



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.05.2002 Bulletin 2002/18

(51) Int Cl.7: **B24B 5/16**

(21) Application number: **01118859.6**

(22) Date of filing: **14.08.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR
 Designated Extension States:
AL LT LV MK RO SI

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(30) Priority: **31.10.2000 JP 2000337245**

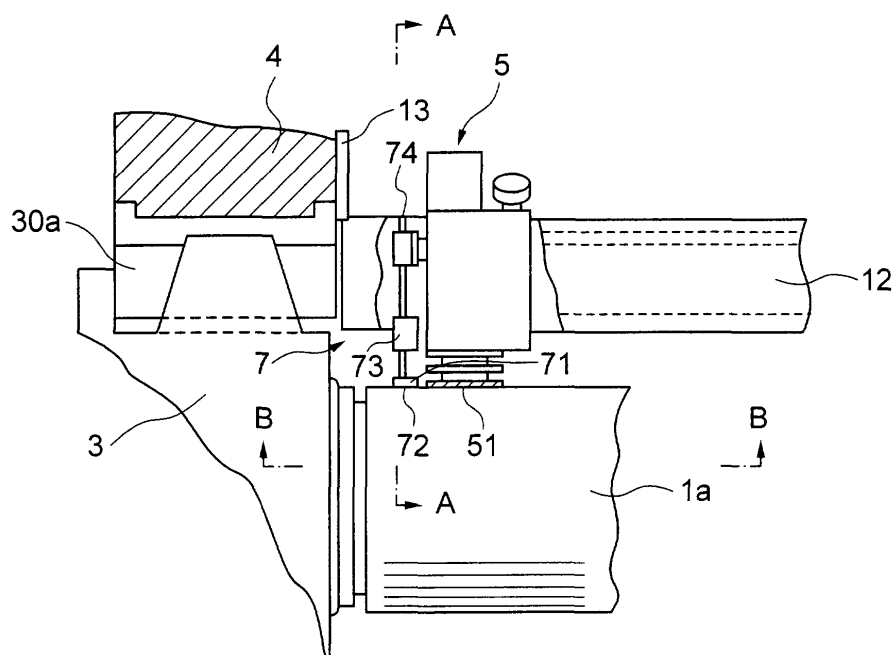
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(54) **On-line roll grinding method and apparatus as well as rolling mill using the same**

(57) An on-line roll grinding apparatus which includes a grinding unit (5) having a rotatable rotary grindstone (20) for on-line grinding a rolling roll (1a) and a

roughness adjusting unit (7) capable of adjusting A surface roughness of the rolling roll (1a), and which can adjust the surface roughness of the rolling roll (1a) in AN on-line roll grinding.

FIG. 1



Description

FIELD OF THE INVENTION

[0001] The present invention relates to an on-line roll grinding apparatus, an on-line roll grinding method, a rolling mill equipment, and a rolling method.

BACKGROUND OF THE INVENTION

[0002] In the rolling roll, as the rolling advances, the part coming into contact with the rolled material is worn, and it becomes impossible to roll a rolled steel plate having a wanted quality, and the replacement with a ground rolling roll is often performed in a roll shop. For this replacement of the rolling roll, it is necessary to stop the rolling, and therefore, the production is damaged.

[0003] JP-A-6-47654 specification discloses a technique of a rolling mill machine having an on-line roll grinding device which grinds the rolling roll in the rolling mill and is suitable mainly for a hot finishing rolling mill, for improving such a damage of production only a little. In the case of this technique, the on-line roll grinding device rotates and drives a rotary grindstone in which a grinding grain layer made of CBN (cubic system boron nitride) grinding grains is stuck on a thin plate disk-shaped alloy with an elastic body function, and grinds the rolling roll.

[0004] In the on-line roll grinding, it is preferable to perform the grinding at a grinding speed of the grindstone of 1000 to 1500 mpm in order to raise the grinding performance and to make the life of the grindstone longer. When the grinding is performed under such a condition, the rolling roll surface made of a nickel grain material is ground to have a degree of roughness of about Ra 1.2 micron to 0.7 micron. Even if one with large grinding grains is used, as the grinding advances, the cutting edge of the grinding grain is smoothed, so that the degree of roughness of the roll surface becomes a degree of roughness of Ra 1.2 micron or less.

[0005] However, in the case of a rolling roll used in a rough rolling mill equipment of a hot rolling mill, it is desirable to grind the rolling roll of the rough rolling mill so that it has a degree of roughness of Ra 1.5 to 3 micron, in order to prevent the sliding between the rolling roll and the slab member at the time of biting of the slab member.

[0006] However, in the case of the above described conventional technique, the biting performance is not considered in the on-line roll grinding, and an on-line roll grinding device is desired, which can perform the grinding to keep the degree of roughness of the rolling roll surface suitable for the rough rolling mill.

SUMMARY OF THE INVENTION

[0007] It is an object of the present invention to adjust a surface roughness of a rolling roll in the on-line roll

grinding.

[0008] That is, it is an object of the on-line roll grinding apparatus of the present invention to include: grinding means having a rotatable rotary grindstone for on-line grinding a rolling roll; and roughness adjusting means capable of adjusting the surface roughness of the above described rolling roll.

[0009] Furthermore, it is an object of the on-line roll grinding method of the present invention to include the steps of: on-line grinding a rolling roll by grinding means having a rotatable rotary grindstone for on-line grinding the rolling roll; and adjusting, after that, the surface roughness of the above described rolling roll by setting up a grinding mark approximately in the circumferential direction of the above described rolling roll.

[0010] Furthermore, it is an object of the rolling mill equipment of the present invention to include: grinding means having a rotatable rotary grindstone for on-line grinding a rolling roll; and roughness adjusting means capable of adjusting the surface roughness of the above described rolling roll.

[0011] Moreover, it is an object of the rolling method of the present invention to include the steps of; on-line grinding a rolling roll by grinding means having a rotatable rotary grindstone for on-line grinding the rolling roll; setting up a grinding mark, after that, approximately in the circumferential direction of the above described rolling roll; and performing the rolling while adjusting the surface roughness of the above described rolling roll.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1 shows a partial top view of a rolling mill having an on-line roll grinding apparatus;

Fig. 2 is a plan view and a block diagram of an interior of a roll grinding device unit;

Fig. 3 is a side cross sectional view of the interior of the roll grinding device unit;

Fig. 4 is a partial horizontal cross sectional view of a rolling mill having an on-line roll grinding apparatus;

Fig. 5 is a side view showing a partial configuration of a rolling mill having an on-line roll grinding apparatus, and shows a drawing shown by arrows A-A in Fig. 1;

Fig. 6 is a partial view seen from a roll surface side of a rolling mill having an on-line roll grinding apparatus, and shows a drawing shown by arrows B-B in Fig. 1;

Fig. 7 shows a drawing of an operation at the time of grinding of a rotary grindstone and a grindstone which does not rotate; and

Fig. 8 is a flow chart of grinding showing the grinding operation at the time of grinding, of a rotary grindstone and a grindstone which does not rotate.

