In a rolling mill in which hydraulic apparatus (12;13), for controlling the roll balance or the shape of the rolled material are incorporated in movable frames (10;11) provided separately from roll chocks (4;5) mounted at each end of the rolls (1,2), reducing the roll inclination thereby making it possible to carry out stable rolling, and also reducing the roll vibrations, and making it possible to manufacture products with a high quality.

Providing hydraulic apparatus (12 and 13) for controlling the roll balance and the shape of the rolled material inside the movable frames (10 and 11), hydraulic apparatus (16 and 17) that push and restrict the roll chocks (4 and 5) and the movable frames (10 and 11) in the direction of flow of the rolled material relative to the roller stand (3), and the hydraulic apparatus (18 and 19) that push and restrict the movable frames (10 and 11) in the up/down direction relative to the roller stand (3).
Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to rolling mills and rolling methods, and in particular to, a rolling mill configured so that the rolls can be moved in the direction of the axis of the rolls depending on the width of the material to be rolled, and with a hydraulic apparatus for carrying out control of the roll balance or of the shape of the rolled material being incorporated in a movable frame provided separately from the roll chocks installed at each end of the rolls, and so that said movable frame can be moved in the direction of the roll axis along with the rolls and the roll chock.

DESCRIPTION OF PRIOR ART

[0002] Rolling mills for sheet materials are generally constructed so that the rolls can be moved in the direction of the roll axis in order to adjust the position of the rolls in the axial direction depending on the width of the material to be rolled. In such a rolling mill, in the one described in Japanese patent disclosure No. Sho 50-12385, the construction is one in which the cylinder part of the of the hydraulic apparatus for carrying out control of roll balance or of the shape of the rolled material is incorporated in a movable frame provided separately from the roll chocks installed at each end of the rolls, and the piston part of the hydraulic apparatus is mated with the flange part of the roll chock, and also the movable frame, the rolls, and the roll chock are moved together in the direction of the roll axis. Because of this, even if the rolls are moved in the direction of the roll axis, since the hydraulic apparatus moves in the direction of the roll axis along with the rolls while maintaining the mating between the piston part of the hydraulic apparatus and the roll chock, it is not only possible to carry out correct control of roll balance and shape of the rolled material at all times, but also possible to carry out movement in the roll axis direction without any problems.

[0003] Further, as a rolling mill provided with a hydraulic apparatus for carrying out control of roll balance or of the shape of the rolled material, there are rolling mills, such as the one disclosed in Japanese patent application laid open No. Sho 61-129208, in which a hydraulic apparatus is provided for pushing and restricting the roll chock against the housing in the rolling direction in order to make zero the gap between the roll chock and the housing.

[0004] In the conventional technology disclosed in Japanese patent disclosure No. Sho 50-12385, in order to make it possible to move the roll in the direction of the roll axis at the time of adjusting the position of the roll in the axial direction or at the time of roll replacement, appropriate gaps are being provided between the roll chock and the movable frame and between the movable frame and the guide frame supporting the movable frame installed in the housing of the rolling mill. Although these gaps are useful for their intended purpose at the time of adjusting the position of the roll in the axial direction or at the time of roll replacement, they will have detrimental effect at the time of rolling the material to be rolled, that is, the roll chocks installed at the ends of the rolls will move due to these gaps, and the rolls become inclined relative to the material being rolled, thereby causing meandering movement of the rolled material or failure of biting of the material at the rolling mill.

[0005] Further, roller bearings having cylindrical rollers are commonly used in the roll chock of the work roll that rolls the material to be rolled. These rollers revolve around the roller axis, and during rolling, vibrate the rolling mill at a frequency of vibration proportional to the number of times the rollers pass per unit time, and if this frequency of vibration unluckily becomes equal to natural frequencies of the rolling mill, there will be resonance which further gets amplified by said gaps, and may even cause chattering marks on the rolled material.

[0006] If the technology disclosed in Japanese patent application laid open No. Sho 61-129208 is added to the roll chock section disclosed in Japanese patent disclosure No. Sho 50-12385 by providing a hydraulic apparatus for pushing and restricting the roll chock and the movable frame against the housing, it is possible to reduce the problems such as the inclination of the roll during rolling, or the meandering movement, or failure of material biting, etc. However, if the roll chock and the movable frame are merely pushed in the direction of rolling, when vibration of the rolls and the roll chocks occurs due to resonance, the effect of the pushing force on the roll chock and the movable frame gets weakened, and hence it will not be possible to prevent the vibrations.

