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(71) Applicant: **Primetals Technologies Japan, Ltd.**
**Hiroshima-shi, Hiroshima 733-8553 (JP)**

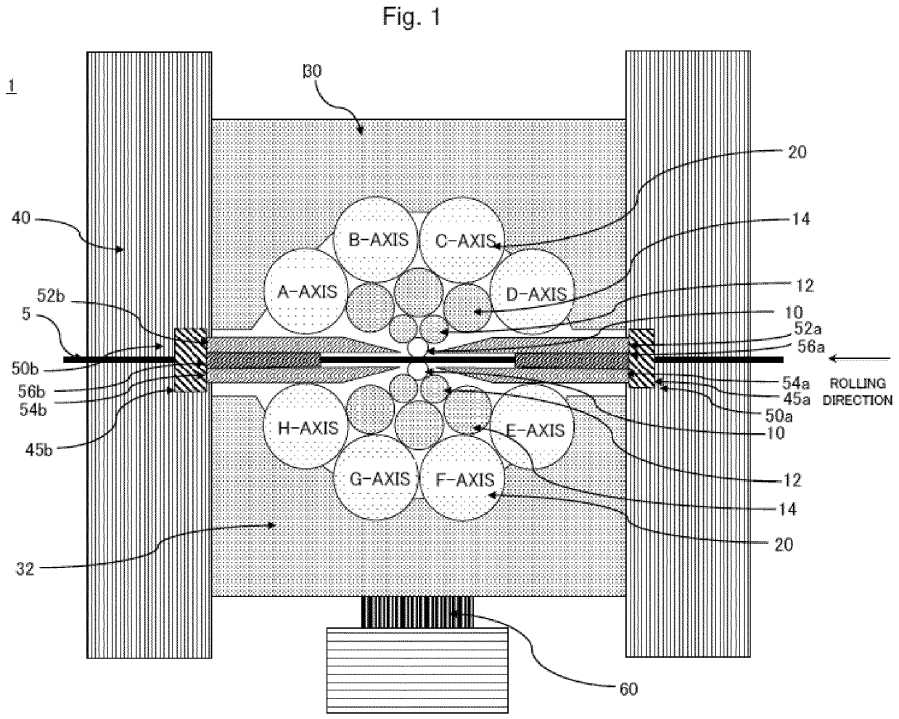
(72) Inventor: **YOSHIDA, Takashi**
**Hiroshima-shi, Hiroshima, 733-8553 (JP)**

(74) Representative: **Strehl Schübel-Hopf & Partner**
**Maximilianstrasse 54**
**80538 München (DE)**

# (54) MULTI-HIGH ROLLING MILL, MAINTENANCE AND INSPECTION METHOD FOR MULTI-HIGH ROLLING MILL, AND USING METHOD FOR MULTI-HIGH ROLLING MILL

(57) There are included: a top inner housing 30 and a bottom inner housing 32 that support a plurality of pairs of backing assemblies 20 thereon; an outer housing 40 that supports the top inner housing 30 and the bottom inner housing 32 thereon from an entry side and an exit side in a rolling direction of a metal strip 5; and an entry side coolant spray header 50a and an exit side coolant spray header 50b configured so as to inject coolant to a bitten portion of the metal strip 5 bitten by a pair of work rolls 10. The entry side coolant spray header 50a and the exit side coolant spray header 50b are configured so as to be movable in the rolling direction and/or an opposite direction to the rolling direction of the metal strip 5. Provided are a multi-high rolling mill, a maintenance and inspection method for a multi-high rolling mill, and a using method for a multi-high rolling mill capable of forming a space between top and bottom roll groups in a shorter time than ever.

Fig. 1

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## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

**[0001]** The present invention relates to a multi-high rolling mill, a maintenance and inspection method for a multi-high rolling mill, and a using method for a multi-high rolling mill.

#### 2. Description of the Related Art

**[0002]** JP-2015-520031-A includes a description relating to a set of stacked rolls having parallel longitudinal direction axes arranged in at least a single plane approximately in a direction perpendicular to a direction of movement of a strip. The longitudinal direction axis of one of the plurality of rolls is defined as an instantaneous axis of rotation, is parallel with a line formed by the roll, and passes through the center of mass of the roll.

### SUMMARY OF THE INVENTION

**[0003]** A cluster type rolling mill (which may hereinafter be described as a "multi-high rolling mill") may be used as a rolling mill for an electrical steel strip.

**[0004]** In such a cluster type rolling mill, coolant nozzles need to be brought into proximity to work rolls in order to appropriately control a strip thickness by injecting a coolant to a portion bitten by the work rolls.

**[0005]** Here, although the rolls need to be replaced and inspected periodically, the cluster type rolling mill has a narrow space between a top roll group and a bottom roll group, and thus it is difficult to make access and perform maintenance and inspection easily.

**[0006]** Accordingly, JP-2015-520031-A, for example, describes easy insertion and removal of a table, to which a spraying device that is used to lubricate and cool the strip and the rolls is fixed, into and out of a rolling mill stand by sliding the table in the longitudinal direction of a row of bearing rolls.

**[0007]** However, with the above-described conventional technology, the sliding direction of the table is the longitudinal direction of the rolls, and therefore a stroke at a time of the sliding is long. Thus, it takes time to form a space between the top and bottom roll groups by retracting the table.

**[0008]** The present invention provides a multi-high rolling mill, a maintenance and inspection method for a multi-high rolling mill, and a using method for a multi-high rolling mill that make it possible to form a space between a top roll group and a bottom roll group in a shorter time than conventional.

