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(54) PLATE-SHAPE CONTROL ROLLER GROUP AND PLATE STRIP ROLLING MILL

(57) A plate-shape control roller group and a plate strip rolling mill. The plate-shape control roller group comprises an upper control roller (3) and a lower control roller (8). The upper control roller (3) is disposed on the upper roll of a plate strip rolling mill, and both ends of the upper control roller (3) are provided with upper control oil cylinders (12) connected to the upper cross beam (10) of the plate strip rolling mill. The lower control roller (8) is disposed under the lower roller of the plate strip rolling mill, and both ends of the lower control roller (8) are provided with lower control cylinders (14) connected to the lower cross beam (9) of the plate strip rolling mill. The upper control oil cylinders (12) provide the upper control roller (3) with the control pressure and position acting on the upper roller, and the lower control oil cylinders (14) provide the lower control roller (8) with the control pressure and position acting on the lower roller. By adjusting the pressures and positions of the upper and lower control rollers (3, 8) respectively, the shapes of roller gaps between upper and lower support rollers (4, 7) and upper and lower work rollers (5, 6) are directly adjusted, thereby achieving the purpose of controlling the deformation of the mill rollers of the plate strip rolling mill and the rolled plate shape.

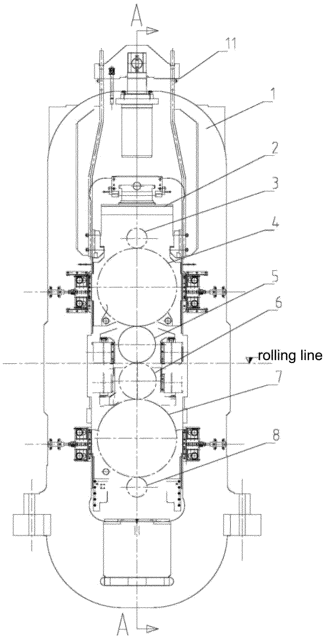

FIG. 1

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the priority of the Chinese Patent Application No. 202010232126.7, titled "Plate-shape control roller group and Plate Strip Rolling Mill", filed with the China Patent Office on March 27, 2020, the entire contents of which are incorporated herein by reference.

Technical Field

[0002] The present application belongs to the technical field of plate strip rolling mills used in the metallurgical machinery industry, and in particular, relates to a plate-shape control roller group and a plate strip rolling mill (also called as a strip rolling mill).

Background Art

[0003] At present, medium and heavy plate rolling mill and plate strip rolling mill used in the metallurgical machinery industry basically includes conventional two-roller rolling mills, four-roller rolling mills, six-roller rolling mills, etc. After the rollers thereof are deformed by force, the shape of the plate is controlled in the method including: a bending force of 100 to 500 tons, that is, about 1-5MN, is applied on each side of the roller; the roller is axially moved; or the shape curve of the roller is grinded, and so on. It has the disadvantages of increasing the load of the roller; roller bending cylinders + roller axial movement cylinders (total about 16+4=20 cylinders) being added for one rolling mill; or grinding for the special roller curve. In order to improve the rigidity of the roller, the size of the roller is increased. For example, as for a rolling mill with a width of 5 meters, the diameter of the support roller reaches 2.0 to 2.4 meters, and if the surface thickness of about 50 to 100 mm is used off, the roller is scrapped, which increases the costs of rollers, bearings, spare parts, and auxiliary facilities.

Summary

[0004] In view of this, the present application provides a plate-shape control roller group and a plate strip rolling mill, which can solve at least one of the current technical problems, such as, the conventional plate strip rolling mill uses the roller bending technology, increases the roller load and the wear and consumptions of components, reduces the intermediate rollers which are added for the six-roller rolling mill, and uses the roller bending technology for controlling the plate shape. Furthermore, it achieves the following objectives: directly adjusting the shape of the roll gap of the upper and lower support rollers, and the upper and lower work rollers, so as to directly control the force deformation of the rollers and the plate shape.

[0005] The present application is achieved through the following technical solutions:

A plate-shape control roller group provided by the present application comprises an upper control roller and a lower control roller. The upper control roller is arranged above the upper roller of the plate strip rolling mill, and both ends of the upper control roller are provided with upper control oil cylinder connected to the upper cross beam of the plate strip rolling mill. The lower control roller is arranged below the lower roller of the plate strip rolling mill, both ends of the lower control roller are provided with a lower control oil cylinder connected to the lower cross beam of the plate strip rolling mill. The upper control oil cylinder provides the upper control roller with the control pressure acting on the upper roller and the position thereof; and the lower control oil cylinder provides the lower control roller with the control pressure acting on the lower roller and the position thereof.

[0006] Optionally, both the upper control roller and the lower control roller are set in the shape of a convex cylindrical surface or a double conical surface.

[0007] Optionally, the vertical centers of the upper control roller and the lower control roller are located on the same central axis.

[0008] Optionally, the pressure range of a single cylinder of the upper control oil cylinder and the lower control oil cylinder is 50-1000 tons or 0.5-10MN.

[0009] Optionally, the upper control roller and the lower control roller are disposed opposite to each other, the side of the upper control roller away from the lower control roller is connected to the upper control oil cylinder, and the side of the lower control roller away from the upper control roller is connected to the lower control oil cylinder. There is a roller group gap for accommodating the middle roller group between the upper control roller and the lower control roller, and the upper control oil cylinder and the lower control oil cylinder are configured to adjust the roller group gap through the upper control roller and the lower control roller.

[0010] The present application further provides a two-roller plate strip rolling mill based on a plate-shape control roller group, the two-roller plate strip rolling mill comprises a pressing-down hydraulic cylinder, an upper work roller, a lower work roller, a lower cross beam, an upper cross beam, a balancing device and a pressing-up hydraulic cylinder arranged on a frame, wherein the above plate-shape control roller group is applied to the two-roller plate strip rolling mill, that is, the upper control roller is controlled by the upper control oil cylinder to act on an upper work roller, and the lower control roller is controlled by the lower control oil cylinder to act on a lower work roller.

[0011] Optionally, the upper work roller and the lower work roller abut against each other, the upper work roller and the lower work roller are located in a roller group gap between the upper control roller and the lower control roller, the upper work roller and the upper control roller abut against each other, and the lower work roller and

the lower control roller abut against each other.

[0012] Optionally, the pressing-down hydraulic cylinder and the pressing-up hydraulic cylinder are respectively connected with the frame, an end of the pressing-down hydraulic cylinder is connected with the upper work roller through a bearing seat, and the pressing-down hydraulic cylinder is configured to act on the upper work roller by controlling the upper control roller; an end of the pressing-up hydraulic cylinder is connected with the lower work roller through a bearing seat, and the pressing-up hydraulic cylinder is configured to act on the lower work roller by controlling the lower control roller.

