is a cross-section front view of an essential part of one example of a rolling mill making use of a sleeve-system split type backing-up roll in the prior art;

Fig. 17 is a schematic view showing outer diameters and eccentric states of the respective splitted backing-up rolls in Fig. 16;

Fig. 18 is a diagram showing crown patterns at respective depressing positions of the split type backing-up roll shown in Fig. 16;

Fig. 19 is a schematic front view showing a work roll for explaining possible creation of a thermal crown thereon;

Fig. 20 is a cross-section front view of an essential part of another example of a rolling mill making use of a sleeve-system split type backing-up roll in the prior art;

Fig. 21 is a schematic view showing outer diameters and eccentric states of the respective splitted backing-up rolls in Fig. 20; and

Fig. 22 is a diagram showing a crown pattern at the depressing position indicated 315° in Fig. 21 of the split type backing-up roll shown in Fig. 20.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

Now, the present invention will be described in greater detail in connection to a number of preferred embodiments illustrated in Figs. 1 to 15. In these figures, members identical to those included

in the rolling mills in the prior art already described above with reference to Figs. 16 to 22, are given like reference numerals, and further explanation thereof will be omitted here.

As shown in Fig. 1, in a roll shaft 1 are formed a center eccentric shaft portion 1a, a pair of left and right quarter eccentric shaft portions 1b and a pair of left and right side eccentric shaft portions 1c, around these eccentric shaft portions 1a - 1c are respectively fitted anti-friction bearings 2a - 2c, and the outer rings of these respective anti-friction bearings 2a - 2c form a center backing-up roll 3a, a pair of left and right quarter backing-up rolls 3b and a pair of left and right side backing-up rolls 3c, which can rotate freely. Outer diameters of these axially splitted backing-up rolls 3a - 3c are same, and a cylindrical sleeve 55 is loosely fitted around their outer circumferential surfaces. An upper split type backing-up roll 10 is constructed of the above-described members.

As shown in Fig. 2, a center backing-up roll axis Oa and both side backing-up roll axes Oc are arranged as displaced from a roll shaft axis O in the opposite direction to each other, and both quarter backing-up roll axes Ob are arranged as displaced from the roll shaft axis O in the direction at about 90° with respect to a straight line connecting the center backing-up roll axis Oa and the side backing-up roll axes Oc as viewed in the cross-section.

At the time of rolling a strip S by means of a rolling mill having the above-described upper split type backing-up roll 10, an upper work roll 50 is supported by this upper split type backing-up roll 10 by depressing bearing boxes 56, and while a sheet configuration in the widthwise direction of the strip S is observed by means of a sheet configuration detector not shown provided on the outlet side of the rolling mill, the roll shaft 1 is rotated by an appropriate angle via a worm 58 and a worm wheel 57, and thereby an optimum crown pattern corresponding to this sheet configuration can be formed.

This crown pattern changes depending upon a rotated angle of the roll shaft 1 as shown in Fig. 3, and many kinds of crown patterns can be formed.

It is to be noted that without making the roll shaft 1 in an eccentric shape, eccentric bushes could be interposed between the respective anti-friction bearings 2a - 2c and the roll shaft 1.

With the split type backing-up roll in the above-described rolling mill according to the first preferred embodiment of the present invention, the respective backing-up rolls splitted in the direction of the roll shaft are made to have same diameters, the center backing-up roll and the side backing-up rolls are made eccentric in the opposite directions to each other with respect to the axis of the roll

shaft, the quarter backing-up rolls are made eccentric from the axis of the roll shaft in the direction crossing at a desired angle with the first-mentioned eccentric direction, and thereby it becomes possible to form many kinds of crown patterns. Accordingly, a sheet configuration of a strip can be easily controlled. It is to be noted that as the above-described "desired angle", it could be chosen within the range of 20° - 160° .

In the following, description will be made on a second preferred embodiment of a rolling mill according to the present invention illustrated in Figs. 4 to 6.

As shown in Fig. 4, on a roll shaft 21 are formed a center eccentric shaft portion 21a, a pair of left and right quarter eccentric shaft portions 21b and a pair of left and right side eccentric shaft portions 21c, respectively, having different eccentric directions and different diameters, anti-friction bearings 22a - 22c are respectively fitted around these eccentric shaft portions 21a - 21c, and the other rings of these respective anti-friction bearings 22a - 22c respectively form a center backing-up roll 23a, quarter backing-up rolls 23b and side backing-up rolls 23c, which can rotate freely.

The outer diameters of the quarter backing-up rolls 23b and the outer diameters of the side backing-up rolls 23c are made equal, but made smaller than the outer diameter of the center backing-up roll 23a.

Around the outer circumferential surfaces of these axially splitted respective backing-up rolls 23a - 23c is loosely fitted a cylindrical sleeve 55.

An upper split type backing-up roll 30 is constructed of the above-mentioned members.

As shown in Fig. 5, quarter backing-up roll axes O_b and side backing-up roll axes O_c are displaced from a roll shaft axis O in the opposite directions to each other, and further, a center backing-up roll axis O_a is arranged as displaced from the roll shaft axis O in the direction nearly at 90° with respect to a straight line connecting the quarter backing-up roll axes O_b and the side backing-up roll axes O_c .

At the time of rolling a strip S by means of a rolling mill including the above-described upper split type backing-up roll 30, an upper work roll 50 is supported by this upper split type backing-up roll by depressing bearing boxes 56, and while a sheet configuration of the strip S is observed by means of a sheet configuration detector not shown provided on the outlet side of the rolling mill, by rotating the roll shaft 21 by an appropriate angle via a worm 58 and a worm wheel 57, an optimum crown pattern corresponding to the sheet configuration is formed.

This crown pattern changes smoothly and largely from a flat shape at depressing position I,

successively, to the crown patterns at depressing positions III, V, VII and VIII.

The above-described split type backing-up roll in the rolling mill according to the second preferred embodiment of the present invention can change its crown pattern smoothly and largely from a flat shape at depressing position I, successively, to the crown patterns at depressing positions III, V, VII and VIII in Fig. 3, owing to the fact that the quarter backing-up rolls and the side backing-up rolls are made to have a smaller diameter than the center backing-up roll, the axes of the quarter and side backing-up rolls are displaced from the axis of the roll shaft in the opposite directions to each other, and the axis of the center backing-up roll is displaced from the axis of the roll shaft in the direction crossing at a desired angle with the eccentric direction of the first-mentioned backing-up rolls.