**[0009]** The present invention includes a plurality of means for solving the above-described problems. To cite an example of the means, there are provided: a pair of work rolls that roll a metal strip; a plurality of pairs of intermediate rolls that support the pair of work rolls; a plurality of pairs of backing assemblies that support the plurality of pairs of intermediate rolls; inner housings that support the plurality of pairs of backing assemblies; an outer housing that supports the inner housings from an entry side and an exit side in a rolling direction of the metal strip; and coolant spray headers configured to inject a coolant to a bitten portion of the metal strip bitten by the pair of work rolls, the coolant spray headers being configured to be movable in the rolling direction and/or an opposite direction to the rolling direction of the metal strip.

**[0010]** According to the present invention, a space between the top and bottom roll groups can be formed in a shorter time than conventional. Problems, configurations, and effects other than those described above will be made clear by the description of the following embodiment.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0011]**

FIG. 1 is a front view of the multi-high rolling mill according to the embodiment;

FIG. 2 is a front view illustrating a state in which coolant spray headers are retracted in a rolling direction and an opposite direction to the rolling direction in the multi-high rolling mill according to the embodiment;

FIG. 3 is a front view illustrating a state in which a top inner housing and a bottom inner housing are separated from each other, and a top work roll is removed in the multi-high rolling mill according to the embodiment;

FIG. 4 is a front view illustrating a state in which a bottom work roll and bottom first intermediate rolls are removed, and top first intermediate rolls are supported by a support base in the multi-high rolling mill according to the embodiment;

FIG. 5 is a front view illustrating a state in which the top first intermediate rolls are removed in the multi-high rolling mill according to the embodiment;

FIG. 6 is a front view illustrating a state in which bottom second intermediate rolls are removed in the multi-high rolling mill according to the embodiment;

FIG. 7 is a front view illustrating a state in which top second intermediate rolls and bottom backing assemblies are removed in the multi-high rolling mill according to the embodiment;

FIG. 8 is a front view illustrating another configuration of the multi-high rolling mill according to the embodiment; and

FIG. 9 is a front view illustrating a state in which the bottom inner housing is extracted to the outside of the rolling mill in another configuration of the multi-high rolling mill according to the embodiment.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0012]** An embodiment of a multi-high rolling mill, a maintenance and inspection method for a multi-high rolling mill, and a using method for a multi-high rolling mill according to the present invention will be described with reference to FIGS. 1 to 9.

**[0013]** FIG. 1 is a front view of the multi-high rolling mill according to the embodiment. FIG. 2 is a front view illustrating a state in which coolant spray headers are retracted in a rolling direction and an opposite direction to the rolling direction. FIG. 3 is a front view illustrating a state in which a top inner housing and a bottom inner housing are separated from each other, and a top work roll is removed. FIG. 4 is a front view illustrating a state in which a bottom work roll and bottom first intermediate rolls are removed, and top first intermediate rolls are supported by a support base. FIG. 5 is a front view illustrating a state in which the top first intermediate rolls are removed. FIG. 6 is a front view illustrating a state in which bottom second intermediate rolls are removed. FIG. 7 is a front view illustrating a state in which top second intermediate rolls and bottom backing assemblies are removed. FIG. 8 is a front view illustrating another configuration of the multi-high rolling mill. FIG. 9 is a front view illustrating a state in which the bottom inner housing is extracted to the outside of the rolling mill.

**[0014]** Incidentally, in the drawings used in the present specification, identical or corresponding constituent elements are identified by identical or similar reference numerals, and repeated description of these constituent elements may be omitted.

**[0015]** In the present embodiment, the following description will be made by illustrating an example of a multi-high rolling mill of a 20-high cluster type that includes inner housings and an outer housing and in which the divided top and bottom inner housings can be vertically opened and closed. However, the multi-high rolling mill is not limited to this structure, and the structure of the present embodiment can be applied to various multi-high rolling mills.

**[0016]** First, a general configuration of the multi-high rolling mill according to the present embodiment will be described with reference to FIG. 1.

**[0017]** The multi-high rolling mill 1 according to the present embodiment illustrated in FIG. 1 is a cluster type 20-high rolling mill for rolling a metal strip 5, and is, in particular, a rolling mill suitable for rolling a hard material such as a stainless steel strip, an electromagnetic steel strip, or a copper alloy.

**[0018]** In FIG. 1, the multi-high rolling mill 1 includes, as rolls, a pair of top and bottom work rolls 10, two pairs of top and bottom first intermediate rolls 12, three pairs of top and bottom second intermediate rolls 14, and four pairs of top and bottom top backing assemblies (an A-axis, a B-axis, a C-axis, and a D-axis) and bottom backing assemblies (an E-axis, an F-axis, a G-axis, and an H-axis) (hereinafter also described collectively as backing assemblies 20) including a divided backing bearing, a shaft, and a saddle (neither is omitted for the convenience of illustration).

**[0019]** The pair of work rolls 10 is rolls that come into direct contact with the metal strip 5. The pair of work rolls 10 rolls the metal strip 5.

**[0020]** The pair of top and bottom work rolls 10 is respectively in contact with and supported by the two pairs of top and bottom first intermediate rolls 12. In addition, these two pairs of top and bottom first intermediate rolls 12 are respectively in contact with and supported by the three pairs of top and bottom second intermediate rolls 14.

**[0021]** The three pairs of top and bottom second intermediate rolls 14 are respectively in contact with and supported by the backing assemblies 20 on an upward side in a vertical direction with respect to the metal strip 5 (the A-axis, the B-axis, the C-axis, and the D-axis) and the backing assemblies 20 on a downward side in the vertical direction with respect to the metal strip 5 (the E-axis, the F-axis, the G-axis, and the H-axis).