[0013] Optionally, two pressing-down hydraulic cylinders are provided, and the two pressing-down hydraulic cylinders are symmetrically arranged on two ends of the upper work roller with respect to the balancing device.

[0014] Optionally, two pressing-up hydraulic cylinders are provided, and the two pressing-up hydraulic cylinders are symmetrically arranged at two ends of the lower work roller with respect to the balancing device.

[0015] Optionally, the lower cross beam and the upper cross beam are respectively connected with the frame, the end of the upper control oil cylinder away from the upper control roller is connected with the upper cross beam, and the end of the lower control oil cylinder away from the lower control roller is connected with the lower cross beam.

[0016] The present application also provides a four-roller plate strip rolling mill based on a plate-shape control roller group, the four-roller plate strip rolling mill comprises a pressing-down hydraulic cylinder, an upper support roller, an upper work roller, a lower work roller, a lower support roller, a lower cross beam, an upper cross beam, a balancing device and a pressing-up hydraulic cylinder arranged on a frame, wherein the plate-shape control roller group mentioned above is applied to the four-roller plate strip rolling mill, that is, the upper control roller is controlled by the upper control oil cylinder to act on an upper support roller, and the lower control roller is controlled by the lower control oil cylinder to act on a lower support roller.

[0017] Optionally, the upper support roller and the lower support roller are located in a roller group gap between the upper control roller and the lower control roller, the upper support roller abuts against the upper control roller, and the lower support roller abuts against the lower control roller.

[0018] Optionally, the upper work roller and the lower work roller abut against each other, the upper work roller and the lower work roller are located in a roller group gap between the upper control roller and the lower control roller, the upper work roller abuts against the end of the upper support roller away from the upper control roller, and the lower work roller abuts against the end of the lower support roller away from the lower control roller.

[0019] Optionally, the pressing-down hydraulic cylinder and the pressing-up hydraulic cylinder are respectively connected with the frame, an end of the pressing-down hydraulic cylinder is connected with the upper support roller through a bearing seat, the pressing-down hydraulic cylinder is configured to act on the upper support roller by controlling the upper control roller; and an end of the pressing-up hydraulic cylinder is connected with the lower support roller through a bearing seat, and the pressing-up hydraulic cylinder is configured to act on the lower support roller by controlling the lower control roller.

[0020] Optionally, two pressing-down hydraulic cylinders are provided, and the two pressing-down hydraulic cylinders are symmetrically arranged on two ends of the upper support roller with respect to the balancing device and bear the main load.

[0021] Optionally, two pressing-up hydraulic cylinders are provided, and the two pressing-up hydraulic cylinders are symmetrically arranged at two ends of the lower support roller with respect to the balancing device, and bear the main load.

[0022] Optionally, the four-roller plate strip rolling mill is obtained by modifying a six-roller plate strip rolling mill; and the upper roller, the lower roller and the intermediate roller of the six-roller plate strip rolling mill are removed.

[0023] The advantages of the embodiments of the present application include the follows.

1. In the conventional two-roller rolling mill, four-roller rolling mill and six-roller rolling mill, upper and lower plate-shape control rollers and oil cylinders are added, which are respectively installed on the upper and lower cross beams, With a certain pressure, the pressure and the pressing position of the convex cylindrical surface control roller are adjusted to achieve the purpose of directly controlling the deformation of the roller and the plate shape.

2. The present application is achieved in a manner that a control roller is used to directly limit the deformation of the roller, without increasing the load of the roller, leaving out the bending roller oil cylinders + the roller axial movement cylinders for one rolling mill (totally about 16+4=20 oil cylinders), reducing the number of rollers and the bearing size, and costs of spare parts and auxiliary facilities; and reducing the costs of auxiliary facilities, such as, fluid systems, electrical systems, specifications for the support roller replacement crane as well as workshops and roller grinding machines.

3. For the upper and lower plate-shape control roller groups used in the present application, a special replacement tool (trolley) can be used to replace the upper and lower plate-shape control roller groups when replacing the upper and lower support rollers.

4. For the upper and lower plate-shape control roller group used in the present application, a special on-machine roller grinding technology (currently mature technology) can be used to grind the shape of the

upper and lower plate-type control rollers and prolong the replacement cycle of the upper and lower control rollers.

[0024] Other advantages, objects, and features of the present application will be set forth in the following description, which will be apparent to those skilled in the art based on the following study and research, or may be learned from the practice of the present application, to a certain extent. The objectives and other advantages of the present application may be realized and attained by the following description.

Brief Description of Drawings

[0025] In order to more clearly illustrate the embodiments of the present application or the technical solutions in the prior art, the drawings that need to be used in the description of the embodiments or the prior art will be briefly introduced below. Obviously, the drawings described below show some of the embodiments of the present application. For those skilled in the art, other drawings can also be obtained from these drawings without any creative efforts.

FIG. 1 is a front structural schematic diagram of a four-roller plate strip rolling mill based on the plate-shape control roller group;

FIG. 2 is a sectional view along the A-A of FIG. 1;

FIG. 3 is a schematic diagram of the roller of the four-roller plate strip rolling mill based on the plate-shape control roller group;

FIG. 4 is a schematic diagram of the roller of a current conventional six-roller rolling mill, which will become the four-roller plate strip rolling mill in FIG. 3 if the upper, lower and intermediate rollers are removed;

FIG. 5 is a schematic diagram of the roller of the two-roller plate strip rolling mill based on the plate-shape control roller group;

FIG. 6 is a schematic diagram showing the positions of the upper and lower control rollers (the four-roller rolling mill is merely schematic, but not limited to the combination shown in the drawings), wherein "a" shows that the upper and lower control rollers are deflected to the right, "b" shows that the upper and lower control rollers are deflected to the left, "c" shows that the upper control roller is deflected to the right and the lower control roller is deflected to the left, and "d" shows that the upper control roller is deflected to the left and the lower control roller is deflected to the right.

Reference Numbers:

[0026] 1-frame; 2-pressing-down hydraulic cylinder; 3-upper control roller; 4-upper support roller; 5-upper work roller; 6-lower work roller; 7-lower support roller; 8-lower control roller; 9-lower cross beam; 10-upper cross beam; 11-balancing device; 12-upper control oil cylinder; 13-pressing-up hydraulic cylinder; 14-lower control oil cylinder.

Detailed Description of Embodiments

[0027] The embodiments of the present application are described below through specific examples. Those skilled in the art can easily learn other advantages and effects of the present application from the contents disclosed in this specification. The present application can also be implemented or applied through other different embodiments. Various details in this specification can also be modified or changed based on different viewpoints and usages without departing from the spirit of the present application. It should be noted that the drawings provided in the following embodiments are only used to illustrate the basic concept of the present application in an illustrative manner, and the following embodiments and features in the embodiments may be combined with each other without conflict.