Accordingly, control for a sheet configuration of a strip becomes easy, and its quality can be improved.

It is to be noted that even if the outer diameters of the respective backing-up rolls 23a, 23b and 23c are all made equal, similar effects and advantages can be obtained.

Next, description will be made on a third preferred embodiment of the present invention illustrated in Figs. 7 to 9.

Outer diameters of a center backing-up roll 33a and quarter backing-up rolls 33b consisting of outer rings of anti-friction bearings 32a and 32b, respectively, fitted around a roll shaft 41 are equal to each other, and outer diameters of side backing-up rolls 33c also consisting of outer rings of anti-friction bearings 32c are smaller than the outer diameters of the center backing-up roll 33a and the quarter backing-up rolls 33b.

As shown in Fig. 8, both quarter backing-up roll axes O_b are identical to a roll shaft axis O , and a center backing-up roll axis O_a and side backing-up roll axes O_c are arranged as displaced from the roll shaft axis O in different directions at about 90° to each other.

By supporting an upper work roll 50 by means of the above-described upper split typed backing-up roll 40 and rotating the roll shaft 41 by an appropriate angle while observing a sheet configuration of a strip S , an optimum crown pattern corresponding to the sheet configuration can be formed.

This crown pattern changes depending upon a rotated angle of the roll shaft 41 in the manner shown in Fig. 9, and the changes from a flat pattern to other various patterns are smooth.

With the split type backing-up roll in the rolling mill according to the above-described third preferred embodiment of the present invention, owing to the fact that the side backing-up roll is made to

have a smaller diameter than the center backing-up roll and the quarter backing-up rolls, the quarter backing-up rolls are made concentric with the roll shaft, and the center backing-up roll and the side backing-up rolls have their axes displaced from the axis of the roll shaft in the directions at a desired angle to each other, it becomes possible to smoothly change its crown pattern from a flat pattern to other various patterns.

Accordingly, strips having a good sheet configuration can be obtained. Also, it is to be noted that even if the outer diameters of the respective backing-up rolls are made identical, effects and advantages equivalent to the previously described preferred embodiments can be obtained.

Next, description will be made on a fourth preferred embodiment of the present invention illustrated in Figs. 10 to 12.

In these figures, reference numeral 41 designates a roll shaft of a sleeve-system split type backing-up roll 46, which consists of a center eccentric portion 41a, quarter eccentric portions 41b and side eccentric portions 41c whose respective axes Oa, Ob and Oc are displaced from the axis O of this roll shaft 41, and the opposite ends of the roll shaft 41 are supported by backing-up roll chocks 44.

Around the respective eccentric portions 41a, 41b and 41c is rotatably fitted a cylindrical sleeve 55 via anti-friction bearings 43a, 43b and 43c, respectively, and the outer rings of these anti-friction bearings 43a, 43b and 43c form splitted rolls.

In the respective backing-up roll chocks 44 are studded bending cylinders 45. A sleeve-system split type backing-up roll 46 is constructed of the above-mentioned members.

Reference numerals 50 and 60 designate work rolls on which thermal crown were created by heat-generation and temperature-rise due to rolling, numeral 47 designates work roll chocks for supporting these work rolls 50 and 60, symbol S designates a sheet material to be rolled, and in the case of this preferred embodiment, the sheet material S is illustrated as a broad-width material.

Now describing about the operations in the method of rolling a sheet material according to this preferred embodiment, if thermal crowns are created on the work rolls 50 and 60 as a result of temperature-rise of the work rolls 50 and 60, then as shown in Fig. 11 the upper and lower roll shafts 41 are rotated by 45° in the anticlockwise direction starting from the position 0°, thereby a crown pattern of the splitted eccentric roll type backing-up roll 46 is formed in the shape shown in Fig. 12, and then the upper and lower work rolls 50 and 60 are depressed to give a dish-shaped crown pattern to these work rolls 50 and 60.

Furthermore, decrease bending is given to the upper and lower work rolls 50 and 60 by pressing the upper and lower work roll chocks 47 by means of the respective bending cylinders 45 studded in the respective backing-up roll chocks 44, and thereby flatness of the sheet material S is improved.

Now, description will be made on a fifth preferred embodiment of the present invention illustrated in Figs. 13 to 15.

In this preferred embodiment, a sleeve-system split type backing-up roll 46 constructed in a similar manner to the above-described fourth preferred embodiment is used as an upper backing-up roll, and by way of example, a sheet material S to be rolled is illustrated as a narrow-width sheet material.

In this preferred embodiment for a lower backing-up roll 48, a normal backing-up roll is used.

Now, describing about the operations of this preferred embodiment, if thermal crowns are created on the work rolls 50 and 60, the roll shaft 41 is rotated by 90° in the anticlockwise direction starting from the position 0°, thereby the crown pattern of the splitted eccentric roll type backing-up roll 46 supporting the work roll 50 is formed in the V-shape as shown in Fig. 15, and the upper work roll 50 is depressed by the above-mentioned backing-up roll 46 to give a V-shaped crown pattern to this upper work roll 50.

In addition, like the fourth preferred embodiment, decrease bending is given to the upper and lower work rolls 50 and 60.

As a result, similarly to the case of the fourth preferred embodiment, flatness of the narrow-width sheet material S can be improved.

It is to be noted that even if the sleeve-system split type backing-up roll 46 could be used as only the lower backing-up roll, and the operations of such modification are identical to those described above.

Furthermore, the rolling method according to the present invention should not be limited to only the above-described embodiments, but for instance, it can be applied to a multi-stage cluster rolling mill.

And, for instance, even if a sleeve-system split type backing-up roll, in which the outer diameters of the both quarter backing-up rolls and the both side backing-up rolls are formed smaller than the outer diameter of the center backing-up roll, the axes of the both quarter backing-up rolls and the axes of the both side backing-up rolls are displaced from the axis of the roll shaft in the opposite directions to each other, and the axis of the center backing-up roll is displaced from the axis of the roll shaft in the direction crossing at a desired angle with the straight line connecting the axes of the

quarter backing-up rolls and the axes of the side backing-up rolls, is used, the operations are the same as those described above.

As described above, the method for rolling sheet materials according to the present invention should not be limited to the above-described embodiments, but various changes and modifications could be made within the scope of the inventive concept of the present invention, and they all belong to the technical scope of the present invention.