SUMMARY OF THE INVENTION

[0007] An object of the present invention is, in a rolling mill in which a hydraulic apparatus for carrying out control of the roll balance or of the shape of the rolled material is incorporated in a movable frame provided separately from the roll chocks installed at each end of the rolls, to provided a rolling mill and a rolling method that make it possible to carry out stable rolling with small roll inclination, to reduce roll vibrations, and to manufacture high quality products.

(1) In order to achieve the above object, in a rolling mill configured so that the rolls can be moved in the direction of the axis of the rolls depending on the width of the material to be rolled, and having a construction in which roll chocks mounted at two ends of the rolls are supported by the housing of the rolling mill via a movable frame provided separately from these roll chocks, the movable frame is provided with a first hydraulic apparatus for carrying out
control of the roll balance or of the shape of the rolled material, and also, a part of this first hydraulic apparatus is made to mate with the flange part of the roll chock section so that the movable frame can be moved in the direction of the roll axis along with the rolls, and the roll chock, in the present invention, the movable frame is provided with a second hydraulic apparatus that pushes and restricts the roll chock and movable frame relative to the housing of the rolling mill in the direction of flow of the rolled material, and a third hydraulic apparatus that pushes and restricts the movable frame relative to the housing of the rolling mill in the up/down direction.

In this manner, by providing the second hydraulic apparatus and pushing and restricting the roll chock and movable frame in the direction of flow of the rolled material, it is possible to make zero the gaps between the roll chock, movable frame, and rolling mill housing, to reduce the roll inclination during rolling, and carry out stable rolling with small meandering movement of the rolled material and with few failures of biting of the material.

Further, by providing the third hydraulic apparatus in addition to the second hydraulic apparatus and pushing and restricting the movable frame in the up/down direction while pushing and restricting the roll chock and movable frame in the direction of flow of the rolled material, when the rolls and the roll chock attempt to vibrate due to resonance, as a result of the roll chock being restricted in the direction of the flow of the rolled material due to the second hydraulic apparatus in addition to the movable frame being restricted in the up/down direction due to the third hydraulic apparatus, even the roll chock will be restricted in the up/down direction due to the friction force between the movable frame and the roll chock, and hence it is possible to reduce the vibrations due to resonance. Therefore, the product surface becomes smooth and it will be possible to manufacture high quality products.

(2) In (1) above, preferably, slipping prevention treatment is made on both side surfaces of the roll chocks and at least one side surface of the movable frame adjacent to the roll chocks.

Because of this, when being pushed by the second hydraulic apparatus, the friction force between the movable frame and the roll chock increases, and the action of restricting the roll stock in the up/down direction becomes stronger due to pushing and restricting the movable frame in the up/down direction, thereby making it possible to reduce further the vibrations due to resonance.

(3) Further, in order to achieve the above-mentioned object, in the rolling method using the rolling mill of (1) above, the present invention resides in that the second and third hydraulic apparatus are operated while the rolled material is being rolled, the roll chock and movable frame are pushed and restricted against the housing of the rolling mill, and the second and third hydraulic apparatus are released when the rolled material is not being rolled, and the movable frame, rolls, and roll chock are moved together in the axial direction of the rolls.

Because of this, during rolling, as has been described in (1) above, the gap is eliminated, even the inclination of the roll axis is eliminated, and even the rolling is made stable. In addition, even the vibrations are reduced because the roll chock is restricted in the direction of flow of the rolled material and in the up/down direction.

(4) In (3) above, preferably, vibrations of the rolls are detected and the pushing force of the second hydraulic apparatus is increased when the amplitude or acceleration of vibrations exceeds beyond a certain value.

[0008] Because of this, the pushing force of the second hydraulic apparatus is weakened when the vibrations are small, and the function of controlling the roll balance or the shape of the rolled material by the first hydraulic apparatus is effectively utilized, and the pushing force of the second hydraulic apparatus is increased only when the vibrations due to resonance become a problem, and the roll chock is restricted in the up/down direction by increasing the friction force between the movable frame and the roll chock, thereby reducing the vibrations due to resonance.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

Fig. 1 is a front view of a rolling mill according to a preferred embodiment of the present invention; Fig. 2 is a side view of the rolling mill shown in Fig. 1; Fig. 3 is a horizontal sectional view of the roll chock section of the work roll end part in the driving side of the rolling mill shown in Fig. 1; and Fig. 4 is a vertical sectional view of the roll chock section of the work roll end part in the driving side of the rolling mill shown in Fig. 1.

PREFERRED EMBODIMENT OF THE INVENTION

[0010] In the following, a preferred embodiment of the present invention is described referring to the figures.