[0028] The same or similar reference numbers in the drawings of the embodiment correspond to the same or similar components. In the description of the embodiment, it should be understood that if any, the orientation or position relationships, indicated by the terms, "upper", "lower", "left" and "right", "front", "rear" and others, are based on the orientation or position relationship shown in the drawings, which are only for the convenience of describing the embodiment and simplifying the description, rather than indicating or implying that the indicated devices or elements must be the specific orientation, or be constructed and operated in the specific orientation, so that the terms for describing the positional relationship in the drawings are only used for exemplary illustration, and should not be construed as a limitation on the technical solution. For those skilled in the art, the specific meanings of the above terms should be understood according to specific situations.

[0029] As shown in FIGS. 1-3, in the embodiment, a plate-shape control roller group is provided on a four-roller plate strip rolling mill. The four-roller plate strip rolling mill comprises a frame 1, a pressing-down hydraulic cylinder 2, an upper support roller 4, an upper work roller 5, a lower work roller 6, a lower support roller 7, a lower cross beam 9, an upper cross beam 10, a balancing device 11 and a pressing-up hydraulic cylinder 13. The pressing-down hydraulic cylinder 2 is installed on the frame 1 and acts on the upper support roller 4, two ends of which are provided with the bearing seats (not marked). The pressing-up hydraulic cylinder 13 is installed on the frame 1 and acts on the lower support roller

7, two ends of which are provided with bearing seats (not marked). The bearing seats are each installed on the frame and the gaps therebetween are adjusted by the pressing-tight hydraulic cylinder (not marked) arranged on the side. The upper support roller 4 is configured to support the upper work roller 5, and the lower support roller 7 is configured to support the lower work roller 6. The balancing device 11 is configured to balance the weight of the upper support roller 4 and the bearing seat thereof, and be arranged on the upper cross beam 10 of the frame 1. The control roller group comprises an upper control roller 3 and a lower control roller 8 which are arranged correspondingly up and down. The upper control roller 3 is arranged above the upper support roller of the four-roller plate strip rolling mill, and each of the two ends thereof is provided with an upper control oil cylinder 12 connected to the upper cross beam 10 of the four-roller plate strip rolling mill. The lower control roller 8 is arranged below the lower support roller 7 of the four-roller plate strip rolling mill, and each of the two ends thereof is provided with a lower control oil cylinder 14 connected to the lower cross beam 9 of the four-roller plate strip rolling mill, that is, the upper control oil cylinder 12 provides to the upper control roller 3 the different control pressure acting on the upper support roller 4 and the position thereof, and the lower control oil cylinder 14 provides to the lower control roller 8 the different control pressure acting on the lower support roller and the position thereof, so as to solve the problems, such as, the current conventional plate strip rolling mill adopts the bending technology, increasing the load of the rollers as well as the wear and tear of the components, leaving out the intermediate roller added in the six-roller rolling mill, and using the roller bending technology to control the plate shape, to realize that the shapes of the roller gaps of the upper and lower support rollers and the upper and lower work rollers are directly adjusted, achieving the purpose of directly controlling the plate shape and the force deformation of the rollers.

[0030] It should be noted that the upper control roller 3 and the lower control roller 8 are arranged opposite to each other. The side of the upper control roller 3 away from the lower control roller 8 is connected with the upper control oil cylinder 12, and the side of the lower control roller 8 away from the upper control roller 3 is connected with the lower control oil cylinder 14. The upper control roller 3 and the lower control roller 8 have a roller group gap therebetween for accommodating the intermediate roller group. The upper control oil cylinder 12 and the lower control oil cylinder 14 are configured to adjust the roller group gap through the upper control roller 3 and the lower control roller 8.

[0031] In this embodiment, the upper control roller 3 and the lower control roller 8 are both provided in the shape of a convex cylindrical surface, and the centers thereof in the vertical direction are located on the same central axis. By matching the respective ends thereof to the cylinder pressures of the upper control oil cylinder 12 and the lower control oil cylinder 14, the shapes of the roller gaps of the upper and lower support rollers as well as the upper and lower work rollers can be adjusted. FIG. 6 is a schematic diagram showing the positions of the upper and lower control rollers, wherein "a" shows that the upper and lower control rollers are deflected to the right, "b" shows that the upper and lower control rollers are deflected to the left, "c" shows that the upper control roller is deflected to the right and the lower control roller is deflected to the left, and "d" shows that the upper control roller is deflected to the left and the lower control roller is deflected to the right. Of course, in different embodiments, the shape of a double conical surface can also be used, which can also achieve the above-mentioned purpose.

[0032] The single-cylinder pressure range of the upper control oil cylinder 12 and the lower control oil cylinder 14 in the embodiment is 50-1000 tons or 0.5-10 MN (meganewton), which can meet the conditions of use.

[0033] In the embodiment, the pressing-down hydraulic cylinder and the pressing-up hydraulic cylinder installed in the frame are used to adjust the upper and lower positions of the upper and lower work rollers, the support rollers, and the control rollers respectively, and bear the main load.

[0034] As shown in FIG. 5, the difference between this embodiment and the above-mentioned embodiment in which the plate-shape control roller group is provided on the four-roller plate strip rolling mill is that, the above-mentioned plate shape control roller group is applied to the two-roller plate strip rolling mill, that is, no upper support roller 4 and lower support roller 7 are provided; the upper control roller 3 is controlled by the upper control oil cylinder 12 to directly act on the upper work roller 5, and the lower control roller 8 is controlled by the lower control oil cylinder 14 to directly act on the lower work roller 6.

[0035] Optionally, the upper work roller 5 and the lower work roller 6 abut against each other, and the upper work roller 5 and the lower work roller 6 are located in the roller group gap between the upper control roller 3 and the lower control roller 8; the upper work roller 5 and the upper control roller 3 abut against each other, and the lower work roller 6 and the lower control roller 8 abut against each other.

[0036] It should be noted that the upper work roller 5 and the lower work roller 6 have a gap therebetween, through which the rolled plate passes, and the upper work roller 5 and the lower work roller 6 respectively press the rolled plate under load.

[0037] Optionally, the pressing-down hydraulic cylinder 2 and the pressing-up hydraulic cylinder 13 are respectively connected to the frame 1, the end of the pressing-down hydraulic cylinder 2 is connected to the upper work roller 5 through the bearing seat, and the pressing-down hydraulic cylinder 2 is configured to act on the upper work roller 5 by controlling the upper control roller 3. The end of the pressing-up hydraulic cylinder 13 is connected

to the lower work roller 6 through a bearing seat, and the pressing-up hydraulic cylinder 13 is configured to act on the lower work roller 6 by controlling the lower control roller 8.