**[0022]** The multi-high rolling mill 1 also includes a top inner housing 30 that supports the top side backing assemblies 20 on the top side in the vertical direction of the metal strip 5 (the A-axis, the B-axis, the C-axis, and the D-axis) and a bottom inner housing 32 that supports the bottom side backing assemblies 20 on the bottom side in the vertical direction of the metal strip 5 (the E-axis, the F-axis, the G-axis, and the H-axis).

**[0023]** The top inner housing 30 and the bottom inner housing 32 are supported by an outer housing 40 from an entry side and an exit side in the rolling direction of the metal strip 5.

**[0024]** A push-up cylinder 60 is provided under the bottom inner housing 32 in the vertical direction so as to support the bottom inner housing 32. The push-up cylinder 60 is driven when a gap is to be created between the top and bottom rolls.

**[0025]** Also provided are, for roll cooling and rolling lubrication, an entry side coolant spray header 50a that injects a coolant to a bitten portion of the metal strip 5 bitten by the pair of top and bottom work rolls 10 from top and bottom on the entry side in the rolling direction of the metal strip 5 and an exit side coolant spray header 50b that injects the coolant to the bitten portion from the upward and downward directions on the exit side in the rolling direction of the metal strip 5.

**[0026]** In the entry side coolant spray header 50a, an entry side top coolant spray header 52a located on the upward side in the vertical direction of the metal strip 5 and an entry side bottom coolant spray header 54a located on the downward side in the vertical direction are connected and integrated with each other by an entry side connecting member 56a in an outer housing portion(s) on a drive side and/or a work side among outsides in the width direction of the metal strip 5.

**[0027]** The entry side coolant spray header 50a has a shape extending from the work roll 10 side to the outer

housing 40 side as viewed from the front side of the multi-high rolling mill 1. The entry side coolant spray header 50a is supported by a member disposed outward in an opposite direction to the rolling direction with respect to the top inner housing 30 and the bottom inner housing 32.

**[0028]** In particular, in the present embodiment, the entry side connecting member 56a of the entry side coolant spray header 50a is supported by the outer housing 40 as a member disposed outward in the opposite direction to the rolling direction with respect to the top inner housing 30 and the bottom inner housing 32. It is to be noted that without being limited to the configuration supported by the outer housing 40, a structure can be adopted in which the entry side coolant spray header penetrates the outer housing 40 without coming in contact with the outer housing 40, and is supported by a further outward mill guide.

**[0029]** Also in the exit side coolant spray header 50b, as in the entry side coolant spray header 50a, an exit side top coolant spray header 52b located on the upward side in the vertical direction of the metal strip 5 and an exit side bottom coolant spray header 54b located on the downward side in the vertical direction are connected and integrated with each other by an exit side connecting member 56b in an outer housing portion(s) on the drive side and/or the work side among the outsides in the width direction of the metal strip 5.

**[0030]** The exit side coolant spray header 50b has a shape extending from the work roll 10 side to the outer housing 40 side as viewed from the front side of the multi-high rolling mill 1. The exit side coolant spray header 50b is supported by a member disposed outward in the rolling direction with respect to the top inner housing 30 and the bottom inner housing 32.

**[0031]** In particular, in the present embodiment, the exit side connecting member 56b of the exit side coolant spray header 50b is supported by the outer housing 40 as a member disposed outward in the rolling direction with respect to the top inner housing 30 and the bottom inner housing 32. It is to be noted that without being limited to the configuration supported by the outer housing 40, a structure can be adopted in which the exit side coolant spray header penetrates the outer housing 40 without coming into contact with the outer housing 40, and is supported by a further outward mill guide.

**[0032]** In the present embodiment, the entry side coolant spray header 50a is further provided with a moving mechanism 45a that makes a top end on the work roll 10 side of the entry side coolant spray header 50a movable in the opposite direction to the rolling direction of the metal strip 5, more specifically movable in the opposite direction to the rolling direction to a position outward in the rolling direction with respect to the axes of backing assemblies 20 most distant from the work rolls 10 in the rolling direction (the D-axis and the E-axis, or the centers of the backing assemblies 20) as viewed from the front side of the multi-high rolling mill 1, as illustrated in FIG. 2, and the exit side coolant spray header 50b is further provided with a moving mechanism 45b that makes a top end on the work roll 10 side of the exit side coolant spray header 50b movable in the rolling direction of the metal strip 5, more specifically, movable in the rolling direction to a position outward in the rolling direction with respect to the axes of backing assemblies 20 most distant from the work rolls 10 in the rolling direction (the A-axis and the H-axis, or the centers of the backing assemblies 20) as viewed from the front side of the multi-high rolling mill 1, as illustrated in FIG. 2.

**[0033]** The configuration of these moving mechanisms 45a and 45b is not particularly limited, the moving mechanisms 45a and 45b making the top end on the work roll 10 side of the entry side coolant spray header 50a movable to a position outward on the entry side in the rolling direction with respect to the axes of the backing assemblies 20 most distant from the work rolls 10 in the rolling direction, and making the top end on the work roll 10 side of the exit side coolant spray header 50b movable to a position outward on the exit side in the rolling direction with respect to the axes of the backing assemblies 20 most distant from the work rolls 10 in the rolling direction. It is possible to adopt various configurations such as a hydraulic cylinder that extends in the rolling direction or in the opposite direction to the rolling direction, a ball screw that converts rotary motion into rectilinear motion, a rack, and a pinion. Thus, the configuration of the moving mechanisms 45a and 45b is not particularly limited.