In the method of rolling sheet materials according to the present invention, if a thermal crown is created on a work roll due to heat-generation and temperature-rise at the time of rolling sheet materials, the crown pattern of the splitted eccentric roll type backing-up roll is formed in a dish-shape or in a V-shape, thereby a similar crown pattern is given to the work roll, and further, by giving decrease bending to the work roll, quarter elongation of the sheet material is prevented, and flatness can be improved.

In addition, since a sheet configuration of sheet materials can be kept good as described above even if a thermal crown is created due to temperature-rise of the work roll, speed-up of a rolling line can be realized.

It is to be noted that while a backing-up roll splitted along an axial direction into 5 sections is employed in the above-described first to fifth preferred embodiments, as another preferred embodiment a backing-up roll splitted along an axial direction into 6 or 7 sections could be used.

In this instance, in the case of splitting into 6 sections, the central two sections are used as center backing-up rolls. Or in the case of splitting into 7 sections, the central one section is used as a center backing-up roll and the respective two sections (four sections in total) on the both sides thereof are used as quarter backing-up rolls. Accordingly, the crown patterns in this case are nearly similar to those of the above-described respective embodiments.

While a principle of the present invention has been described above in connection to a number of preferred embodiments of the invention, it is intended that all matter contained in the above-description and illustrated in the accompanying drawings shall be interpreted to be illustrative and not in a limiting sense.

Claims

1. A rolling mill including working rolls and a split type backing-up roll constructed by rotatably fitting around a roll shaft a center backing-up roll, a pair of quarter backing-up rolls and a pair of side backing-up rolls splitted in the

direction of the roll shaft, and loosely fitting a cylindrical sleeve around the outer circumferential surfaces of these respective backing-up rolls; characterized in that an axis (Oa or Ob) of either one of said center backing-up roll (3a, 23a) and said quarter backing-up rolls (3b, 23b) and an axis (Oc) of said side backing-up rolls are positioned as displaced from an axis (O) of said roll shaft (1, 21) in the opposite direction to each other, and that an axis (Ob or Oa) of the other one of said center backing-up roll (3a, 23a) and said quarter backing-up rolls (3b, 23b) is positioned as displaced from the axis (O) of said roll shaft (1, 21) in the direction crossing at a desired angle with a straight line connecting the axis (Oc) of said side backing-up rolls (3c, 23c) and the axis (Oa or Ob) of said either one roll.

2. A rolling mill as claimed in Claim 1, wherein the outer diameters of said respective backing-up rolls (3a, 23a; 3b, 23b; 3c, 23c) are formed to be identical.

3. A rolling mill as claimed in Claim 1, wherein the outer diameter of said one backing-up roll (3a, 23a or 3b, 23b) and said side backing-up roll (3c, 23c) are formed to be smaller than the outer diameter of said the other backing-up roll (3b, 23b or 3a, 23a).

4. A rolling mill including working rolls and a split type backing-up roll constructed by rotatably fitting around a roll shaft a center backing-up roll, a pair of quarter backing-up rolls and a pair of side backing-up rolls splitted in the direction of the roll shaft, and loosely fitting a cylindrical sleeve around the outer circumferential surfaces of these respective backing-up rolls; characterized in that axes (Ob) of said both quarter backing-up rolls (33b) are positioned at the same place as an axis (O) of said roll shaft (41), an axis (Oa) of said center backing-up roll (33a) is positioned as displaced from the axes (O, Ob) of said roll shaft (41) and said quarter backing-up rolls (33b), and axes (Oc) of said both side backing-up rolls (33c) are positioned as displaced from the axis (O) of said roll shaft (41) in the direction crossing at a desired angle with a straight line connecting the axes (O, Ob) of said roll shaft (41) and said quarter backing-up rolls (33b) and the axis (Oa) of said center backing-up roll (33a).

5. A rolling mill as claimed in Claim 4, wherein the outer diameters of said center backing-up roll (33a) and said both quarter backing-up

rolls (33b) are formed to be identical, and the outer diameters of said both side backing-up rolls (33c) are formed to be smaller than the outer diameters of said center backing-up rolls (33a) and said quarter backing-up rolls (33b).

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6. A rolling mill as claimed in any one of Claims 1 to 5, wherein bending cylinders (45) are provided in respective roll chocks for said backing-up roll, so that decrease bending may be given to the work rolls (50, 60) by pressing the roll chocks (47) of said work rolls (50, 60) by means of said bending cylinders (45).
7. A method of rolling sheet materials, characterized by the steps of supporting work rolls (50, 60) by means of a split eccentric roll type backing-up roll (46) splitted into three or more along the direction of a roll shaft, forming a crown pattern of the backing-up roll (46) in a dish-shape or in a V-shape to depress one or both of the upper and lower work rolls (50, 60), thereby giving a dish-shaped or V-shaped crown pattern to said work rolls, and giving decrease bending to the work rolls by pressing work roll chocks (47) by means of respective bending cylinders (45) provided in the backing-up roll chocks (44).