[0038] It should be noted that, the balancing device 11 is configured to balance the weight of the upper support roller 4 and its bearing seat, and thus the balancing device 11 is located at the position of the central axis of the frame. Optionally, there are two pressing-down hydraulic cylinders 2 provided, which are symmetrically arranged at two ends of the upper work roller 5 relative to the balancing device 11, and bear the main load.

[0039] Optionally, there are two pressing-up hydraulic cylinders 13 provided, which are symmetrically arranged at two ends of the lower work roller 6 relative to the balancing device 11.

[0040] Optionally, the lower cross beam 9 and the upper cross beam 10 are respectively connected to the frame. One end of the upper control oil cylinder 12 away from the upper control roller 3 is connected to the upper cross beam 10, and one end of the lower control oil cylinder 14 away from the lower control roller 8 is connected to the lower cross beam 9.

[0041] As shown in FIG. 4, the difference between this embodiment and the above-mentioned embodiment in which the plate-shape control roller group is provided on the four-roller plate strip rolling mill is that, the four-roller plate strip rolling mill is obtained by modifying a six-roller plate strip rolling mill, that is: the upper, lower, and intermediate rollers of the six-roller plate strip rolling mill are removed; the upper control oil cylinder 12 provides to the upper control roller 3 the different control pressures and the positions thereof configured for the upper support roller 4; the upper control roller 3 is controlled by the upper control oil cylinder 12 to act on the upper support roller 4; and the lower control roller 8 is controlled by the lower control oil cylinder 14 to act on the lower support roller 7.

[0042] Optionally, the upper support roller 4 and the lower support roller 7 are located in the roller group gap between the upper control roller 3 and the lower control roller 8. The upper support roller 4 abuts against the upper control roller 3, and the lower support roller 7 abuts against the lower control roller 8.

[0043] Optionally, the upper work roller 5 and the lower work roller 6 abut against each other, and the upper work roller 5 and the lower work roller 6 are located in the roller group gap between the upper control roller 3 and the lower control roller 8. The upper work roller 5 abuts against the end of the upper support roller 4 away from the upper control roller 3, and the lower work roller 6 abuts against the end of the lower support roller 7 away from the lower control roller 8.

[0044] It should be noted that the upper work roller 5 and the lower work roller 6 have a gap therebetween, through which the rolled plate passes. The upper work roller 5 and the lower work roller 6 respectively press the rolled plate under load.

[0045] Optionally, the pressing-down hydraulic cylinder 2 and the pressing-up hydraulic cylinder 13 are respectively connected to the frame 1. The end of the pressing-down hydraulic cylinder 2 is connected to the upper support roller 4 through the bearing seat. The pressing-down hydraulic cylinder 2 is configured to act on the upper support roller 4 by controlling the upper control roller 3. The end of the pressing-up hydraulic cylinder 13 is connected to the lower support roller 7 through the bearing seat, and the pressing-up hydraulic cylinder 13 is configured to act on the lower support roller 7 by controlling the lower control roller 8.

[0046] Optionally, two pressing-down hydraulic cylinders 2 are provided, and the two pressing-down hydraulic cylinders 2 are symmetrically arranged at two ends of the upper support roller 4 relative to the balancing device 11, and bear the main load.

[0047] Optionally, two pressing-up hydraulic cylinders 13 are provided, and the two pressing-up hydraulic cylinders 13 are symmetrically arranged at two ends of the lower support roller 7 relative to the balancing device 11, and bear the main load.

[0048] Only preferred embodiments of the present application are provided above, and they are not configured to limit the present application. Obviously, those skilled in the art can make various changes and modifications to the present application without departing from the spirit and scope of the present application. Thus, if these modifications and variations of the present application fall within the scope of the claims of the present application and the equivalents thereof, the present application is also intended to include these modifications and variations.

Industrial Applicability

[0049] The embodiments of the present application provide a plate-shape control roller group and a strip rolling mill. The plate-shape control roller group can achieve the purpose of directly controlling the deformation of the rollers and the plate shape; and can reduce costs. The special replacement tool is used to replace the upper and lower plate-shape control roller group and the replacement cycle of the upper and lower control rollers can be prolonged.

Claims

1. A plate-shape control roller group, **characterized by** comprising an upper control roller (3) and a lower control roller (8), wherein the upper control roller is arranged above an upper roller of a plate strip rolling mill, each of the two ends of the upper control roller is provided with an upper control oil cylinder (12) connected to an upper cross beam (10) of the plate strip rolling mill, the lower control roller is arranged below a lower roller of the plate strip rolling mill, each

of the two ends of the lower control roller is provided with a lower control oil cylinder (14) connected to a lower cross beam (9) of the plate strip rolling mill, the upper control oil cylinder (12) provides the upper control roller (3) with a control pressure for acting on the upper roller and a position thereof, and the lower control oil cylinder provides the lower control roller with a control pressure for acting on the lower roller and a position thereof.

2. The plate-shape control roller group according to claim 1, **characterized in that** the upper control roller and the lower control roller are both provided in a shape of a convex cylindrical surface or a double conical surface.

3. The plate-shape control roller group according to claim 1 or 2, **characterized in that** centers of the upper control roller and the lower control roller in a vertical direction are located on the same central axis.

4. The plate-shape control roller group according to any one of claims 1-3, **characterized in that** a pressure range of a single cylinder of the upper control oil cylinder and the lower control oil cylinder is 50-1000 tons.

5. The plate-shape control roller group according to any one of claims 1-4, **characterized in that** the upper control roller (3) and the lower control roller (8) are arranged opposite to each other, one side of the upper control roller (3) away from the lower control roller (8) is connected to the upper control oil cylinder (12), one side of the lower control roller (8) away from the upper control roller (3) is connected to the lower control oil cylinder (14), a roller group gap for accommodating an intermediate roller group is formed between the upper control roller (3) and the lower control roller (8); and the upper control oil cylinder (12) and the lower control oil cylinder (14) are configured to adjust the roller group gap by the upper control roller (3) and the lower control roller (8).

6. A two-roller plate strip rolling mill based on a plate-shape control roller group, with the two-roller plate strip rolling mill comprising a pressing-down hydraulic cylinder (2), an upper work roller (5), a lower work roller (6), a lower cross beam (9), an upper cross beam (10), a balancing device (11) and a pressing-up hydraulic cylinder (13) arranged on a frame (1), **characterized in that** the plate-shape control roller group according to any one of claims 1-5 is applied to the two-roller plate strip rolling mill, that is, the upper control roller is controlled by the upper control oil cylinder to act on the upper work roller, and the lower control roller is controlled by the lower control oil cylinder to act on the lower work roller.