**[0034]** At a time of maintenance and inspection of the multi-high rolling mill 1, for example, the moving mechanisms 45a and 45b move the entry side coolant spray header 50a in the opposite direction to the rolling direction of the metal strip 5, and move the exit side coolant spray header 50b in the rolling direction of the metal strip 5. Consequently, the top end of the entry side coolant spray header 50a is opened to the outside of the D-axis and the E-axis, and the top end of the exit side coolant spray header 50b is opened to the outside of the A-axis and the H-axis. Thus, as illustrated in FIG. 3, a space can be obtained within the multi-high rolling mill 1 by separating the top inner housing 30 and the bottom inner housing 32 from each other. Hence, various roll rearrangement tools can be proposed, and a rearrangement can be performed in a short time.

**[0035]** Therefore, it is easy to extract and remove the top work roll 10 in the width direction of the metal strip 5 as illustrated in FIG. 3, remove the bottom work roll 10 as illustrated in FIG. 4, further support the top first intermediate rolls 12 by a support base 70 and thereby stabilize the top first intermediate rolls 12 at a time of removing the bottom first intermediate rolls 12 as illustrated in FIG. 4, further remove the top first intermediate rolls 12 as illustrated in FIG. 5, remove the bottom second intermediate rolls 14 as illustrated in FIG. 6, remove the top second intermediate rolls 14 and the bottom backing assemblies 20 as illustrated in FIG. 7, and further extract and remove the top backing assemblies 20. Thus, replacement work can be performed easily as compared

with conventional replacement work.

**[0036]** In addition, conventionally, also in a rearrangement using an automatic rearrangement device, because the device may become larger in scale, rolls are generally extracted from within the multi-high rolling mill 1 one by one, and therefore replacement takes time. However, the configuration according to the present embodiment makes it possible to adopt various rearrangement methods such as a stable and simultaneous rearrangement of a plurality of rolls. In particular, it becomes possible to perform replacement of the second intermediate rolls 14 and the backing assemblies 20 stably and efficiently, which replacement is performed by an unstable porter bar operation.

**[0037]** Incidentally, when only the work rolls 10 are to be rearranged, the work rolls 10 can be extracted in the axial direction in a state in which the metal strip 5 remains passed between the top and bottom work rolls 10. On the other hand, suppose that in a case of rearranging the first intermediate rolls 12, the second intermediate rolls 14, and the backing assemblies 20, the metal strip 5 is extracted first, and then the retraction of the entry side coolant spray header 50a and the exit side coolant spray header 50b and the removal of the work rolls 10 are started.

**[0038]** In addition, timing at which the entry side coolant spray header 50a and the exit side coolant spray header 50b are moved in the rolling direction or in the opposite direction to the rolling direction is not limited to a time of maintenance and inspection.

**[0039]** For example, when a front end portion of the metal strip 5 is passed between the pair of work rolls 10 in rolling the metal strip 5, the entry side coolant spray header 50a and the exit side coolant spray header 50b can be brought into proximity to the pair of work rolls 10 as compared with a time of normal rolling by moving the entry side coolant spray header 50a and the exit side coolant spray header 50b in the rolling direction and/or the opposite direction to the rolling direction of the metal strip 5.

**[0040]** In addition, at a time of normal rolling of the metal strip 5, the entry side coolant spray header 50a and the exit side coolant spray header 50b can be more separated from the pair of work rolls 10 than at the time of passing the front end portion.

**[0041]** Another configuration of the multi-high rolling mill will next be described with reference to FIG. 8 and FIG. 9.

**[0042]** In a multi-high rolling mill 1A illustrated in FIG. 8 and FIG. 9, a bottom inner housing 32A includes, in a bottom portion thereof, bottom mono-block housing wheels 80 for moving the bottom inner housing 32A in the width direction of the metal strip 5. The bottom inner housing 32A can therefore be moved on an installation floor 85 in the width direction of the metal strip 5.

**[0043]** Thus, a bottom roll group (the bottom work roll 10, the bottom first intermediate rolls 12, the bottom second intermediate rolls 14, and the bottom backing assemblies 20 (the E-axis, the F-axis, the G-axis, and the H-axis)) can be extracted from the multi-high rolling mill 1A at the same time, and roll detachment and attachment by crane operation is made possible. This facilitates a rearrangement of rolls, particularly the backing assemblies 20, and makes it possible to shorten a rearrangement time to half or less as compared with the conventional rearrangement time.

**[0044]** Effects of the present embodiment will next be described.

**[0045]** The multi-high rolling mill 1 or 1A according to the present embodiment described above includes: the pair of work rolls 10 that roll the metal strip 5; a plurality of pairs of the first intermediate rolls 12 and the second intermediate rolls 14 that support the pair of work rolls 10; a plurality of pairs of the backing assemblies 20 that support the plurality of pairs of the first intermediate rolls 12 and the second intermediate rolls 14; the top inner housing 30 and the bottom inner housing 32 that support the plurality of pairs of the backing assemblies 20; the outer housing 40 that supports the top inner housing 30 and the bottom inner housing 32 from the entry side and the exit side in the rolling direction of the metal strip 5; and the entry side coolant spray header 50a and the exit side coolant spray header 50b configured to inject the coolant to a bitten portion of the metal strip 5 bitten by the pair of work rolls 10; the entry side coolant spray header 50a and the exit side coolant spray header 50b being configured to be movable in the rolling direction and/or the opposite direction to the rolling direction of the metal strip 5.

**[0046]** In the multi-high rolling mill, unless injection from top end portions of the coolant spray headers is performed aimed between the work rolls and the metal strip 5, strip thickness becomes instable, which represents a disturbance in control.