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Fig. 1

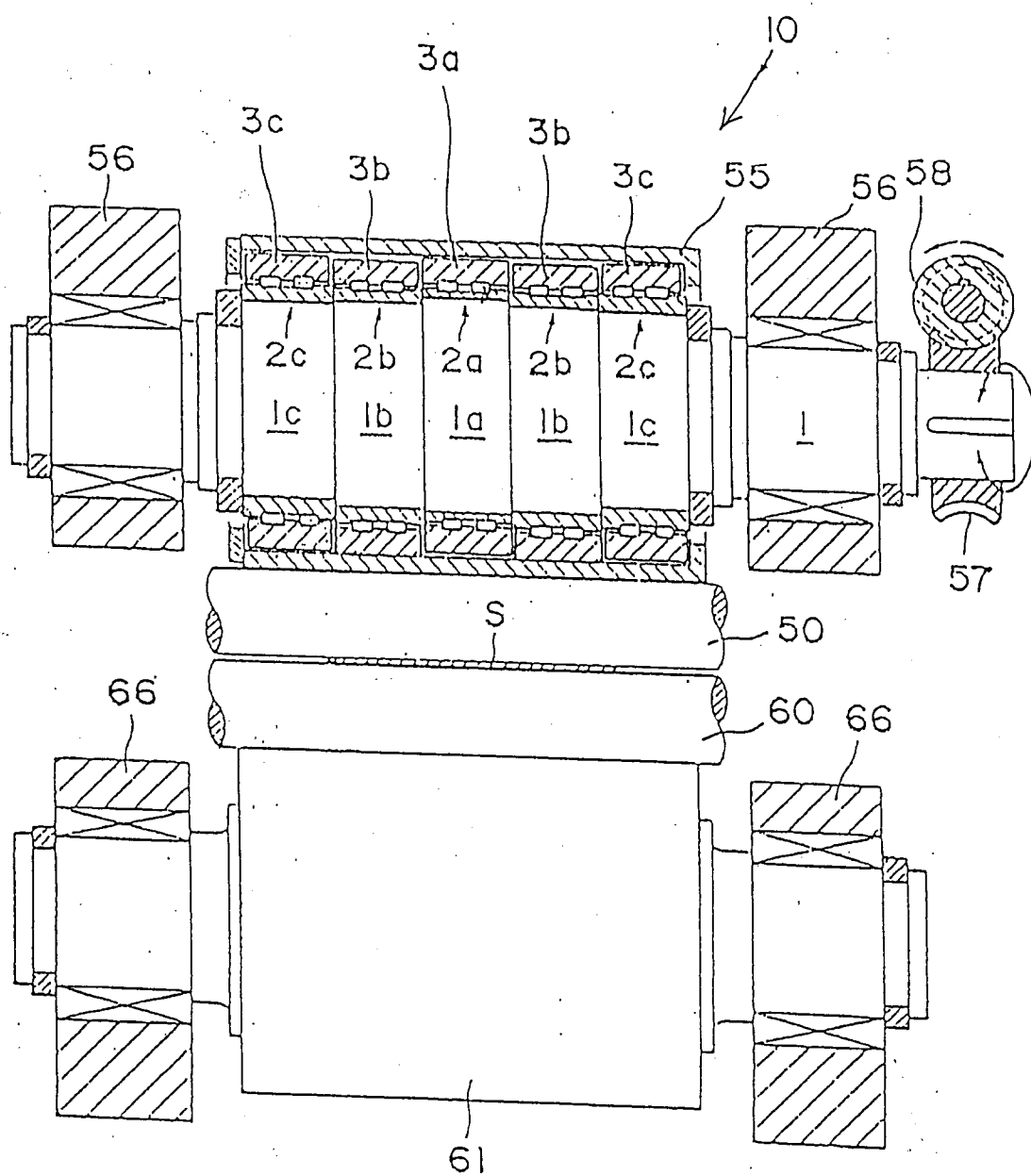


Fig. 2

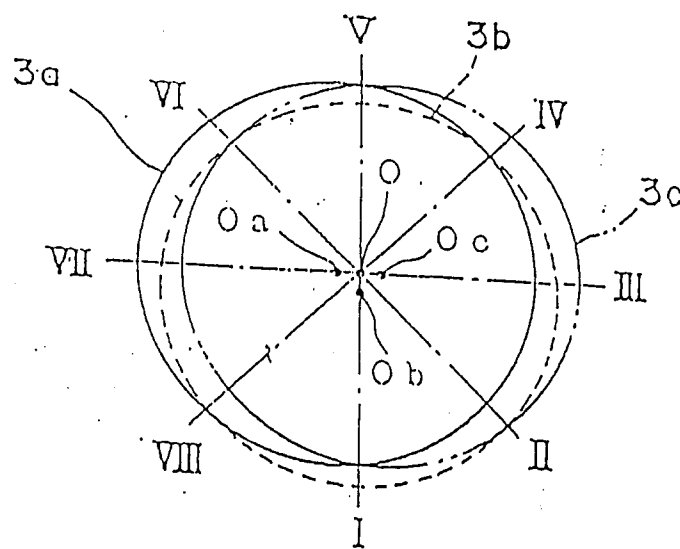


Fig. 3

Depressing Positions	Crown Patterns	Depressing Positions	Crown Patterns
I		V	
II		VI	
III		VII	
IV		VIII	

Fig. 5

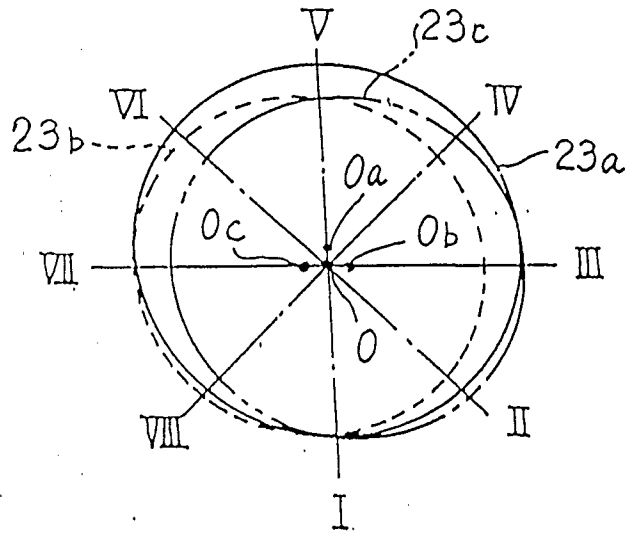


Fig. 6

Depressing Positions	Crown Patterns	Depressing Positions	Crown Patterns
I		V	
II		VI	
III		VII	
IV		VIII	