7. The two-roller plate strip rolling mill based on the plate-shape control roller group according to claim 6, **characterized in that** the upper work roller (5) and the lower work roller (6) abut against each other, the upper work roller (5) and the lower work roller (6) are located in a roller group gap between the upper control roller (3) and the lower control roller (8), the upper work roller (5) and the upper control roller (3) abut against each other, and the lower work roller (6) and the lower control roller (8) abut against each other.

8. The two-roller plate strip rolling mill based on the plate-shape control roller group according to claim 7, **characterized in that** the pressing-down hydraulic cylinder (2) and the pressing-up hydraulic cylinder (13) are respectively connected with the frame (1), an end of the pressing-down hydraulic cylinder (2) is connected with the upper work roller (5) through a bearing seat, the pressing-down hydraulic cylinder (2) is configured to act on the upper work roller (5) by controlling the upper control roller (3); and an end of the pressing-up hydraulic cylinder (13) is connected with the lower work roller (6) through a bearing seat, and the pressing-up hydraulic cylinder (13) is configured to act on the lower work roller (6) by controlling the lower control roller (8).

9. The two-roller plate strip rolling mill based on the plate-shape control roller group according to claim 8, **characterized in that** two pressing-down hydraulic cylinders (2) are provided, and the two pressing-down hydraulic cylinders (2) are symmetrically arranged at two ends of the upper work roller (5) with respect to the balancing device (11).

10. The two-roller plate strip rolling mill based on the plate-shape control roller group according to claim 8 or 9, **characterized in that** two pressing-up hydraulic cylinders (13) are provided, and the two pressing-up hydraulic cylinders (13) are symmetrically arranged at two ends of the lower work roller (6) with respect to the balancing device (11).

11. The two-roller plate strip rolling mill based on the plate-shape control roller group according to any one of claims 8-10, **characterized in that** the lower cross beam (9) and the upper cross beam (10) are respectively connected with the frame, one end of the upper control oil cylinder (12) away from the upper control roller (3) is connected with the upper cross beam (10), and one end of the lower control oil cylinder (14) away from the lower control roller (8) is connected with the lower cross beam (9).

12. A four-roller plate strip rolling mill based on a plate-shape control roller group, with the four-roller plate strip rolling mill comprising a pressing-down hydrau-

lic cylinder (2), an upper support roller (4), an upper work roller (5), a lower work roller (6), a lower support roller (7), a lower cross beam (9), an upper cross beam (10), a balancing device (11) and a pressing-up hydraulic cylinder (13) arranged on a frame (1), **characterized in that** the plate-shape control roller group according to any one of claims 1-5 is applied to the four-roller plate strip rolling mill, that is, the upper control roller is controlled by the upper control oil cylinder to act on the upper support roller, and the lower control roller is controlled by the lower control oil cylinder to act on the lower support roller.

13. The four-roller plate strip rolling mill based on the plate-shape control roller group according to claim 12, **characterized in that** the upper support roller (4) and the lower support roller (7) are located in a roller group gap between the upper control roller (3) and the lower control roller (8), the upper support roller (4) abuts against the upper control roller (3), and the lower support roller (7) abuts against the lower control roller (8).

14. The four-roller plate strip rolling mill based on the plate-shape control roller group according to claim 13, **characterized in that** the upper work roller (5) and the lower work roller (6) abut against each other, the upper work roller (5) and the lower work roller (6) are located in a roller group gap between the upper control roller (3) and the lower control roller (8), the upper work roller (5) abuts against one end of the upper support roller (4) away from the upper control roller (3), and the lower work roller (6) abuts against one end of the lower support roller (7) away from the lower control roller (8).

15. The four-roller plate strip rolling mill based on the plate-shape control roller group according to claim 14, **characterized in that** the pressing-down hydraulic cylinder (2) and the pressing-up hydraulic cylinder (13) are respectively connected with the frame (1), an end of the pressing-down hydraulic cylinder (2) is connected with the upper support roller (4) through a bearing seat, the pressing-down hydraulic cylinder (2) is configured to act on the upper support roller (4) by controlling the upper control roller (3); and an end of the pressing-up hydraulic cylinder (13) is connected with the lower support roller (7) through a bearing seat, and the pressing-up hydraulic cylinder (13) is configured to act on the lower support roller (7) by controlling the lower control roller (8).

16. The two-roller plate strip rolling mill based on the plate-shape control roller group according to claim 15, **characterized in that** two pressing-down hydraulic cylinders (2) are provided, and the two pressing-down hydraulic cylinders (2) are symmetrically arranged at two ends of the upper support roller (4) with respect to the balancing device (11).

17. The two-roller plate strip rolling mill based on the plate-shape control roller group according to claim 15 or 16, **characterized in that** two pressing-up hydraulic cylinders (13) are provided, and the two pressing-up hydraulic cylinders (13) are symmetrically arranged at two ends of the lower support roller (7) with respect to the balancing device (11).

18. The four-roller plate strip rolling mill based on the plate-shape control roller group according to any one of claims 12 to 17, **characterized in that** the four-roller plate strip rolling mill is obtained by modifying a six-roller plate strip rolling mill and an upper roller, a lower roller and an intermediate roller of the six-roller plate strip rolling mill are removed.