**[0047]** In addition, in a reversing rolling mill for rolling an electromagnetic steel strip as an example of the metal strip 5, an amount of injection of the coolant is controlled according to a pass and a strip speed. However, when nozzle top ends are not close to vicinities between the work rolls and the metal strip 5, a state occurs in which the top end portions of the coolant spray headers do not reach between the work rolls and the metal strip 5.

**[0048]** It is therefore essential to bring the nozzles close to the vicinities between the work rolls and the metal strip 5. However, this represents a spatial constraint on an operation of rearranging the second intermediate rolls and the like and the backing assemblies of the multi-high rolling mill. It is thus difficult to make a smooth rearrangement.

**[0049]** In contrast, in the present embodiment, the entry side coolant spray header 50a and the exit side coolant spray header 50b can be moved in the rolling direction and the opposite direction to the rolling direction. Thus, a space between the roll groups can be formed by merely moving the entry side coolant spray header 50a and the exit side coolant spray header 50b by a short distance.

It is consequently possible to shorten a time taken to form the space as compared with the conventional time. In addition, because the movement can be performed in the rolling direction and/or the opposite direction to the rolling direction of the metal strip 5, movement in the vertical direction is practically unnecessary, and also it is easy to move the nozzle top ends to the vicinities between the work rolls 10 and the metal strip 5. Consequently, a burden of adjustment for cooling can also be greatly reduced as compared with the conventional burden.

**[0050]** In addition, the entry side coolant spray header 50a and the exit side coolant spray header 50b have a shape extending from the work roll 10 side to the outer housing 40 side as viewed from the front side of the multi-high rolling mill 1, and are supported by a member disposed outward in the rolling direction with respect to the top inner housing 30 and the bottom inner housing 32. Thus, even when the shape of the headers is a shape long in the rolling direction, the headers can be easily moved in the rolling direction and the opposite direction to the rolling direction, and provision can be made more easily for a change in rolling conditions or the like.

**[0051]** Further, the entry side coolant spray header 50a and the exit side coolant spray header 50b are supported by the outer housing 40. Thus, the positions of the spray headers can be fixed with respect to a pass line. A device and an effort for adjusting the angles of the nozzles at header top ends are therefore rendered unnecessary. It is consequently possible to reduce work at a time of maintenance and inspection, and achieve a further improvement in work efficiency.

**[0052]** In a case of the multi-high rolling mill, in particular, conventionally, the coolant spray headers are respectively attached to the top inner housing and the bottom inner housing. Therefore, nozzle injection angles need to be adjusted according to a combination of the diameters of the respective rolls, that is, the work rolls 10, the first intermediate rolls 12, and the second intermediate rolls 14, and the provision of an angle adjusting device is essential. However, such a device is rendered unnecessary, so that various advantages such as space saving and a reduction in cost are obtained.

**[0053]** In addition, the entry side coolant spray header 50a and the exit side coolant spray header 50b have the entry side connecting member 56a and the exit side connecting member 56b in which the entry side top coolant spray header 52a and the exit side top coolant spray header 52b disposed on the top side of the metal strip 5 and the entry side bottom coolant spray header 54a and the exit side bottom coolant spray header 54b disposed on the bottom side of the metal strip 5 are connected to each other on the outside in the width direction of the metal strip 5, and the entry side connecting member 56a and the exit side connecting member 56b are supported by a member disposed outward in the rolling direction with respect to the top inner housing 30 and the bottom inner housing 32. Thus, the headers on the top side of the metal strip 5 and the headers on the bottom side of the metal strip 5 can be integrated with each other. The top and bottom headers can therefore be moved at a time, so that effects such as a simplification of the configuration of the moving mechanisms 45a and 45b and an improvement in movement efficiency are obtained.

**[0054]** Further, the entry side coolant spray header 50a and the exit side coolant spray header 50b are configured such that top ends on the work roll 10 side of the entry side coolant spray header 50a and the exit side coolant spray header 50b are movable to positions outward in the rolling direction with respect to the axes of the backing assemblies 20 most distant from the work rolls 10 in the rolling direction as viewed from the front side of the multi-high rolling mill 1. Thus, a sufficient space for maintenance and the like can be formed. Because the movement distance of the headers can be made shorter than that in a case of moving the headers in the longitudinal direction of the rolls, a time taken to form the space can be shortened.

**[0055]** In addition, further provided is a supporting carriage that moves in the width direction of the metal strip 5, and holds from below the top backing assemblies 20 arranged on the top side of the metal strip 5 among the plurality of pairs of the backing assemblies 20 in a state in which the entry side coolant spray header 50a and the exit side coolant spray header 50b are disposed at retracted positions to which the entry side coolant spray header 50a and the exit side coolant spray header 50b are moved in the rolling direction, and the bottom backing assemblies 20 arranged on the bottom side of the metal strip 5 among the pair of work rolls 10, the plurality of pairs of the first intermediate rolls 12 and the second intermediate rolls 14, and the plurality of pairs of the backing assemblies 20 are extracted to the outside of the bottom inner housing 32. Conventionally, each of the top first intermediate rolls 12 and the top second intermediate rolls 14 is suspended from above for a purpose of preventing a fall at a time of a roll rearrangement. However, the supporting carriage obviates a need for a top roll suspending device at the time of the roll rearrangement. In addition, the rolls can be extracted to the outside of the multi-high rolling mill 1 while a second intermediate roll 14 bearing box that is removed for the mounting of a porter bar device remains in a mounted state. Thus, bearing box attachment and detachment work in front of the multi-high rolling mill 1 does not need to be performed manually. In addition, in a case of an automatic replacement device, the necessity of the device itself is eliminated.