Fig. 7

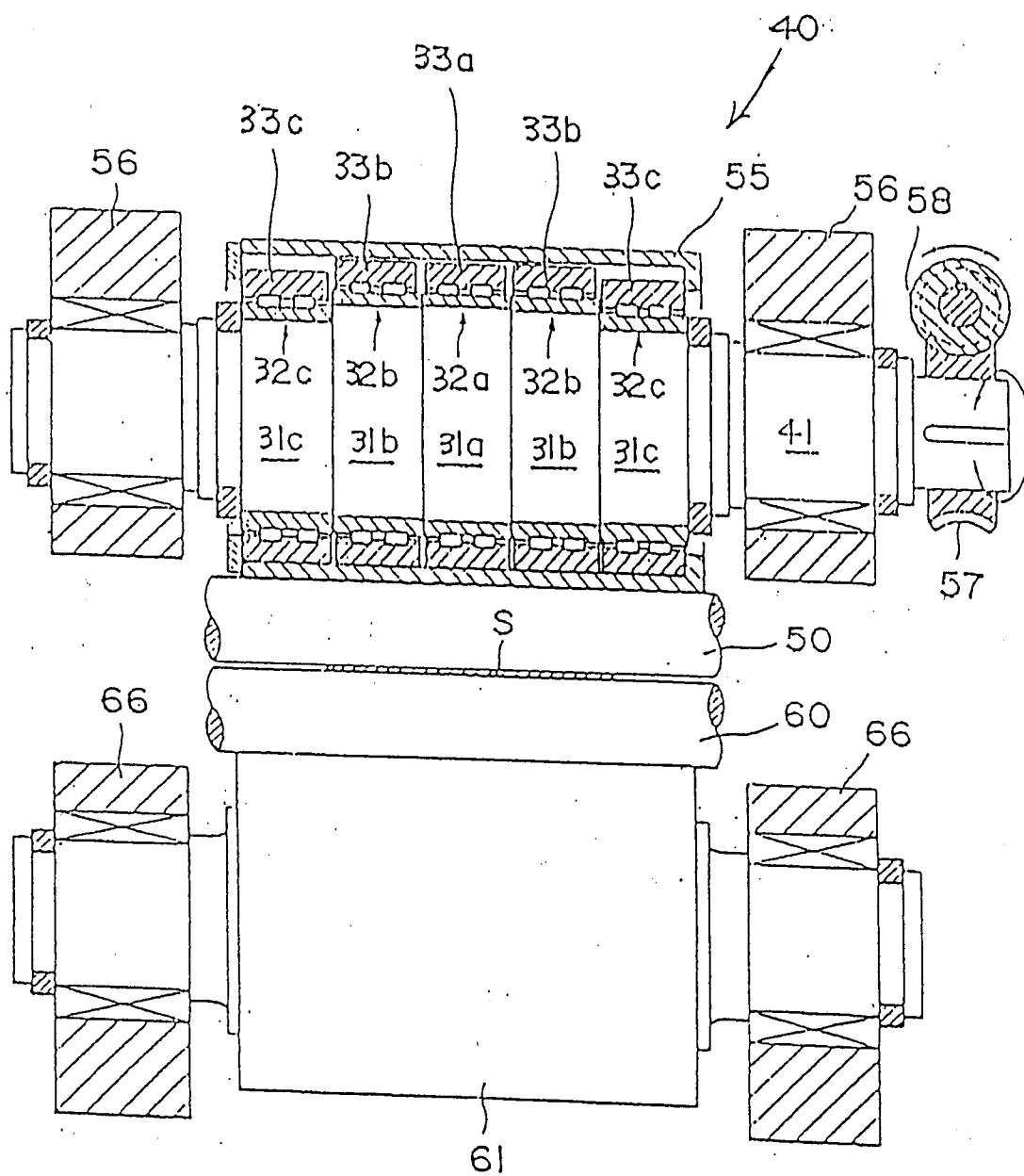


Fig. 8

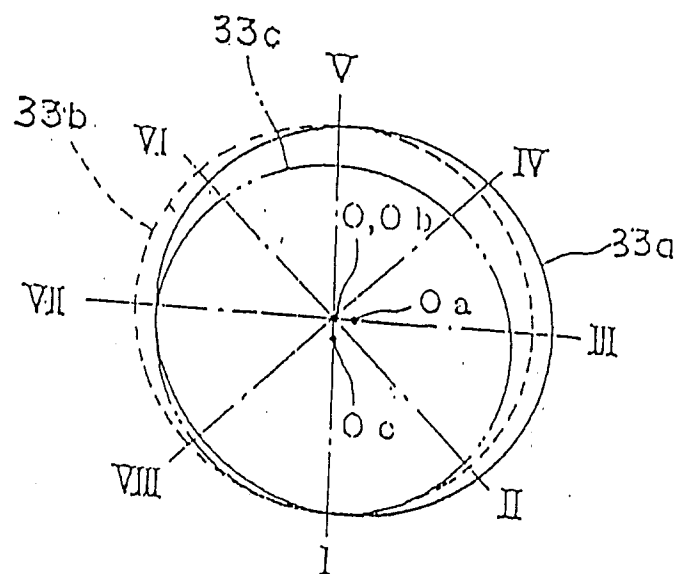


Fig. 9

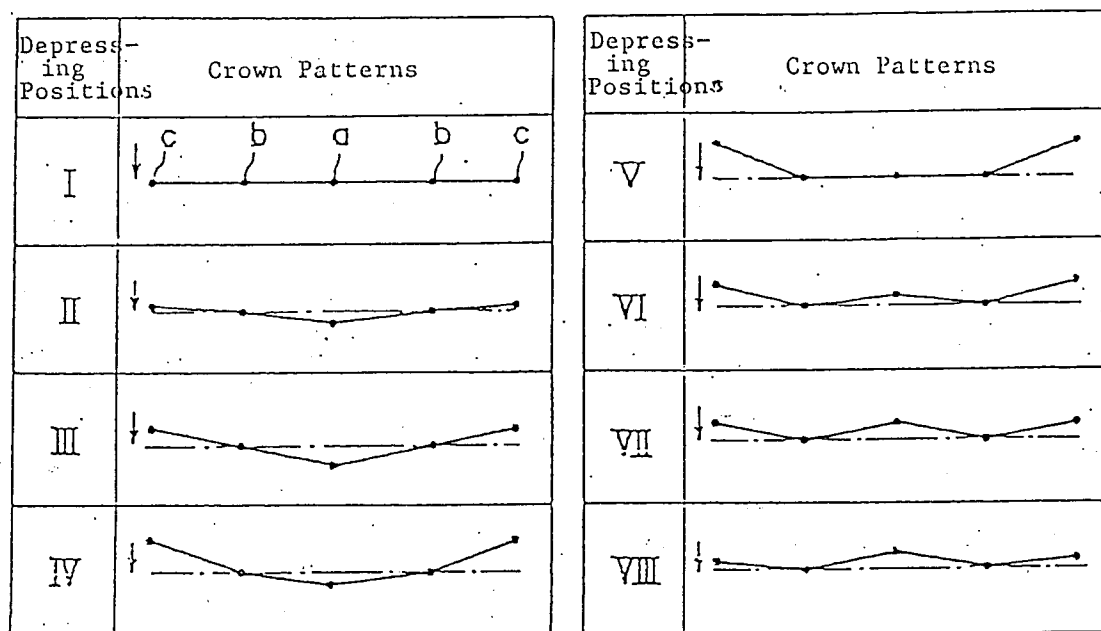


Fig. 10

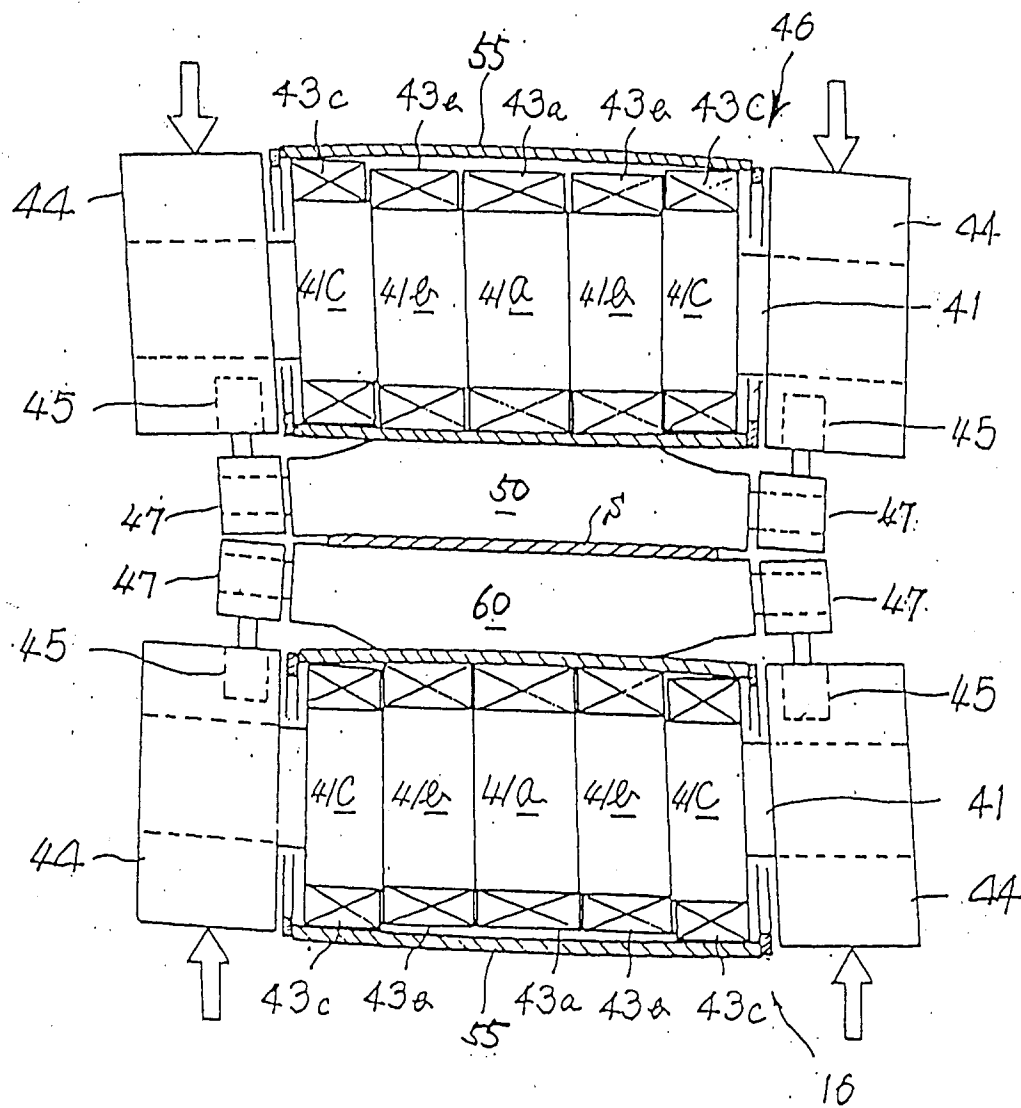


Fig. 11