DETAILED DESCRIPTION OF THE INVENTION

(Embodiment 1)

[0013] The present invention will be described below in detail on the basis of an embodiment. In Fig. 4, a partial horizontal cross sectional view of a rolling mill with an on-line roll grinding apparatus is shown, and in Fig. 1, a partial vertical cross sectional view of a rolling mill with an on-line roll grinding apparatus is shown.

[0014] In Fig. 4, an upper side of a rolling mill is shown. Actually, a lower side also has a similar structure. The rolling mill according to the present embodiment is a four stage rolling mill comprising a pair of upper and lower rolling rolls 1a for drawing a rolled material S, and a pair of upper and lower reinforcing rolls 1b for supporting the rolling rolls 1a, respectively. However, the present invention can also be applied in a rolling mill equipment other than the four stage rolling mill. As shown in Fig. 1, the rolling rolls 1a are rotatably supported by bearing boxes 3, and these bearing boxes 3 are assembled in a stand 4 that is a rolling housing. As shown in Fig. 4, an entry side guide 10 is arranged on the rolling mill entry side, and this entry side guide 10 performs the guide of the rolling roll 1a of the rolled material S. In the case of the rolling mill of the present embodiment, in order to give a bender force in the vertical direction to the rolling roll 1a, a roll bender 30 is provided between the bearing 3 and the bender block 30a. Furthermore, for the cooling of the rolling roll 1a, a coolant header 15 for injecting cooling water is provided.

[0015] In such a rolling mill, an on-line roll grinding apparatus for grinding a rolling roll 1a during the rolling is provided. The on-line roll grinding apparatus has one or a plurality of roll grinding device units 5, for one rolling roll 1a. For example, in Fig. 4, it has a roll grinding device unit 5 which on-line grinds a pair of upper and lower rolling rolls 1a. In the present description, the grinding of the upper side rolling roll 1a will be described as a typical one. Furthermore, it is necessary that the roll grinding device unit 5 does not interfere with the bearing 3 when replacing the roll. Both ends of the rail 12 are slidably supported by guides 13 attached to the stand 4, and the roll grinding device unit 5 can be moved backward integrally with the rail 12 by the cylinder 11 and the guides 13.

[0016] Next, the internal structure of the roll grinding device unit 5 will be described by using Fig. 2 and Fig. 3. Fig. 2 shows a plan view and a block diagram of the interior of the roll grinding device unit, and Fig. 3 shows a side cross sectional view of the interior of the roll grinding device unit.

[0017] The roll grinding device unit 5 comprises: a plane type rotary grindstone 20 for grinding a rolling roll 1a during the rolling; a grindstone rotationally driving device 22 for rotating this rotary grindstone 20 through a grindstone rotary shaft 21; a grindstone feeding device 23 for pressing the rotary grindstone 20 to the rolling roll

1a; and a grindstone laterally moving device 24 for moving the rotary grindstone 20 in the roll shaft direction of the rolling roll 1a.

[0018] The rotary grindstone 20 includes a grindstone layer 51 made of ultra grinding grains, and a thin plate disk 52 which supports the grindstone layer 51 and has an elastic body function. The thin plate disk 52 having the grindstone layer 51 on one surface is attached to the grindstone rotary shaft 21, and rotates by the rotation of the grindstone rotary shaft 21. The rotary grindstone 20 rotates by transmitting the rotational action of a hydraulic motor 54 through a pulley shaft, a belt, and the grindstone rotary shaft 21 that is the output shaft.

[0019] When the rotary grindstone 20 is pressed onto the rolling roll 1a by the grindstone feeding device 23 that is the pressing means, the rotary grindstone 20 bends by the elastic function of the thin plate disk 52. The amount of this bending changes according to the contact force between the rolling roll 1a and the rotary grindstone 20. By this bending, it is possible to absorb the vibration of the rolling roll 1a during the rolling, and to attain a good grinding.

[0020] Furthermore, it is preferable the grindstone rotary shaft 21 is arranged to be inclined by a minute angle to the shaft orthogonal line of the rolling roll 1a so that only one side of the rotary grindstone 20 is brought into contact with the rolling roll 1a. On the opposite side of the rotary grindstone of the rotary grindstone shaft 21, a load cell 53 for measuring the contact force between the rotary grindstone 20 and the rolling roll 1a is arranged. In the case of the present embodiment, an information processing device 14 is provided, which controls the grindstone feeding device 23 and the grindstone laterally moving device 24 on the basis of the information of the contact force of the load cell 53. Furthermore, the detailed structure in the interior of the roll grinding device unit 5 and the action are described, for example, in JP-A-6-47654 specification or the like.

[0021] By the grindstone laterally moving device 24, the roll grinding device unit 5 moves in the roll shaft direction. As shown in Fig. 3 and Fig. 4, the grindstone laterally moving device 24 includes a traverse motor 58 mounted in a case 25 for containing the roll grinding device unit 5, and includes a rotary shaft mounted on the traverse motor 58, and a rack and a pinion or the like for changing the torque from this rotary shaft in the roll shaft direction. By the rotation of the traverse motor 58, the guide roller 26 is engaged along the rail 12 to move the roll grinding device unit 5 in the roll shaft direction.

[0022] The grindstone feeding device 23 performs the pressing action (advance and retreat action) of the rotary grindstone 20 to the rolling roll 1a, by the rotational drive of the feeding motor 57, with the ball screw system.

[0023] Here, in the case of the present embodiment, surface roughness adjusting means (second grinding means) is provided besides the above described grinding means (first grinding means). It is the grinding grain device 7 shown in Fig. 1 and Fig. 5.

[0024] The grinding grain device 7 of the present embodiment comprises a grinding grain layer 72, a grinding plate 71 that is the base of the grinding grain layer 72, a slide rod 74 that is the shaft for supporting the grinding plate 71, a bearing 73 with a direct-acting bearing structure that supports the slide rod 74 so that it can move in the pressing direction (direction of pressing the grinding grain layer 72 to the roll), a pressing cylinder 75 that is moving means for moving the slide rod 74 in the pressing direction, a switching valve 76 for switching the advance and retreat in the pressing direction of the pressing cylinder 75, a pressure control valve 77 for adjusting the pressure supplied to the pressing cylinder 75, and a pressure pump for supplying the pressure to the pressing cylinder 75 through the pressure control valve 77.