**[0056]** Further, the inner housings include the top inner housing 30 disposed on the top side of the metal strip 5 and the bottom inner housing 32A disposed on the bottom side of the metal strip 5, and the bottom inner housing 32A includes the bottom mono-block housing wheels 80 for moving the bottom inner housing 32A in the width direction of the metal strip 5 in a bottom portion of the bottom inner housing 32A. Thus, the roll group on the bottom side can be extracted from the rolling mill at the

same time, so that efficiency of replacement work for the roll group on the bottom side can be greatly improved.

**[0057]** In addition, according to a using method for the multi-high rolling mill 1 in the present invention, the using method including bringing the entry side coolant spray header 50a and the exit side coolant spray header 50b into proximity to the pair of work rolls 10 by moving the entry side coolant spray header 50a and the exit side coolant spray header 50b in the rolling direction and/or the opposite direction to the rolling direction of the metal strip 5 at a time of passing a front end portion of the metal strip 5 between the pair of work rolls 10, the coolant can be supplied effectively at a biting time at which a large load is applied to the work rolls 10 and the like. Thus, a reduction in the load can be achieved.

**[0058]** Further, at a time of normal rolling of the metal strip 5, the entry side coolant spray header 50a and the exit side coolant spray header 50b are more separated from the pair of work rolls 10 than at the time of passing the front end portion. It is thereby possible to inhibit top end portions of the entry side coolant spray header 50a and the exit side coolant spray header 50b from approaching the work rolls 10 more than necessary.

<Others>

**[0059]** It is to be noted that the present invention is not limited to the foregoing embodiments, but is susceptible of various modifications and applications. The foregoing embodiments have been described in detail in order to describe the present invention in an easily understandable manner, and are not necessarily limited to including all of the described configurations.

[Explanation of Reference Numerals]

**[0060]**

1,1a...multi-high rolling mill
5...metal strip
10...work roll
12...first intermediate roll
14...second intermediate roll
20...backing assemblies
30...top inner housing
32, 32a...bottom inner housing
40...outer housing (outer member in the rolling direction)
45a, 45b...movement mechanisms
50a...entry side coolant spray header
50b...exit side coolant spray header
52a...entry side top coolant spray header (top coolant spray header)
52b...exit side top coolant spray header (top coolant spray header)
54a...entry side bottom coolant spray header (bottom coolant spray header)
54b...exit side bottom coolant spray header (bottom coolant spray header)
56a...entry side connecting member (connecting portion)
56b...exit side connecting member (connecting portion)
60...push-up cylinder
70...support base
80...bottom mono-block housing wheel (extracting and inserting unit) 85...installation floor

## Claims

1. A multi-high rolling mill (1, 1A) comprising:

   a pair of work rolls (10) that roll a metal strip (5);
   a plurality of pairs of intermediate rolls (12, 14) that support the pair of work rolls (10);
   a plurality of pairs of backing assemblies (20) that support the plurality of pairs of intermediate rolls (12, 14);
   inner housings (30, 32, 32A) that support the plurality of pairs of backing assemblies (20);
   an outer housing (40) that supports the inner housings (30, 32, 32A) from an entry side and an exit side in a rolling direction of the metal strip (5); and
   coolant spray headers (50a, 50b) configured to inject a coolant to a bitten portion of the metal strip (5) bitten by the pair of work rolls (10), **characterized in that**
   the coolant spray headers (50a, 50b) being configured to be movable in the rolling direction and/or an opposite direction to the rolling direction of the metal strip (5).

2. The multi-high rolling mill according to claim 1, wherein the coolant spray headers (50a, 50b) have a shape extending from a side of the work roll (10) to a side of the outer housing (40) as viewed from a front side of the multi-high rolling mill (1, 1A), and are supported by a member (40) disposed outward in the rolling direction with respect to the inner housings (30, 32).

3. The multi-high rolling mill according to claim 2, wherein the coolant spray headers (50a, 50b) are supported by the outer housing (40).

4. The multi-high rolling mill according to claim 2, wherein

   the coolant spray headers (50a, 50b) have a connecting portion (56a, 56b) in which a top coolant spray header (52a, 52b) disposed on a top side of the metal strip (5) and a bottom coolant spray header (54a, 54b) disposed on a bottom side of the metal strip (5) are connected to

each other on an outside in a width direction of the metal strip (5), and
the connecting portion (56a, 56b) is supported by a member (40) disposed outward in the rolling direction with respect to the inner housings (30, 32).

**5.** The multi-high rolling mill according to any one of claims 1 to 4, wherein
the coolant spray headers (50a, 50b) are configured such that top ends, on a side of the work roll (10), of the coolant spray headers (50a, 50b) are movable to positions outward in the rolling direction with respect to axes of backing assemblies (20) most distant from the work rolls (10) in the rolling direction as viewed from a front side of the multi-high rolling mill (1, 1A).

**6.** The multi-high rolling mill according to any one of claims 1 to 4, further comprising:
a carriage that moves in a width direction of the metal strip (5), and holds from below top backing assemblies (20) arranged on a top side of the metal strip (5) among the plurality of pairs of backing assemblies (20) in a state in which the coolant spray headers (50a, 50b) are disposed at retracted positions to which the coolant spray headers (50a, 50b) are moved in the rolling direction, and bottom backing assemblies (20) arranged on a bottom side of the metal strip (5) among the pair of work rolls (10), the plurality of pairs of intermediate rolls (12, 14), and the plurality of pairs of backing assemblies (20) are extracted to an outside of the inner housings (30, 32) .