[0011] In Fig. 1 and Fig. 2, the top and bottom work rolls 1 and 2 that roll the material to be rolled are supported at both ends by the work roll chocks 4 and 5 that are held inside the window part of the mill stand (rolling mill housing) 3, and the back-up rolls 6 and 7 in contact with the work rolls 1 and 2 are similarly supported at both ends by the back-up roll chocks 8 and 9 that are held within the mill stand 3. The back-up rolls 6 and 7 and the back-up roll chocks 8 and 9 can move in the up/down direction as in the conventional manner, and are fixed
in the direction of the roll axis. The work roll chocks 4 and 5 are formed with a width narrower than the width of the window part of the mill stand 3, and are held and supported by the mill stand 3 via the movable frames 10 and 11 placed almost at the middle of the mill stand in the up/down direction.

[0012] The movable frames 10 and 11 are respectively placed on both sides of each of the work roll chocks 4 and 5 on the rolling mill driving side (the right side in Fig. 2) and the operation side (the left side in Fig. 2), and also the top and bottom ones have been made independent. Further, the hydraulic apparatus 12 and 13 for carrying out control of the roll balance and the shape of the rolled material are incorporated in the movable frames 10 and 11 corresponding to the work rolls 1 and 2, and these hydraulic apparatus 12 and 13 are constituted of the cylinders 12a and 13a formed inside the movable frames 10 and 11, and the pistons 12b and 13b that mate with the flanges 4a and 5a of the work roll chocks 4 and 5.

[0013] Further, as is shown in Fig. 3 and Fig. 4, inside the movable frames 10 and 11 are incorporated the hydraulic apparatus 16 and 17 that push and restrict the roll chocks 4 and 5 and the movable frames 10 and 11 in the direction of flow of the rolled material relative to the mill stand 3, and the hydraulic apparatus 18 and 19 (described later) that push and restrict the movable frames 10 and 11 in the up/down direction relative to the mill stand 3.

[0014] At the central part of the mill stand 3 is provided the guide frame 20 that support the movable frames 10 and 11 so that they can not move in the up/down direction but can move in the direction of the roll axis. This guide frame 20 is a part separate from the mill stand 3, and can either be fitted mating with the inside surface of the mill stand 3 or can have an integrated construction with the mill stand 3. The guide frame 20 is formed in shape of the letter "E" having projecting parts at the top, bottom, and middle so that the top and bottom movable frames 10 and 11 can be supported and guided, and also so that it is sufficient to support the work rolls 1 and 2 during rolling and said movable frames 10 and 11 when the work roll chocks 4 and 5 are being moved in the roll axis direction, and their inside surfaces are provided with liner 21 where they come into contact with the movable frames 10 and 11.

[0015] In addition, the movable frame 10 and 11 on the operation side of the rolling mill and the work roll chocks 4 and 5 are held fixed by the keeper plates 22 and 23, and also each of the movable frames 10 and 11 on the operation side and driving side are mutually coupled by coupling links 24 and 25, and can be moved in the roll axis direction together with the work rolls 1 and 2 and the work roll chocks 4 and 5.

[0016] Here, the keeper plates 22 and 23 are fixed to the end surfaces of the movable frames 10 and 11 using bolts via long holes, and the front ends of the keeper plates 22 and 23 enter into the vertical grooves formed in the work roll chocks 4 and 5, and a small gap is formed between keeper plates 22 and 23 and the vertical grooves in the work roll chocks 4 and 5 so that the work roll chocks 4 and 5 can move up/down. Further, by loosening the bolts holding the keeper plates 22 and 23, and moving the keeper plates 22 and 23 by a distance equal to the length of the long hole for bolts, the front ends of the keeper plates 22 and 23 are detached from the vertical groove in the work roll chocks 4 and 5, thereby making it possible to move the work roll chocks 4 and 5 relative to the movable frames 10 and 11 in the roll axis direction at the time of replacing the rolls. In addition, the end surface of the guide frame 20 on the operation side is provided with stopper 14 linked to said movable frames 10 and 11 so that the movable frames 10 and 11 can be held in the guide frame 20 at the time of roll replacement.

[0017] The respective coupling parts 26 and 27 shown in Fig. 2 are fitted to the driving side end sections of the work rolls 1 and 2, and the rotation drive is applied here using roll driving units not shown in the figure. Further, the work rolls 1 and 2 together with couplings 26 and 27 are moved in the roll axis direction according to the width of the rolled material by the roll movement equipment not shown in this figure. At the time of such movement in the roll axis direction, the movement in the same axial direction is done together with the movable frames 10 and 11 along with the work rolls 1 and 2 and the work roll chocks 4 and 5, the keeper plates 22 and 23 and the coupling links 24 and 25. Therefore, all the hydraulic apparatus 12, 13, 16, 17, 18, and 19 incorporated in the movable frames 10 and 11, and the work roll chocks 4 and 5 will always be maintained in the same positional relationships.