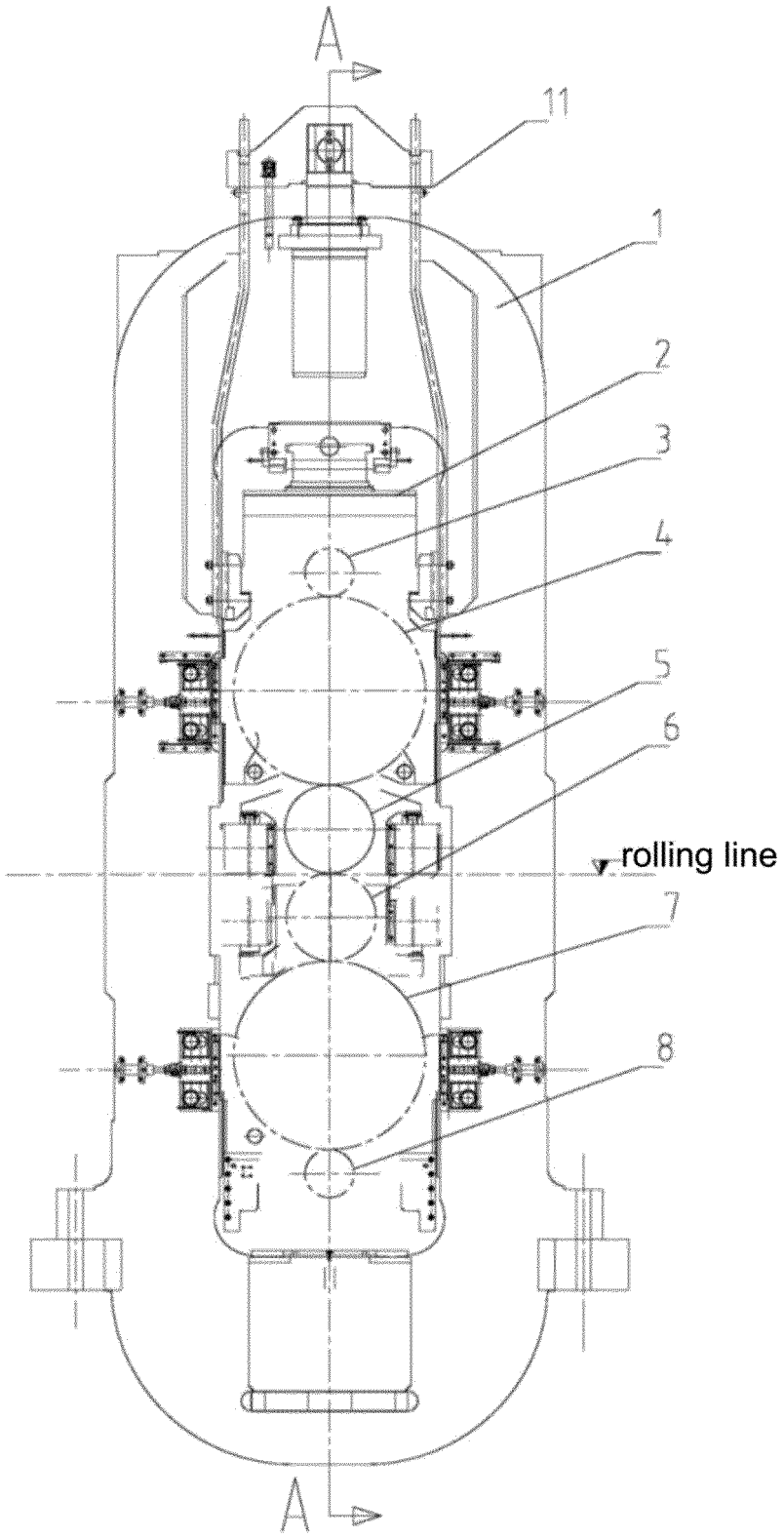

FIG. 1

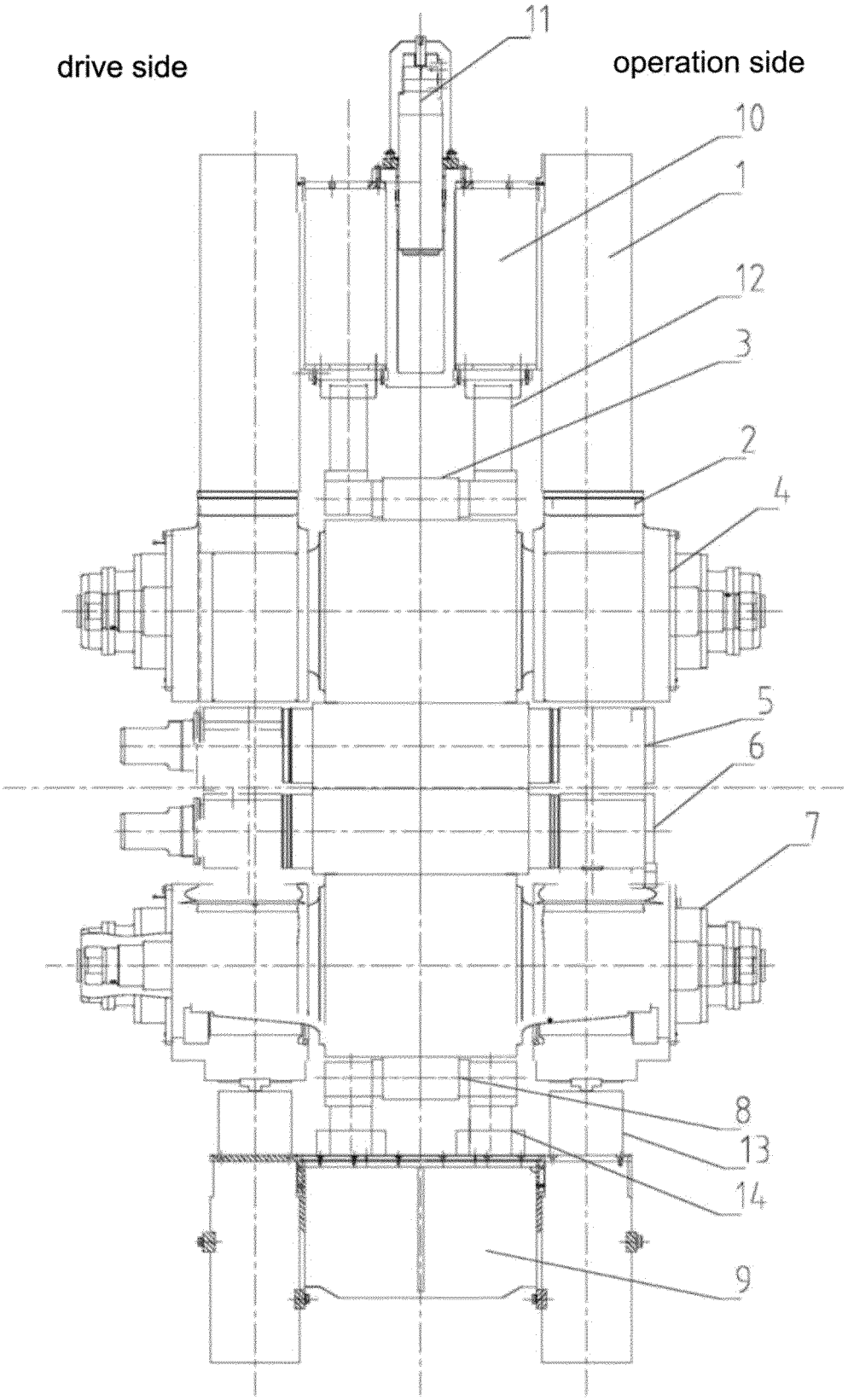

FIG. 2

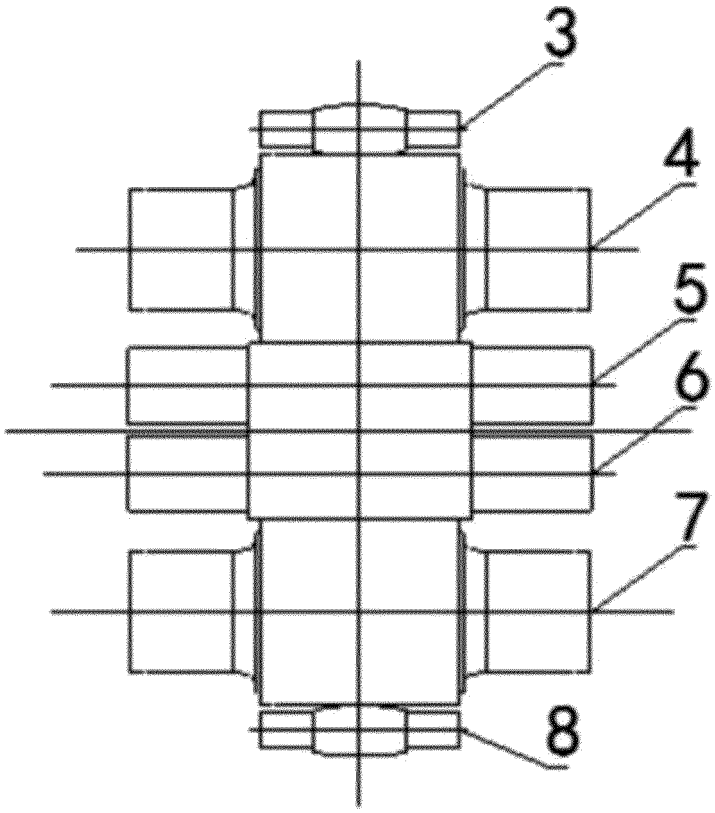