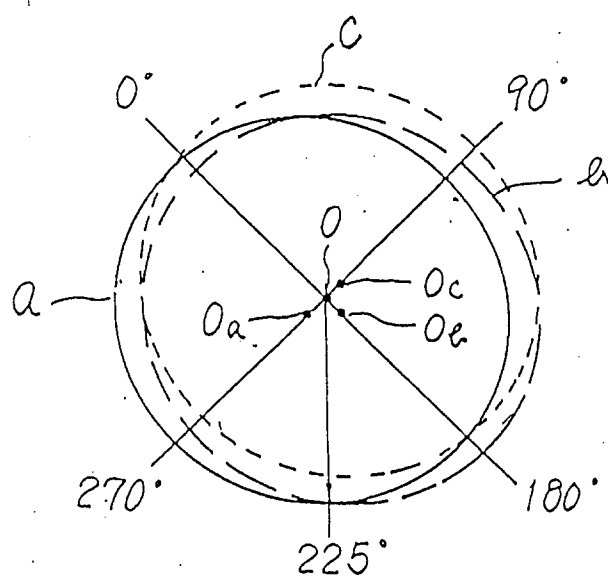


Fig. 12

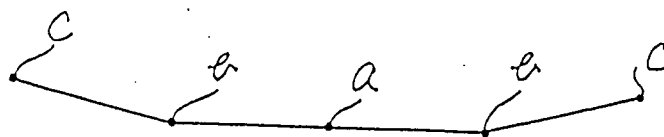


Fig. 13

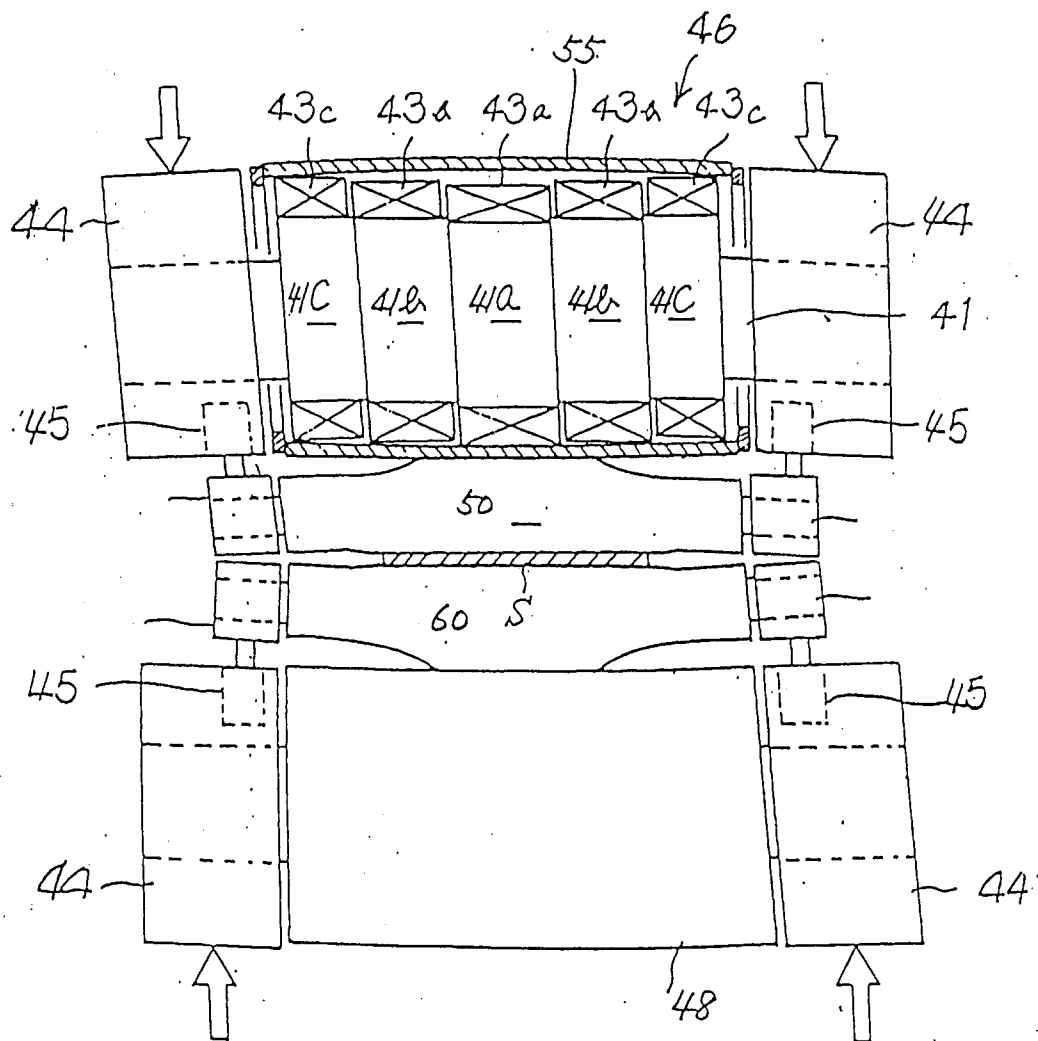


Fig. 14

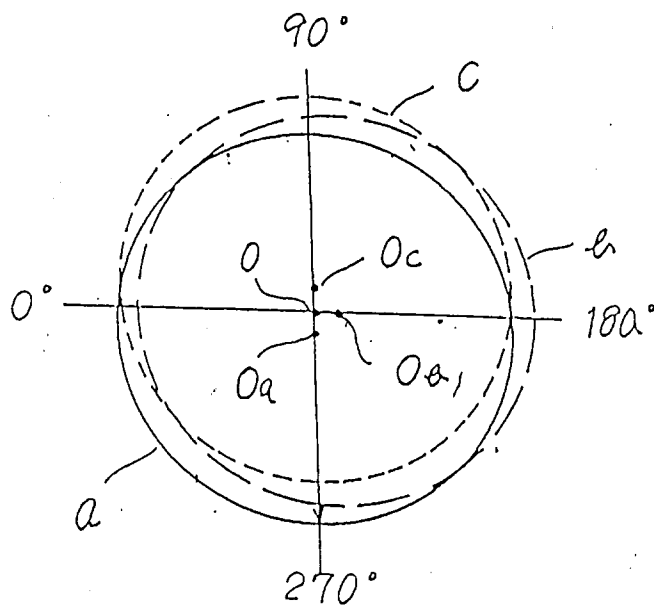


Fig. 15

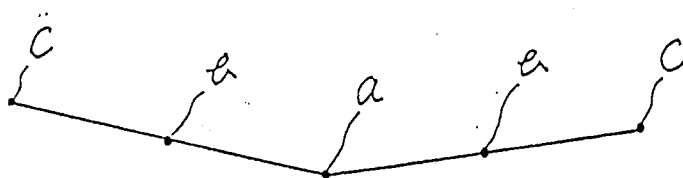