[0018] In Fig. 3 and Fig. 4, the hydraulic apparatus 16 and 17 that push and restrict the roll chocks 4 and 5 and the movable frames 10 and 11 in the direction of the flow of the rolled material relative to the mill stand 3 consist of the cylinders 16a and 17a formed inside the movable frames 10 and 11, and the pistons 16b and 17b that mate with the guiding frame 20 via liners 21. The hydraulic apparatus 18 and 19 that push and restrict the movable frames 10 and 11 in the up/down direction relative to the mill stand 3 consist of the cylinders 18a and 19a formed inside the movable frames 10 and 11, and the pistons 18b and 19b that mate with the top and bottom projections of the guide frame 20.

[0019] Generally, in rolling mills, as is shown in Fig. 4, since the configuration is such that the center of the work roll has an eccentricity of 'e' towards the outlet side in the rolling direction relative to the center of the stand, the hydraulic apparatus 16 and 17 that push and restrict the roll chocks 4 and 5 and the movable frames 10 and 11 in the direction of flow of the rolled material relative to the mill stand 3 are installed on the inlet side of the movable frames 10 and 11 in the direction of flow of the rolled material, thereby pushing the roll chocks 4 and 5 and the movable frames 10 and 11 towards the outlet.
side of the flow direction of the rolled material. The hydraulic apparatus 18 and 19 for pushing and restricting in the up/down direction relative to the mill stand 3 are installed in the movable frames 10 and 11 on both the inlet side and the outlet side of the flow direction of the rolled material.

Further, the work roll chocks 4 and 5 contain roller bearings 28, and the work rolls 1 and 2 are supported by the work roll chocks 4 and 5 via these roller bearings 28. Gaps that are necessary during replacement of work rolls 1 and 2 have been provided between the work roll chocks 4 and 5 and the movable frames 10 and 11, and at least one of each contacting surface (at least one of the side surface on the side of the work roll chocks 4 and 5, and the side surface on the side of the movable frames 10 and 11 that is adjacent to the first surface) has been subjected to surface roughening treatment such as ragging, shot-blasting, etc., for preventing slipping in order to increase the friction coefficient.

Further, it is also possible to provide liners on at least one of the side surfaces between the work roll chocks 4 and 5 and the movable frames 10 and 11, and in this case, such liners are subjected to surface roughening treated such as ragging for preventing slipping.

In a rolling mill configured in the above manner, the movements in the axial direction of the work rolls 1 and 2 are done in mutually opposite directions before starting rolling, thereby adjusting the positions of the work rolls 1 and 2 in the axial direction according to the width of the material to be rolled.

During rolling of the material, the hydraulic apparatus 12 and 13 inside the movable frames 10 and 11, and the hydraulic apparatus 16, 17, 18, and 19 are made to operate. As a result of this, the hydraulic apparatus 12 and 13 apply a bending force on the work rolls in a manner similar to the conventional rolling mills, thereby controlling the shape of the rolled material. Further, the hydraulic apparatus 16, 17, 18, and 19 push the roll chocks 4 and 5 and the movable frames 10 and 11 thereby making small the inclination of the roll axis center and the vibrations, and making it possible to obtain stable rolling and products. At this time, since the contact surface (at least one of the side surface on the side of the work roll chocks 4 and 5 and the movable frames 10 and 11 that is adjacent to the first surface) has been subjected to surface roughening treatment such as ragging, shot-blasting, etc., for preventing slipping, the friction coefficient is achieved because the hydraulic apparatus 12 and 13 apply a bending force in the up/down direction on the roll chocks 4 and 5, the bending force will be affected if the pushing force due to the hydraulic apparatus 16 and 17 is too large. On the other hand, if the pushing force due to the hydraulic apparatus 16 and 17 is too small, the vibration stopping function will not be effective. In view of this, the vibrations of the work rolls 1 and 2 are detected by providing a vibration detector, not shown the figures here, in the roll chock section 4 and 5, and reducing the hydraulic pressure operating on the hydraulic apparatus 16 an 17 when the vibrations are smaller than a preset threshold value, and increasing said hydraulic pressure when the vibrations are more than the threshold value thereby increasing the pushing force of the hydraulic apparatus 16 and 17. As a result of this, when the vibrations are small, the shape control function due to the hydraulic apparatus 12 and 13 will become effective, and only when the vibrations caused by resonance become a problem, the pushing force of the hydraulic apparatus 16 and 17 is increased, thereby increasing the friction force between the movable frames 10 and 11 and the roll chocks 4 and 5, thus restricting the roll chocks 4 and 5 in the up/down direction and effectively reducing the vibrations caused by resonance.