[0025] Here, this grinding grain device 7 does not rotate the grinding plate 71 at the time of grinding. Then, this grinding grain device 7 is attached to the case 25 which contains the roll grinding device unit 5.

[0026] The structure of the grinding plate 71 is such a structure where the grinding grain layer 72 is stuck on one side of the surface. Then, this grinding plate 71 is fixed like a cantilever, and makes the grinding plate 71 have an elastic body function. It is preferable that the spring constant of the elastic body function of the grinding plate 71 is approximately the spring constant of the thin plate disk 52 of the above described rotary grindstone 20 having an elastic body function, since the object is to give the function of absorbing the vibration of the rolling roll 1a. That is, it is preferable that the grinding plate 71 has a spring constant in the range of 9800 KN/mm to 300 KN/mm.

[0027] The grinding grain layer 72 and the grinding plate 71 have pressing means to the roll that can be separately operated. That is, they have a pressing cylinder 75 so that the contact and non-contact can arbitrarily be set to the rolling roll 1a. Then, to this pressing cylinder 75, a switching valve 76 is provided, which switches the action of the pressing cylinder 75, so that the grinding plate 71 is pressed to the rolling roll 1a, and that it can retreat from the rolling roll 1a at the time of non-grinding.

[0028] The pressing cylinder 75 may be anyone of a hydraulic cylinder or a pneumatic cylinder. However, the pressing force herein may be a small force of about 19.6 KN/mm for a grindstone width of 1 mm, and therefore, the control of the pressing force is easier in the case of the pneumatic cylinder. In the case of the present embodiment, the grinding plate 71 is pressed onto the rolling roll 1a through the pressing cylinder 75 and the slide rod 74, and therefore, a structure in which the retreat is possible when not used is made. The slide rod 74 is held by a bearing 73 with a direct-acting bearing structure in which there is no looseness and back and forth sliding is possible.

[0029] The grinding grain layer 72 stuck to the grinding plate 71 does not perform the rotation approximately around the roll radius direction. When the grinding grain layer 72 is pressed to the rotating rolling roll 1a in this

state, a circumferential speed difference is caused between the grinding grain layer 72 and the rotating rolling roll 1a, and by using this circumferential speed difference, the rolling roll 1a is ground. However, the grinding grain layer 72 does not perform the rotation approximately around the roll radius direction, and therefore, the grinding performance like that of the above described rotary grindstone 20 cannot be expected, but it is possible to set up a grinding mark approximately in the roll circumferential direction on the surface of the rolling roll 1a by the grinding grains in the grinding grain layer 72.

[0030] That is, the amount of grinding is main, and it is worse in the grinding ability, but excellent in the setting up of a grinding mark. By controlling the depth of this grinding mark, it is possible to control the surface of the rolling roll 1a so that it has a target roughness. That is, thus, the surface roughness can be adjusted, since means for set up a grinding mark approximately in the roll circumferential direction is provided.

[0031] Here, the direction of the grinding mark set up by the grinding grain layer 72 stuck to the grinding plate 71 is the roll circumferential direction (roll rotating direction), since the grinding is performed by pressing the rotating roll to the fixed grinding grain layer 72. However, the grinding grain layer 72 stuck to the grinding plate 71 moves in the roll shaft direction during the grinding, and therefore, the grinding mark thereof is a little inclined, and the direction of the grinding mark is approximately the roll circumferential direction.

[0032] This grinding grain of the grindstone for adjusting the surface roughness will be described. Generally, even in the case of the grinding grain layer made of grinding grain with the same size, the surface of the rolling roll 1a ground by the rotary grindstone or the like has a degree of roughness smaller than that of the surface of the rolling roll 1a ground by this grinding grain device 7. In the case of this grinding grain layer 72, the grinding grain bites in the surface of the rolling roll 1a, so that the degree of the surface roughness can be Ra 1.5 μ m or more. However, when a normal grinding grain made of aluminum oxide or the like is used, the hardness of the grinding grain is low, and therefore, it does not bite in the rolling roll 1a, and it is difficult to set up a sharp grinding mark. Furthermore, the life of the grindstone itself is short, and it is necessary to often replace the grindstone. Therefore, it is not so suitable for the on-line grinding which is practiced during the rolling in the interior of the rolling mill.

[0033] Therefore, in the case of the grinding grain layer 72 of the present embodiment, the force received by the grinding grain biting in the rolling roll 1a is large, and therefore, the grinding grain layer 72 uses the diamond grinding grain or the cubic system boron nitride (CBN) grinding grain with a high hardness. Then, the grinding grain with a high hardness bites in the surface of the rolling roll 1a, so that it can set up a sharp grinding mark. Furthermore, the life of the grindstone itself is long, and

the frequency of the replacement of the grindstone is reduced. Therefore, it is suitable for the on-line grinding which is practiced during the rolling in the interior of the rolling mill.

[0034] Usually, in the case of the rolling roll 1a used in the rough rolling mill equipment, it is desired that the degree of roughness of the surface thereof is about Ra 2 μm . However, in the case where it is necessary to change the degree of roughness of the rolling roll 1a according to the rolling condition, it is arranged that the force produced by the cylinder 75 is controlled by the pressure control valve 77 so that the contact force between the grinding grain layer 72 and the rolling roll 1a can be changed. Accordingly, by changing the contact force between the grinding grain layer 72 and the rolling roll 1a, the degree of roughness of the surface of the rolling roll 1a can be changed.

[0035] Next, the grinding during the actual rolling will be described. The part through which the rolled material passes is degraded in terms of the metal by the heat or the like of the rolled material as the rolling advances. Therefore, first, the surface of this degraded rolling roll 1a is ground by the rotary grindstone 20 of the roll grinding device unit 5. This grinding is performed by pressing this rotary grindstone 20 to the rolling roll 1a with the grindstone feeding device 23 while rotating the rotary grindstone 20 through the grindstone rotary shaft 21 by the grindstone rotationally driving device 22. Then, by the grindstone laterally moving device 24, the rotary grindstone 20 is moved in the roll shaft direction, and the surface of the rolling roll 1a is ground. This plane type rotary grindstone 20 performs grinding, while itself bends to absorb the roll vibration during the rolling, and therefore, the roll surface can cleanly be ground. That is, when the grinding is performed by the rotary grindstone 20, the surface part degraded in terms of the metal is ground and eliminated, and in the meantime, the surface of the rolling roll 1a is ground to be a surface with a roughness more fine than a desired roughness.