**7.** The multi-high rolling mill according to any one of claims 1 to 4, wherein

the inner housings (30, 32A) include a top inner housing (30) disposed on a top side of the metal strip (5) and a bottom inner housing (32A) disposed on a bottom side of the metal strip (5), and the bottom inner housing (32A) includes an extracting and inserting unit (80) for moving the bottom inner housing (32A) in a width direction of the metal strip (5) in a bottom portion of the bottom inner housing (32A).

**8.** A maintenance and inspection method for a multi-high rolling mill (1, 1A) including

a pair of work rolls (10) that roll a metal strip (5),
a plurality of pairs of intermediate rolls (12, 14) that support the pair of work rolls (10),
a plurality of pairs of backing assemblies (20) that support the plurality of pairs of intermediate rolls (12, 14),
inner housings (30, 32, 32A) that support the plurality of pairs of backing assemblies (20),
an outer housing (40) that supports the inner housings (30, 32, 32A) from an entry side and an exit side in a rolling direction of the metal strip (5), and
coolant spray headers (50a, 50b) configured to inject a coolant to a bitten portion of the metal strip (5) bitten by the pair of work rolls (10), **characterized in that** the maintenance and inspection method comprising:

extracting the pair of work rolls (10) in a width direction of the metal strip (5);
extracting the plurality of pairs of intermediate rolls (12, 14) supporting the pair of work rolls (10) in the width direction of the metal strip (5); and
moving the coolant spray headers (50a, 50b) in the rolling direction and/or an opposite direction to the rolling direction of the metal strip (5).

**9.** The maintenance and inspection method for the multi-high rolling mill according to claim 8, further comprising:

disposing the coolant spray headers (50a, 50b) at retracted positions to which the coolant spray headers (50a, 50b) are moved in the rolling direction and/or the opposite direction to the rolling direction, and extracting bottom backing assemblies (20) arranged on a bottom side of the metal strip (5) among the pair of work rolls (10), the plurality of pairs of intermediate rolls (12, 14), and the plurality of pairs of backing assemblies (20) to an outside of the inner housings (30, 32, 32A); and
holding from below top backing assemblies (20) arranged on a top side of the metal strip (5) among the plurality of pairs of backing assemblies (20) by moving, in the width direction of the metal strip (5), a carriage that holds the top backing assemblies (20) from below.

**10.** The maintenance and inspection method for the multi-high rolling mill according to claim 8, further comprising:

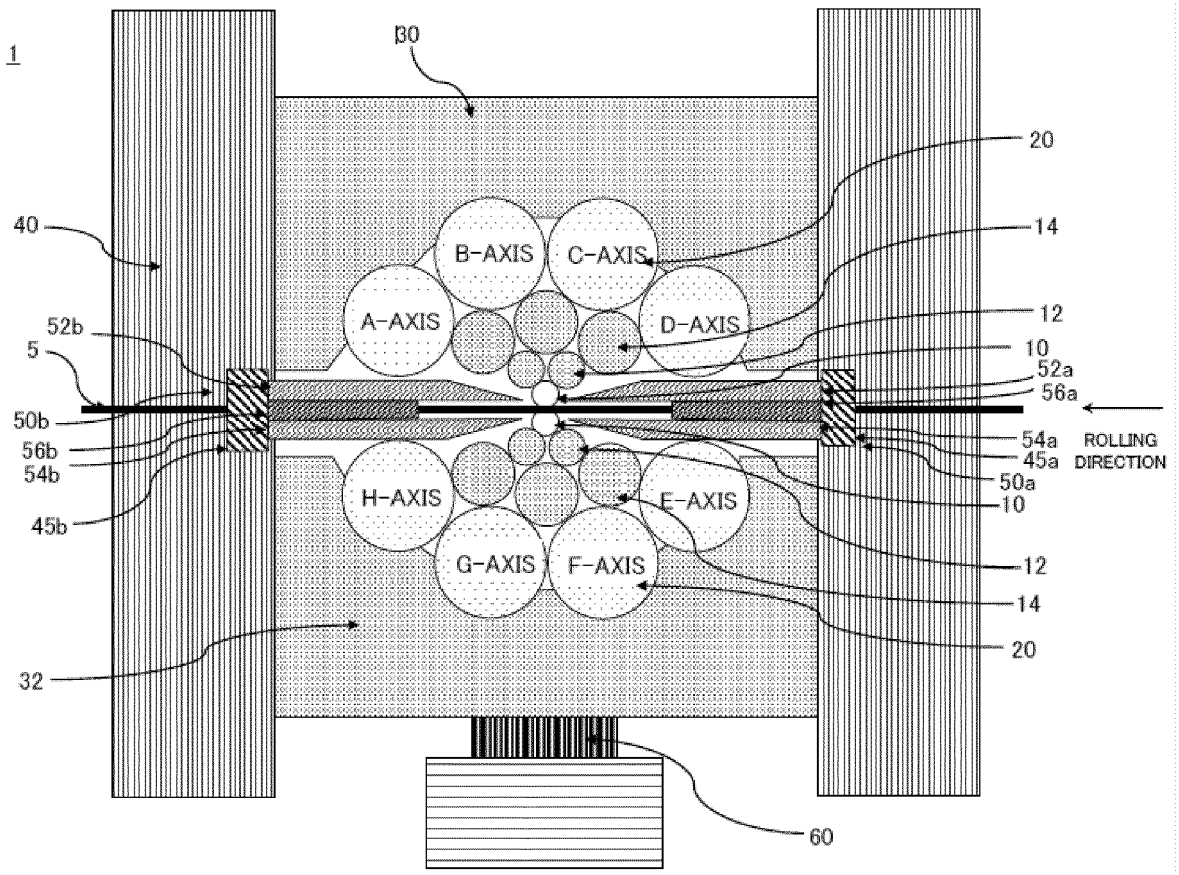
in a case where the inner housings (30, 32A) include a top inner housing (30) disposed on a top side of the metal strip (5) and a bottom inner housing (32A) disposed on a bottom side of the metal strip (5),
moving the bottom inner housing (32A) in the width direction of the metal strip (5).