When the rolling of the material is completed, the pressures in all the hydraulic apparatus 12, 13, 16, 17, 18, and 19 are released, the work rolls 1 and 2 are moved in the roll axis direction using a roll movement device not shown in the figures here, thereby preparing to roll the next material.

According to the present invention, since the work roll chocks are pushed in the direction of flow of the rolled material, the roll inclination gets eliminated, the meandering movements of the rolled material and...
material biting failures get eliminated, and it becomes possible to carry out stable rolling. Further, since the work roll chocks are restricted in the direction of flow of the rolled material and in the up/down direction, the roll vibrations will be reduced, the surface of the rolled products becomes smooth, and it will be possible to manufacture products with a high quality.

Claims

1. A rolling mill configured so that the rolls can be moved in the direction of the axis of the rolls (1,2) depending on the width of the material to be rolled, and having a construction in which the roll chocks (4,5) mounted at the two ends of the rolls are supported by the housing (3) of the rolling mill via moveable frames (10,11) provided separately from these roll chocks, each movable frame is provided with a first hydraulic apparatus (12,13) for carrying out control of the roll balance or of the shape of the rolled material, and a part of this first hydraulic apparatus is made to mate with the flange part of said roll chock section so that said movable frame can be moved in the direction of the roll axis along with the rolls and the roll chock, characterized in that said movable frame (10;11) is provided with a second hydraulic apparatus (16;17) that pushes and restricts said roll chock (4;5) and movable frame (10;11) relative to said housing (3) of the rolling mill in the direction of flow of the rolled material, and with a third hydraulic apparatus (18;19) that pushes and restricts said movable frame relative to said housing of the rolling mill in the up/down direction.

2. A rolling mill according to Claim 1, characterized in that slipping prevention treatment has been made on both side surfaces of said roll chock and at least one side surface of the movable frame adjacent to said roll chock.

3. A rolling method using the rolling mill according to Claim 1, characterized in that said second and third hydraulic apparatus (16;17;18;19) are operated while the rolled material is being rolled, said roll chock (4,5) and movable frame (10,11) are pushed and restricted against said housing (3) of the rolling mill, and said second and third hydraulic apparatus are released when the rolled material is not being rolled, and said movable frame, rolls, and roll chock are moved together in the axial direction of the rolls (1,2).

4. A rolling method according to Claim 3, characterized in that the vibrations of said rolls (1,2) are detected, and if the amplitude or acceleration of those vibrations exceeds a certain value, the pushing force of said second hydraulic apparatus (16;17) is increased.

5. A rolling mill comprising:
   a moving apparatus for moving a work roll (1;2) in a direction of the roll;
   roll chocks (4,5) rotatably supporting said work roll (1,2);
   a movable frame (10;11) disposed between said work roll and a rolling mill housing (3), supporting said roll chocks against said rolling mill housing and being movable by said moving apparatus in the direction of the roll; and
   a hydraulic apparatus (18;19) pushing said movable frame (10;11) in an up and down direction.

6. A rolling mill comprising:
   a moving apparatus for moving a work roll (1;2) in a direction of the roll;
   roll chocks (4,5) rotatably supporting said work roll (1,2);
   a movable frame (10;11) disposed between said work roll and a rolling mill housing (3), supporting said roll chocks against said rolling mill housing and being movable by said moving apparatus in the direction of the roll; and
   a hydraulic apparatus (16;17) pushing said movable frame in a rolling direction.

7. A rolling method by a rolling mill provided with a moving apparatus for moving a work roll (1;2) in a roll direction and roll chocks (4,5) rotatably supporting said work roll, said method comprising the steps:
   supporting said roll chocks against a rolling mill housing (3) through a movable frame (10;11) which is movable by said moving apparatus in the roll direction;
   moving said work roll, roll chocks and movable frame in the roll direction by said moving apparatus according to the width of a rolling material; and
   rolling while pushing said movable frame in the rolling direction.

8. A rolling method by a rolling mill provided with a moving apparatus for moving a work roll (1;2) in a roll direction and roll chocks (4,5) rotatably supporting said work roll, said method comprising the steps:
supporting said roll chocks (4;5) against a rolling mill housing (3) through a movable frame (10;11) which is movable by said moving apparatus in the roll direction; moving said work roll, roll chocks and movable frame in the roll direction by said moving apparatus according to the width of a rolling material; and rolling while pushing said movable frame in an up and down direction.
FIG. 2