[0036] After performing the grinding by the rotary grindstone 20, the grinding grain layer 72 which does not rotate is pressed onto the surface of the rolling roll 1a by the pressing cylinder 75, and a grinding mark in the roll circumferential direction is set up so that a desired target degree of roughness of the surface of the rolling roll 1a is made. By setting up a grinding mark on the above described surface with a fine roughness, a proper roughness can be made.

[0037] Next, the arrangement of the grinding grain layer 72 that is the roughness adjusting means and the concrete grinding will be described. The case where the grinding grain device 7 which does not rotate is arranged only on one side of the rotary grindstone 20 in the roll shaft direction will be described by using Fig. 7 and Fig. 8. In Fig. 7, the relation of the arrangement and the movement is shown, and the flow of grinding thereof is shown in Fig. 8.

[0038] First, as shown by the step of Fig. 8 (1), the

rotary grindstone 20 is moved to the end of the rolling roll 1a. Then, in the case of grinding a part L (sheet path area) shown in Fig. 7 through which the rolled material passes, as shown by the step of Fig. 8 (2), the rotary grindstone 20 is brought into contact with the rolling roll 1a, and the grinding is started from the roll end. That is, the part (area out of the sheet path) other than the part L through which the rolled material passes does not come into contact with the rolled material, and furthermore, the part coming into contact with the rolled material is worn, and a difference in level is produced between both parts. Therefore, at the time of performing the grinding, the grinding is started from the roll end, for grinding the part (area out of the sheet path) other than the part L through which the rolled material passes, too.

[0039] After that, as shown by the step of Fig. 8 (3), the grinding is performed while moving the rotary grindstone 20 in the direction (direction a) opposite to the place in which the grinding grain device 7 is arranged.

[0040] Next, as shown by the step of Fig. 8 (4), it is detected by an axially moving device or the like that the grinding position of the rotary grindstone 20 has moved to the maximum plate width position (maximum plate width end position of a rolled material to be rolled). When the maximum plate width position in this rolling roll 1a is detected, as shown by the step of Fig. 8 (5), the non-rotary type grinding grain device 7 that is the roughness adjusting means is pressed onto the rolling roll 1a, and the grinding (setting up of a grinding mark for the roughness adjustment) by using the grinding grain device 7 is started. Here, as shown by the step of Fig. 8 (6), both the grindstone device 7 which does not rotate and the rotary grindstone 20 are moved in the direction a while performing the grinding. That is, in the case of the present method, the roughness adjustment is performed in the plate passing part (sheet path) of the rolled material which needs the roughness adjustment, so that the wear of the grindstone of the grinding grain device 7 that is the roughness adjusting means is restrained. Furthermore, thus, the pressing means of the grinding grain device 7 to the roll that is the roughness adjusting means and the pressing means of the rotary grindstone 20 to the roll that is the grinding means are separately provided, respectively, and therefore, it is possible to perform the grinding and the roughness adjustment that are suitable for the sheet path and the place out of the sheet path, respectively.

[0041] Then, as shown by the step of Fig. 8 (7), when the grinding position of the rotary grindstone 20 has moved to the central part of the rolling roll 1a, the rotary grindstone 20 and the grindstone device 7 which does not rotate are separated from the rolling roll 1a, and the grinding is stopped.

[0042] As mentioned above, it is possible to grind approximately half the area (right half in Fig. 7) of the rolling roll 1a in the roll shaft direction, and furthermore to adjust the roughness. As for the other left half area, it is sufficient that similarly, the rotary grindstone 20 and the

grindstone device 7 which does not rotate are provided on the other side, and that similarly, grinding and roughness adjustment are performed.

[0043] Furthermore, after performing the grinding and the roughness adjustment, when moving the rotary grindstone 20 and the grindstone device 7 which does not rotate, both the rotary grindstone 20 and the grindstone device 7 which does not rotate are retreated to the opposite side of the center of the roll so that both the rotary grindstone 20 and the grindstone device 7 which does not rotate do not come into contact with the surface of the rolling roll 1a, and both of them are moved in the end part direction in the roll shaft direction (direction b).

[0044] In the case of the present embodiment, the moving means in the roll shaft direction is shared by the rotary grindstone 20 that is the grinding means and the grindstone device 7 that is the roughness adjusting means, and therefore, simplification of the apparatus can be attained. That is, the grinding grain device 7 that is the roughness adjusting means is attached to the roll grinding unit 5 that is the grinding means, and therefore, the moving means for the movement in the roll shaft direction can be shared, and the simplification of the apparatus can be attained.

[0045] Furthermore, as means for setting up a grinding mark in the roll circumferential direction, a grindstone rotating around the shaft in parallel with the roll shaft or the like can also be considered, and the roughness adjustment of the roll surface can be performed. However, from the viewpoint of the apparatus or the accuracy, the above described grinding grain device 7 is excellent. In the case of the above described grinding grain device 7, it is of the non-rotary type, and therefore, the apparatus is simple and the installation is easy. Furthermore, the above described grinding grain device 7 can use a flexible elastic body for the base, and therefore, during the rolling, it is possible to set up a grinding mark while absorbing the vibration of the rolling roll at the time of on-line, and therefore, it is possible to accurately set up the grinding mark in the roll circumferential direction.

[0046] In many cases, the part L through which the rolled material passes is not all of the width of the rolling roll 1a, but the width of two-third to half. Therefore, in many cases, the range to be ground by the grinding grain device 7 which does not rotate does not require all the width of the rolling roll 1a. In the necessary grinding range, if the maximum rolled material width to be rolled for one replacement of the rolling roll 1a is ground, it is possible to keep the range where the rolled material comes into contact with the rolling roll 1a to have a necessary roughness at all times. Even if at all times, all the width of the rolling roll 1a is ground by the grinding grain device 7 which does not rotate, no problem is caused, but if the unnecessary range is ground by the grinding grain device 7 which does not rotate, there is such a problem that the wear of the grinding grain layer 72

which does not rotate is increased.

[0047] Here, when a slab material or a thick hot billet corresponding thereto is rolled, as mentioned above, the ground rolling roll 1a has a proper roughness, and therefore, there is no fear of sliding between the rolling roll 1a and the hot billet at the time of biting. In the case of the present embodiment, the roughness of the roll surface can be adjusted to a desired roughness, and therefore, the roughness of the roll surface can be made rough, and the biting performance of the rolling mill or the rolling apparatus can be improved. The present embodiment can be applied to various rough rolling mill, finishing rolling mill, rough rolling mill equipment, and finishing rolling mill equipment or the like, and particularly, the problem of biting can remarkably solved in the rough rolling mill equipment or the like in the hot field.