Fig. 19

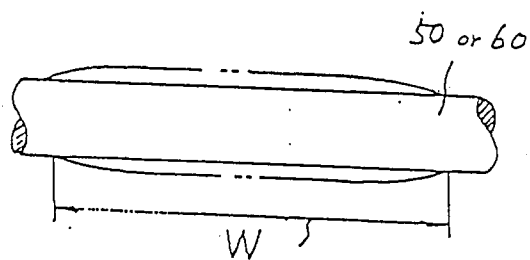


Fig. 17

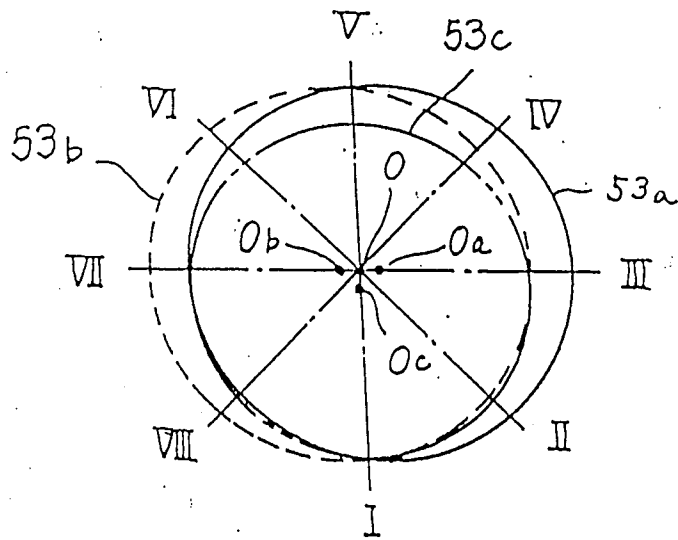


Fig. 18

Depress- ing Positions	Crown Patterns	Depress- ing Positions	Crown Patterns
I		V	
II		VI	
III		VII	
IV		VIII	