FIG. 3

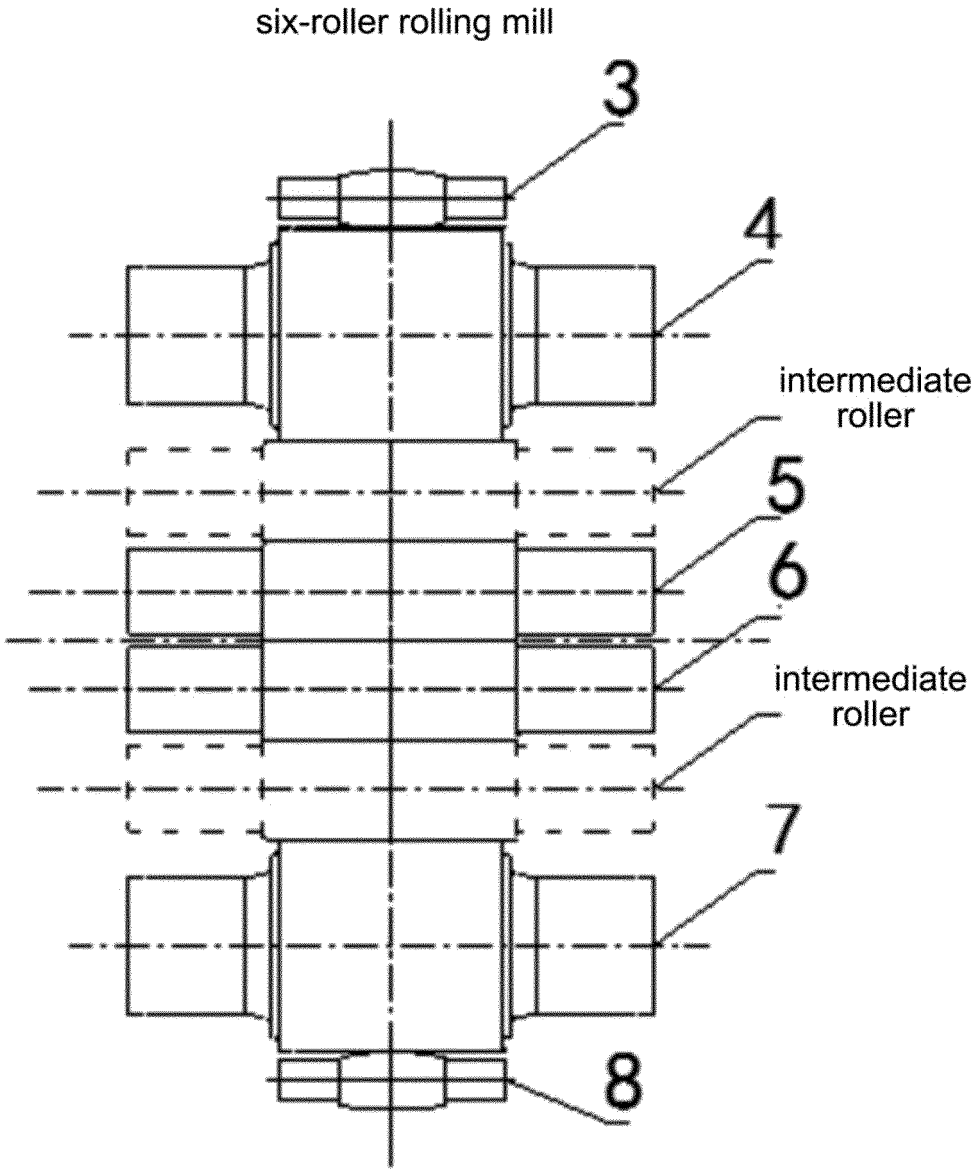
six-roller rolling mill
3
4
intermediate roller
5
6
intermediate roller
7
8