[0048] According to the present embodiment, in the case of the rolling mill equipment used for rolling a slab material such as a rough rolling mill, it is possible that in order to make the surface roughness of a rolling roll be Ra 2 μm to 4 μm , besides the rotary grindstone for eliminating the worn difference in level of the rolling roll, the grinding grain layer which does not rotate is pressed onto the rolling roll and a rough grinding mark is set up on the roll surface by the speed difference with the rolling roll.

[0049] Consequently, at the time of making a thick material such as a slab material bite in the rolling roll, a suitable surface roughness of the rolling roll can be made, and therefore, a trouble of the rolling because of slipping or the like can be prevented, and in the meantime, the rolling can be performed by using a rolling roll with a little difference in level of wearing at all times.

[0050] That is, by practicing the grinding and the roughness adjustment during the rolling as shown in the present embodiment, the problem of biting during the rolling can be restrained. In the on-line roll grinding device, besides the rotary grindstone, a grinding grain layer which does not rotate is attached to the plate at the tip of the pressing device which can advance or retreat, and the grinding grain layer is pressed onto the rolling roll, and the grinding is performed by the speed difference between the rotation of the roll and the fixed grinding grain layer.

[0051] By the biting in the rolling roll of the grinding grain layer attached to the plate at the tip of the pressing device, it is possible to obtain a roll surface with a rough roughness that cannot be obtained by the grinding of the rotary grindstone.

[0052] Furthermore, in the hot rolling mill equipment, in the case where the roll of the rough rolling mill for rolling the slab material is ground by the on-line grinding apparatus provided in the rolling mill, it is possible to make the degree of roughness of the roll surface be a roughness of Ra 1.5 μm or more, so that slipping is not caused between the roll and the rolled material at the time of biting even under the condition of high pressure.

[0053] In the on-line roll grinding device, besides the

rotary grindstone, a grinding grain layer which does not rotate is attached to the plate at the tip of the pressing device which can advance or retreat, and the grinding grain layer is pressed onto the rolling roll, and the grinding is performed by the speed difference between the rotation of the roll and the fixed grinding grain layer, and consequently, by the biting in the rolling roll of the grinding grain layer attached to the plate at the tip of the pressing device, it is possible to obtain a roll surface with a rough roughness which cannot be obtained by the grinding of the rotary grindstone.

Claims

1. An on-line roll grinding apparatus, **characterized by** comprising:

grinding means (5) including a rotatable rotary grindstone (20) for on-line grinding a rolling roll (1a); and
roughness adjusting means (7) capable of adjusting a surface roughness of said rolling roll.

2. An on-line roll grinding apparatus, **characterized by** comprising:

first grinding means (5) including a rotatable rotary grindstone (20) for on-line grinding a rolling roll (1a); and
second grinding means (7) capable of setting up a grinding mark approximately in a circumferential direction of said rolling roll.

3. An on-line roll grinding apparatus which comprises a grindstone device (5) including: a rotary grindstone (20) attached facing to a rolling roll (1a); a grindstone driving device (22) for rotationally driving said rotary grindstone; and a pressing device (23) for pressing said rotary grindstone to said rolling roll, and to which a laterally moving device (24) is provided for moving said grindstone device in the rolling roll shaft direction,

characterized in that a grindstone including a non-rotary type grinding grain layer (72) is provided to said grindstone device.

4. The on-line roll grinding apparatus according to claim 3, **characterized in that** a non-rotary type grinding grain layer pressing device (23) which can advance and retreat is arranged to said rolling roll (1a), and a cantilever plate (71) is provided at a tip of said non-rotary type grinding grain layer pressing device, and an elastic body function is given to said cantilever plate, and to one side of the surface thereof, a grinding grain layer (72) is mounted.

5. The on-line roll grinding apparatus according to

claim 3, **characterized in that** said non-rotary type grinding grain layer (72) includes ultra grinding grains made of diamond or cubic system boron nitride.

6. The on-line roll grinding apparatus according to claim 3, **characterized in that** control means for controlling the pressing force of a pressing device which can advance and retreat the non-rotary type grinding grain layer (72) to and from said rolling roll (1a) is provided.

7. The on-line roll grinding apparatus according to claim 3, **characterized in that** said non-rotary type grinding grain layer (72) is arranged on one side of said rotary grindstone (20) in the roll shaft direction, and when said rotary grindstone moves while performing grinding, only in the case of moving to the opposite side of the place where the non-rotary type grinding grain layer (72) is arranged in the roll shaft direction, said non-rotary type grinding grain layer (72) is pressed onto the rolling roll surface.

8. The on-line roll grinding apparatus according to claim 3, **characterized in that** the non-rotary type grinding grain layer (72) is controlled so that only the part of the rolling roll surface through which the rolled material passes is pressed onto the rolling roll surface.

9. An on-line roll grinding method, **characterized by** comprising the steps of:

on-line grinding a rolling roll (1a) by grinding means (5) including a rotatable rotary grindstone (20) for on-line grinding said rolling roll; and
adjusting the surface roughness of said rolling roll, after that, by setting up a grinding mark approximately in the circumferential direction of said rolling roll.

10. An on-line roll grinding method by using an on-line roll grinding apparatus which comprises a grindstone device (5) including: a rotary grindstone (20) attached facing to a rolling roll (1a); a grindstone driving device (22) for rotationally driving said rotary grindstone; and a pressing device (23) for pressing said rotary grindstone to said rolling roll, and to which a laterally moving device for moving said grindstone device in the rolling roll shaft direction is provided,

characterized in that a grindstone including a non-rotary type grinding grain layer (72) is provided to said grindstone device, and in grinding for eliminating a worn difference in level of said rolling roll, the grinding is performed by using said rotary grindstone, and in order to adjust the degree of

roughness of the rolling roll surface to a desired degree of roughness, the non-rotary type grinding grain layer is pressed onto said rolling roll to perform grinding.

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11. A rolling mill equipment, **characterized by** comprising:

grinding means (5) including a rotatable rotary grindstone (20) for on-line grinding a rolling roll (1a); and
roughness adjusting means (7) capable of adjusting the surface roughness of said rolling roll.

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12. A rolling method, **characterized by** comprising the steps of:

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on-line grinding a rolling roll (1a) by grinding means (5) including a rotatable rotary grindstone (20) for on-line grinding said rolling roll; and
performing rolling, after that, while adjusting the surface roughness of said rolling roll by setting up a grinding mark approximately in the circumferential direction of said rolling roll.