Fig. 20

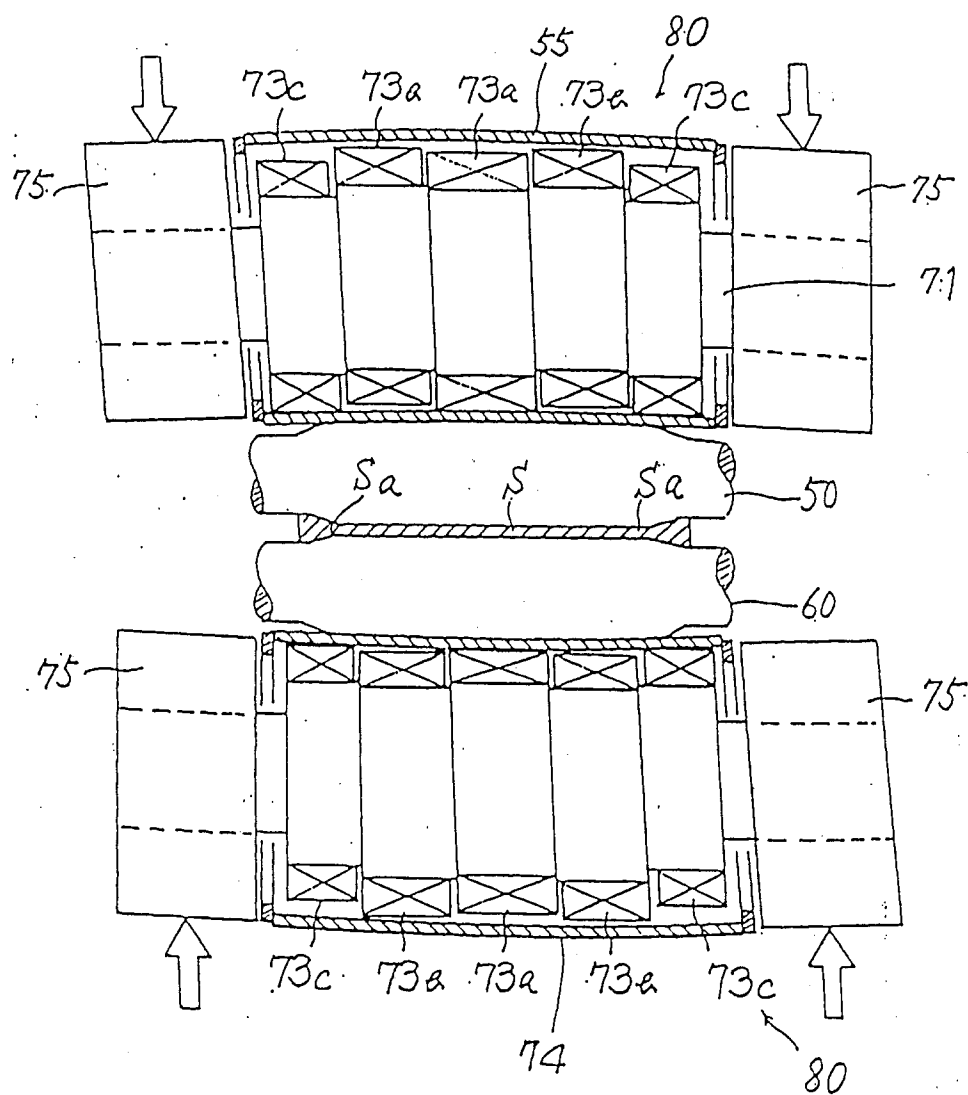


Fig. 21

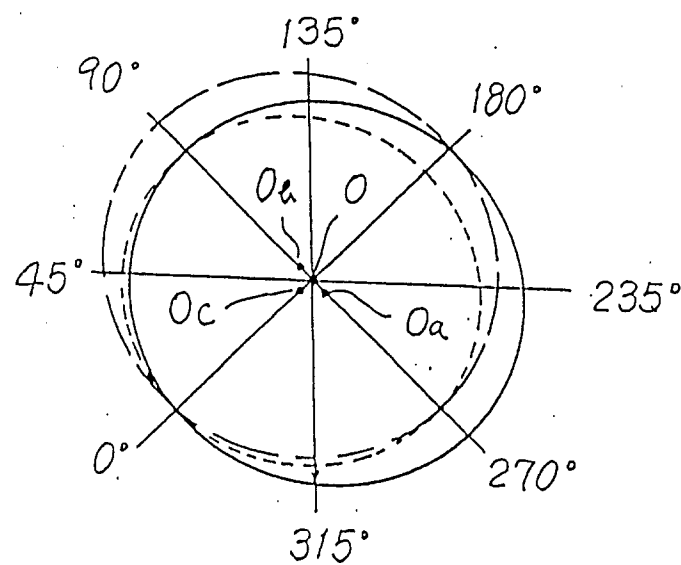


Fig. 22





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 11 2820

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	PATENT ABSTRACTS OF JAPAN vol. 15, no. 354 (M-1155)6 September 1991 & JP-A-03 138 006 (MITSUBISHI HEAVY IND) 12 June 1991 * abstract *	1-3	B21B13/14 B21B27/05 B21B29/00
A	---	4,5,7	
A	PATENT ABSTRACTS OF JAPAN vol. 15, no. 49 (M-1078)6 February 1991 & JP-A-02 284 711 (MITSUBISHI HEAVY IND) 22 November 1990 * abstract *	1,3-5,7	
A	---	1,3-5,7	
A	PATENT ABSTRACTS OF JAPAN vol. 15, no. 481 (M-1187)6 December 1991 & JP-A-03 207 512 (MITSUBISHI HEAVY IND) 10 September 1991 * abstract *	1,3-5,7	
A	---	6,7	
A	IRON AND STEEL ENGINEER vol. 58, no. 3 , March 1981 , PITTSBURGH US pages 60 - 65 TOSHIHIRO OTO ET AL.: 'Effect of backup roll length and roll neck length on profile for 4-h mills' * page 60 - page 61; figure 2 *	6,7	TECHNICAL FIELDS SEARCHED (Int.Cl.5) B21B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 25 November 1993	Examiner Rosenbaum, H
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			