FIG. 4

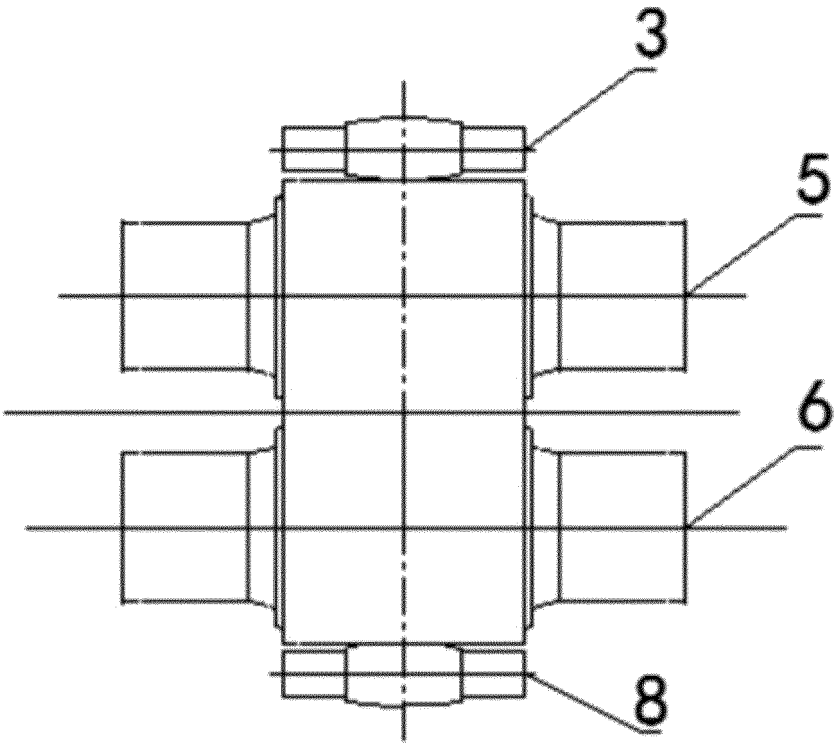

FIG. 5

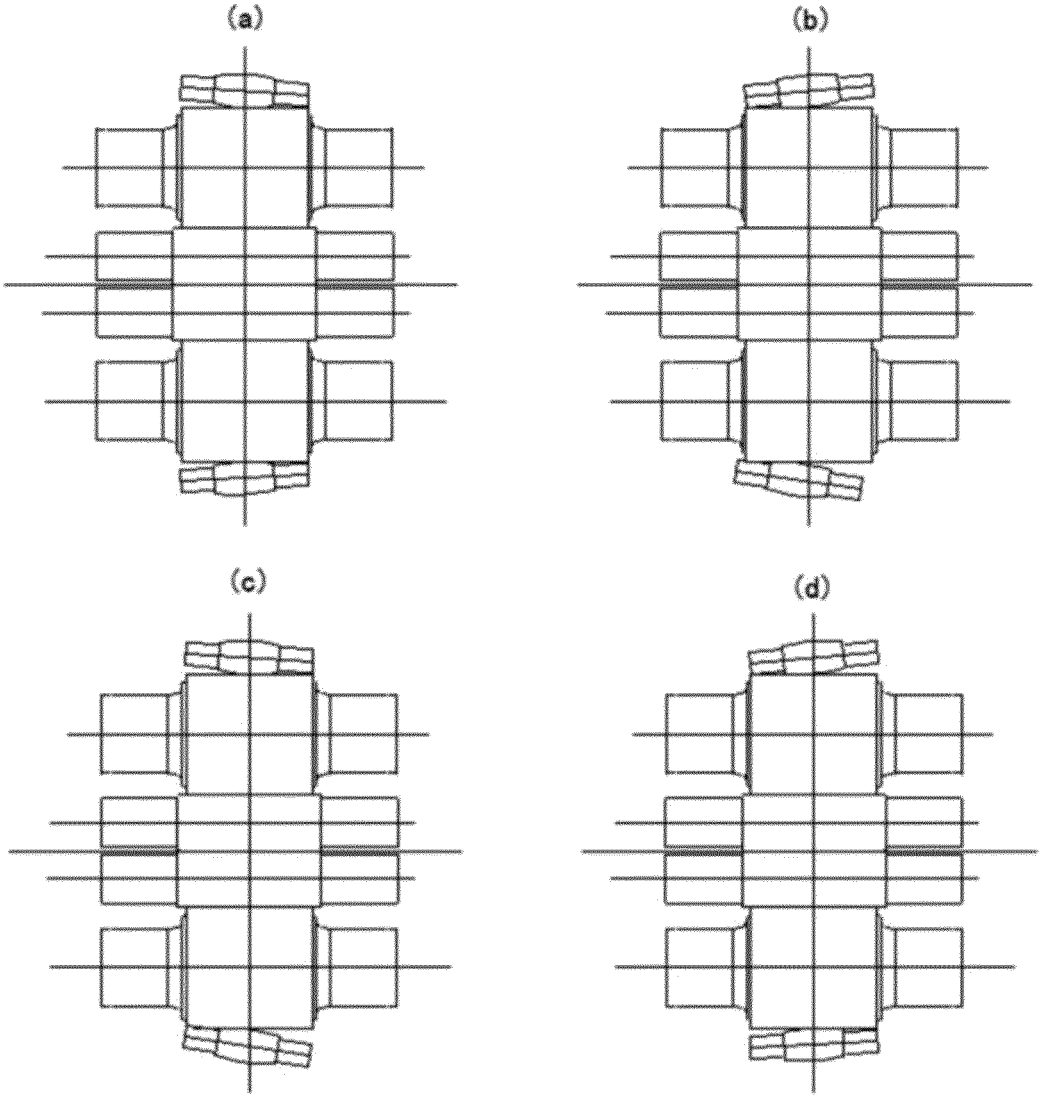

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/120559

A. CLASSIFICATION OF SUBJECT MATTER

B21B 37/28(2006.01)i; B21B 37/38(2006.01)i; B21B 37/62(2006.01)i; B21B 29/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B21B37/-; B21B29/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI; EPODOC; CNPAT; CNKI: 中冶赛迪技术研究中心有限公司, 板型, 板形, 轧制, 轧机, 控制, 辊, 油缸, 横梁, 辊缝, 间隙, 压力, 调节, plate, strip, type, shape?, control, roll+, cylinder, beam, gap, adjust+, pressure

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	CN 212093736 U (MCC CISDI TECH RESEARCH CENTER CO., LTD.) 08 December 2020 (2020-12-08) description, paragraphs [0029]-[0036], and figures 1-6	1-18
PX	CN 111318578 A (MCC CISDI TECH RESEARCH CENTER CO., LTD.) 23 June 2020 (2020-06-23) description, paragraphs [0029]-[0036], and figures 1-6	1-18
X	JP S6133705 A (UBE IND LTD.) 17 February 1986 (1986-02-17) description, columns 5-10, figures 1-9	1-18
X	JP 2002210506 A (KAWASAKI HEAVY IND LTD.) 30 July 2002 (2002-07-30) description, paragraphs [0003]-[0008], and figure 9	1-18
A	CN 104438318 A (QIAN, Gang) 25 March 2015 (2015-03-25) entire document	1-18
A	CN 201516437 U (ZHU, Mianxue) 30 June 2010 (2010-06-30) entire document	1-18
A	CN 102744266 A (CHINA NATIONAL HEAVY MACHINERY RESEARCH INSTITUTE CO., LTD.) 24 October 2012 (2012-10-24) entire document	1-18

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 December 2020	**30 December 2020**

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Facsimile No. **(86-10)62019451**	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/120559

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 20140118473 A (CIS CO., LTD.) 08 October 2014 (2014-10-08) entire document	1-18

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2020/120559

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 212093736 U	08 December 2020	None	
CN 111318578 A	23 June 2020	None	
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CN 201516437 U	30 June 2010	None	
CN 102744266 A	24 October 2012	None	
KR 20140118473 A	08 October 2014	None	

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 202010232126 **[0001]**