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FIG. 1

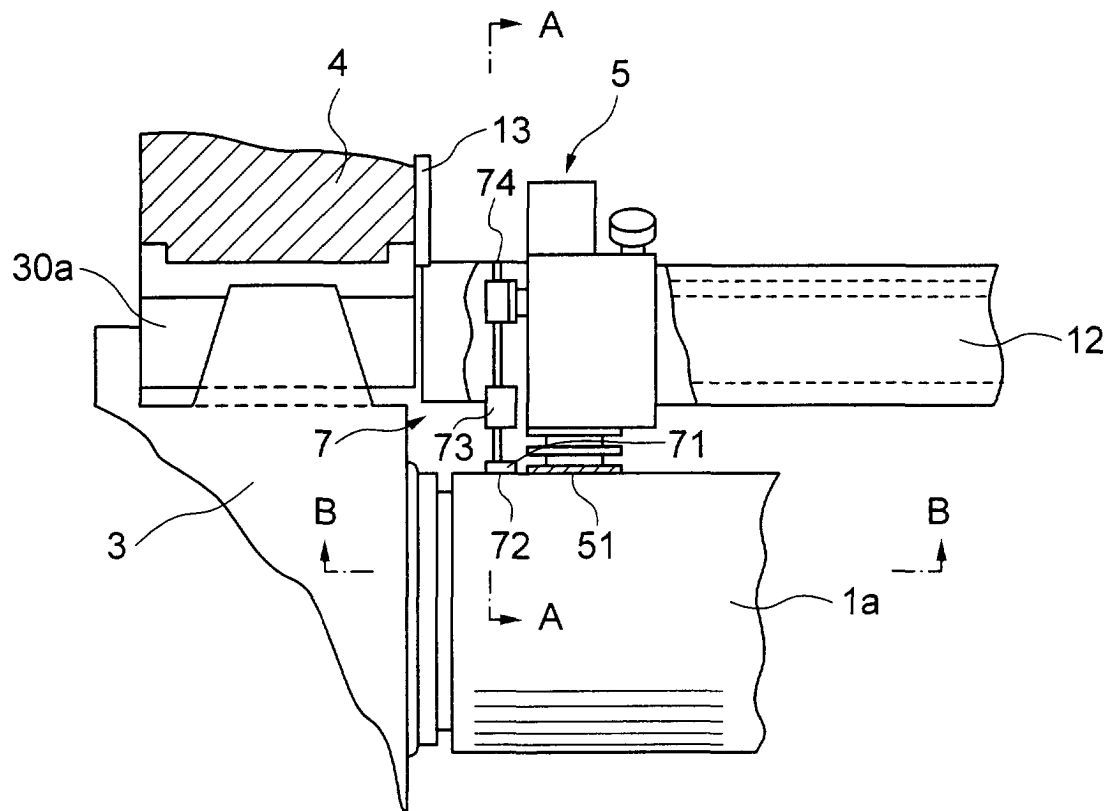


FIG. 2

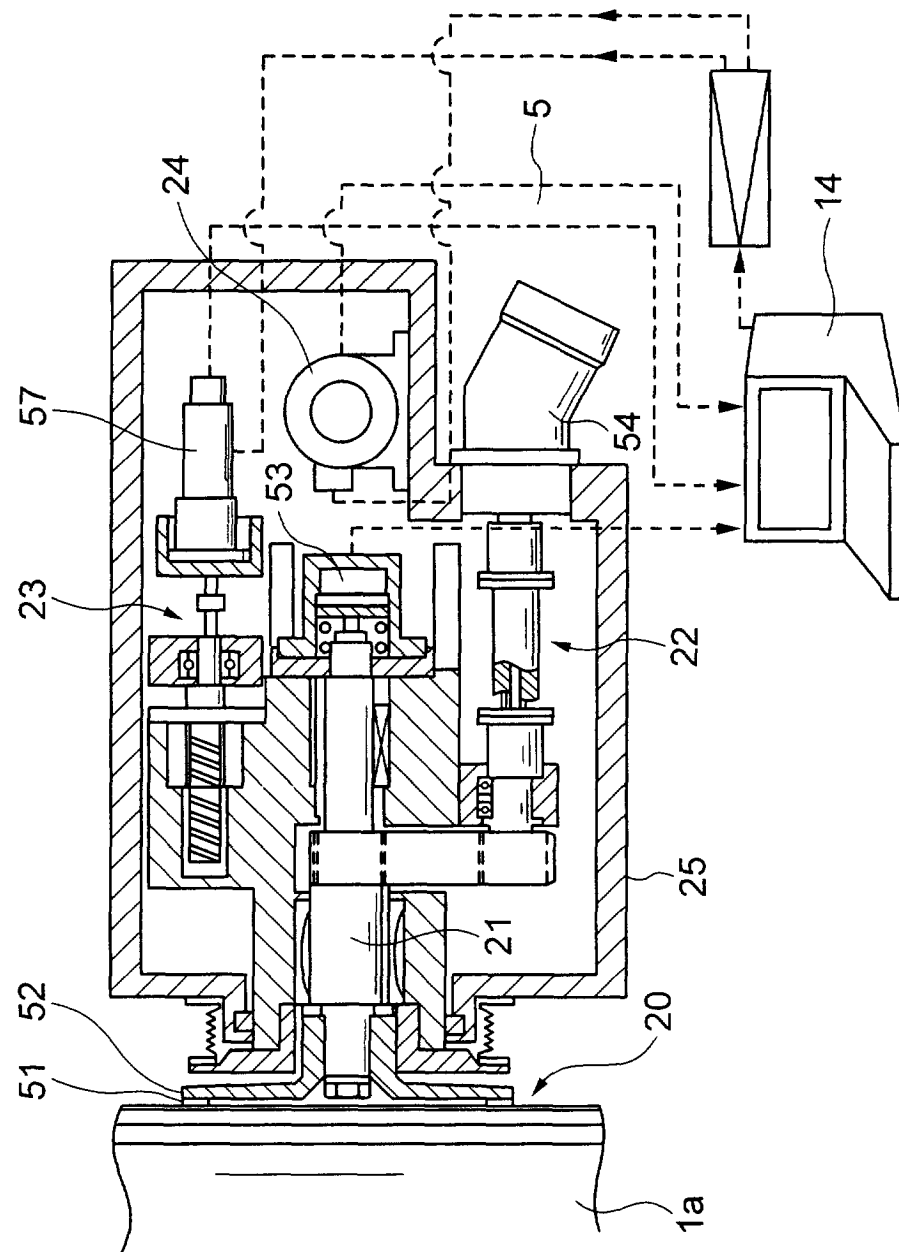


FIG. 3

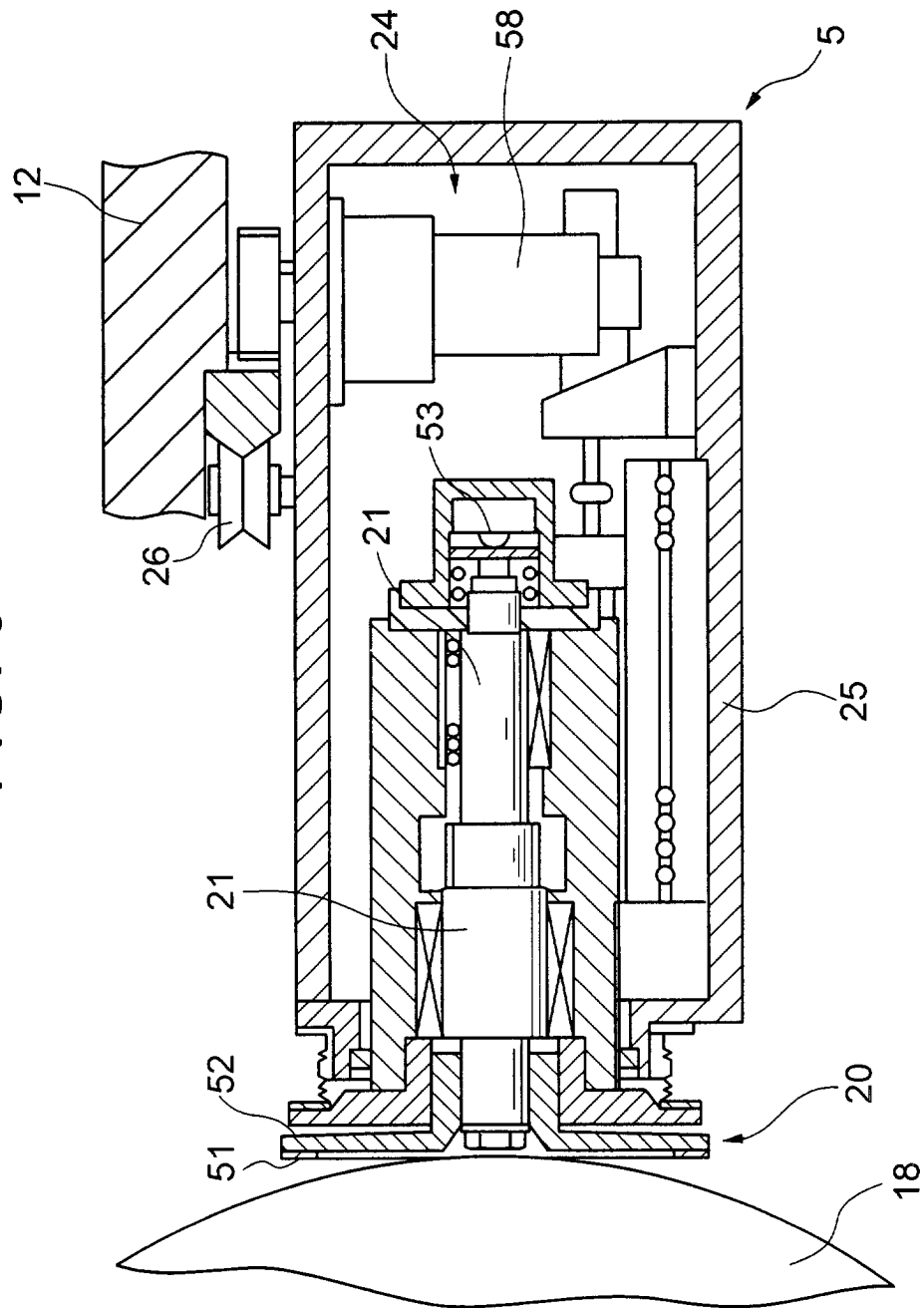


FIG. 4

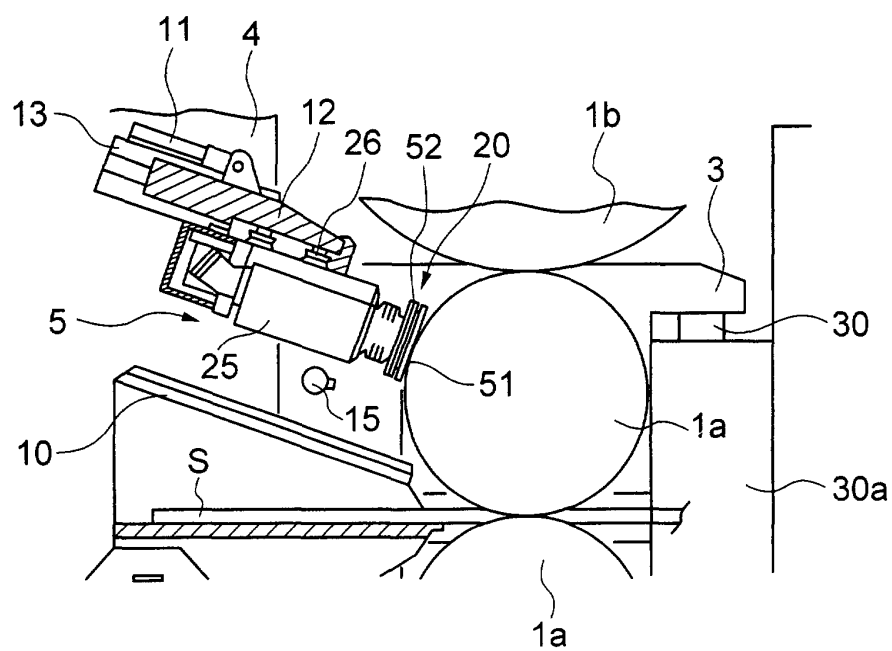


FIG. 5

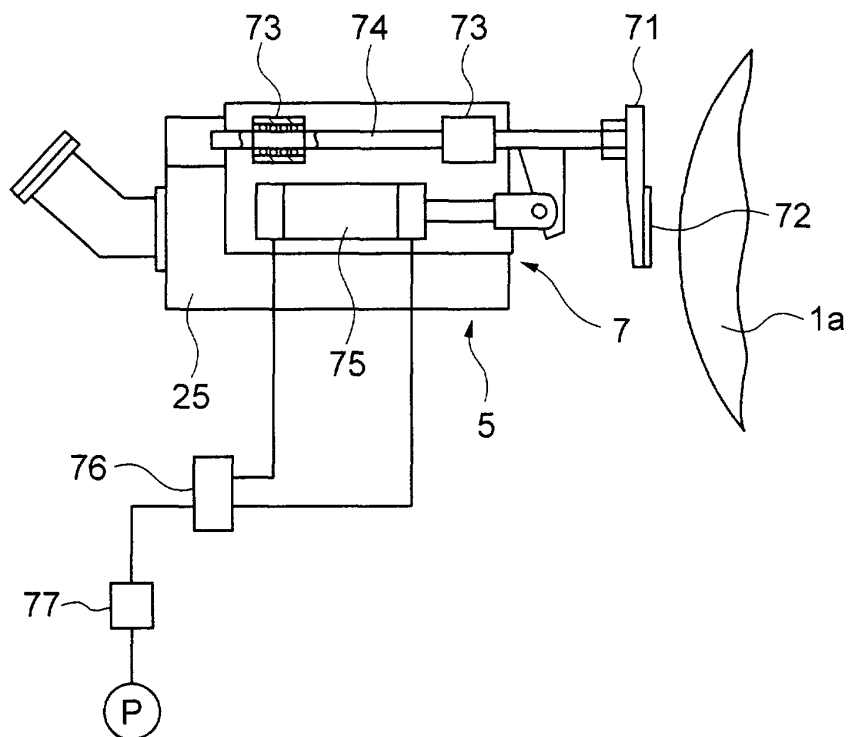


FIG. 6

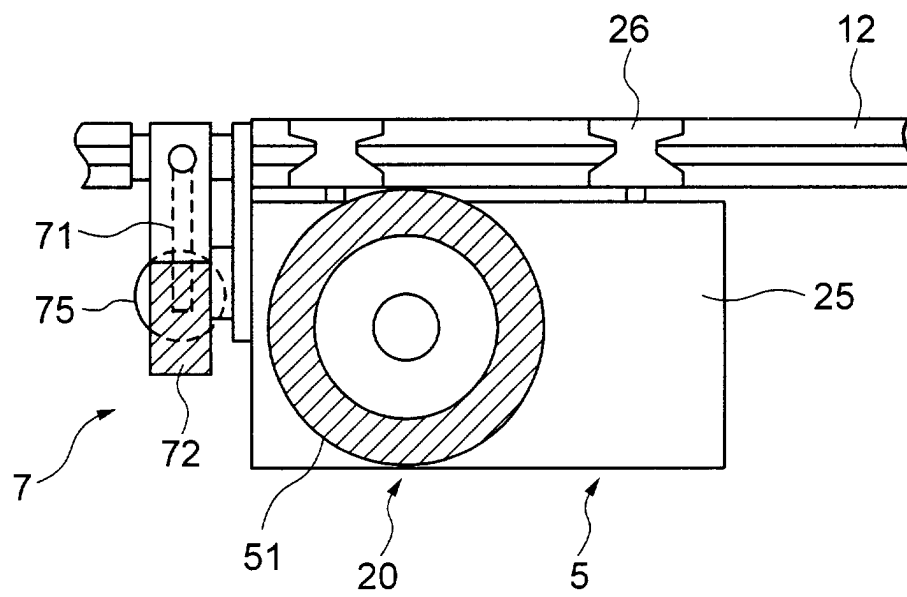


FIG. 7

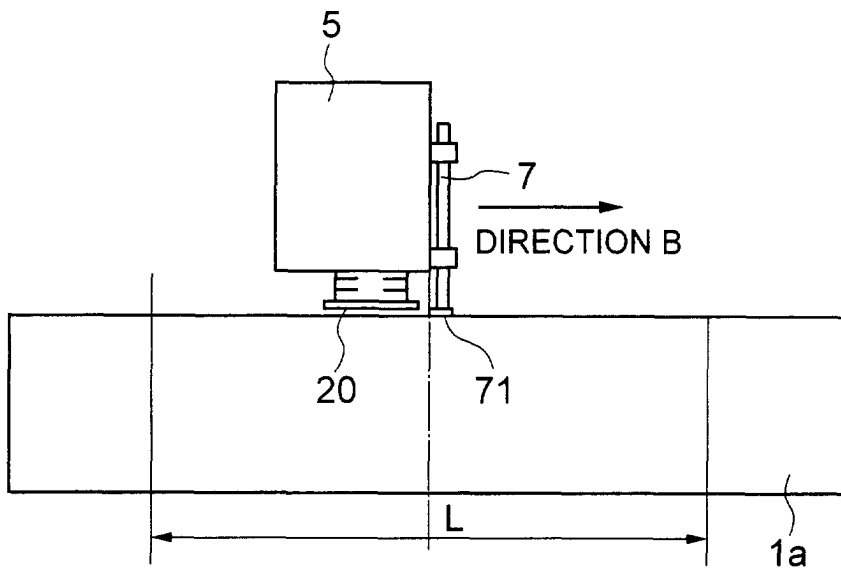
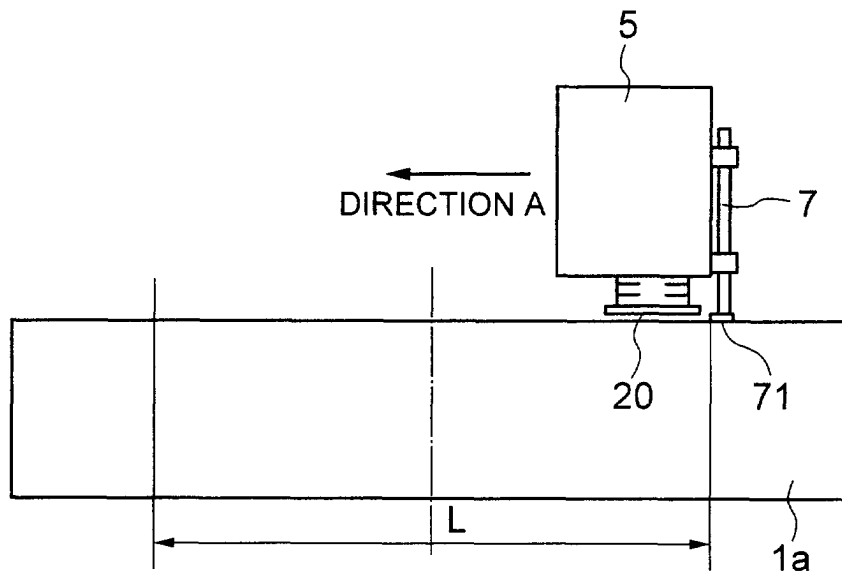


FIG. 8