**11.** A using method for a multi-high rolling mill (1, 1A) including

a pair of work rolls (10) that roll a metal strip (5),
a plurality of pairs of intermediate rolls (12, 14) that support the pair of work rolls (10),
a plurality of pairs of backing assemblies (20) that support the plurality of pairs of intermediate rolls (12, 14),
inner housings (30, 32, 32A) that support the plurality of pairs of backing assemblies (20),
an outer housing (40) that supports the inner housings (30, 32, 32A) from an entry side and an exit side in a rolling direction of the metal strip (5), and
coolant spray headers (50a, 50b) configured to inject a coolant to a bitten portion of the metal strip (5) bitten by the pair of work rolls (10), **characterized in that** the using method comprising:
bringing the coolant spray headers (50a, 50b) into proximity to the pair of work rolls (10) by moving the coolant spray headers (50a, 50b) in the rolling direction and/or an opposite direction to the rolling direction of the metal strip (5) at a time of passing a front end portion of the metal strip (5) between the pair of work rolls (10).

**12.** The using method for the multi-high rolling mill according to claim 11, wherein
at a time of normal rolling of the metal strip (5), the coolant spray headers (50a, 50b) are more separated from the pair of work rolls (10) than at the time of passing the front end portion of the metal strip (5) between the pair of work rolls (10).

Fig. 1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40
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C-AXIS
A-AXIS
D-AXIS
12
52b
5
10
52a
56a
50b
56b
54b
45b
54a
45a
ROLLING DIRECTION
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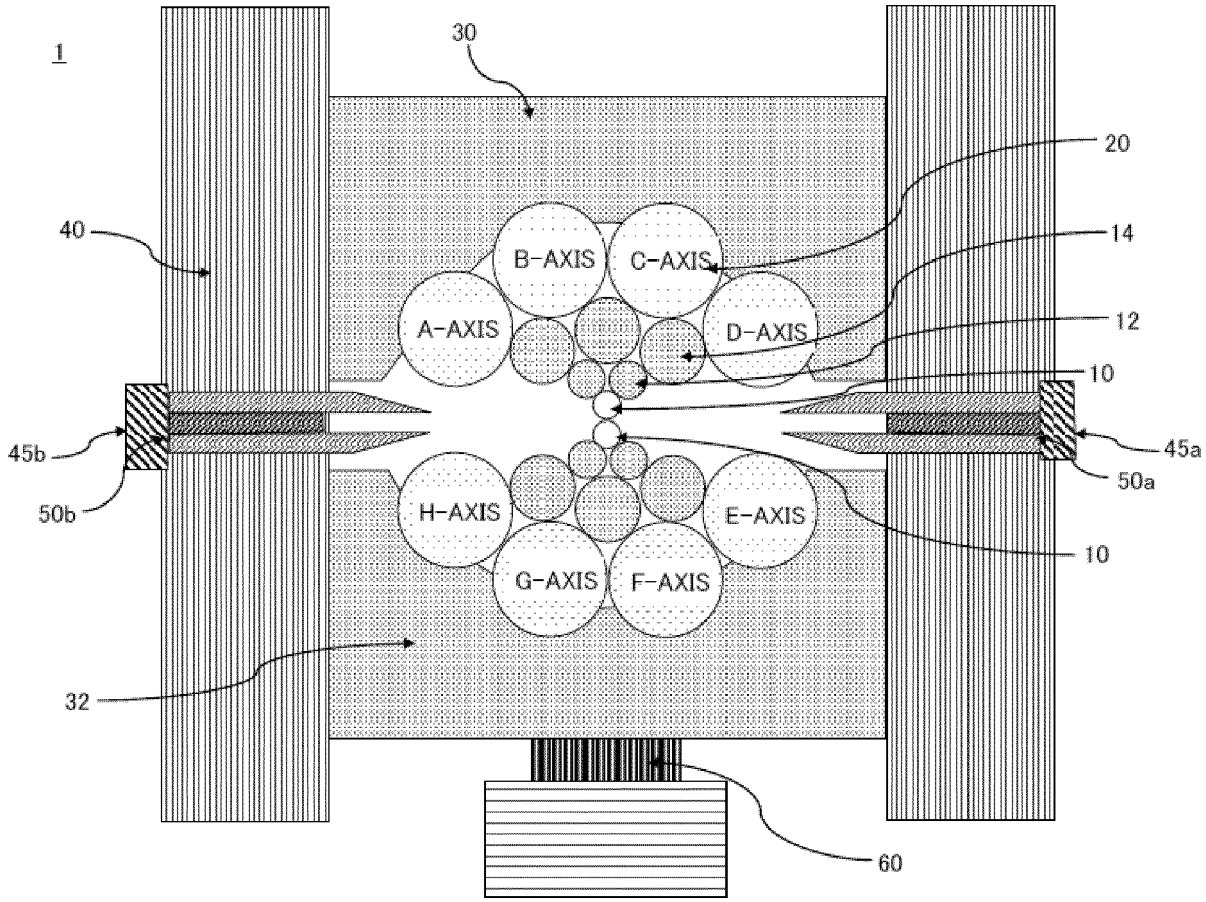
E-AXIS
G-AXIS
F-AXIS
12
14
20
32
60

Fig. 2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G-AXIS
F-AXIS
32
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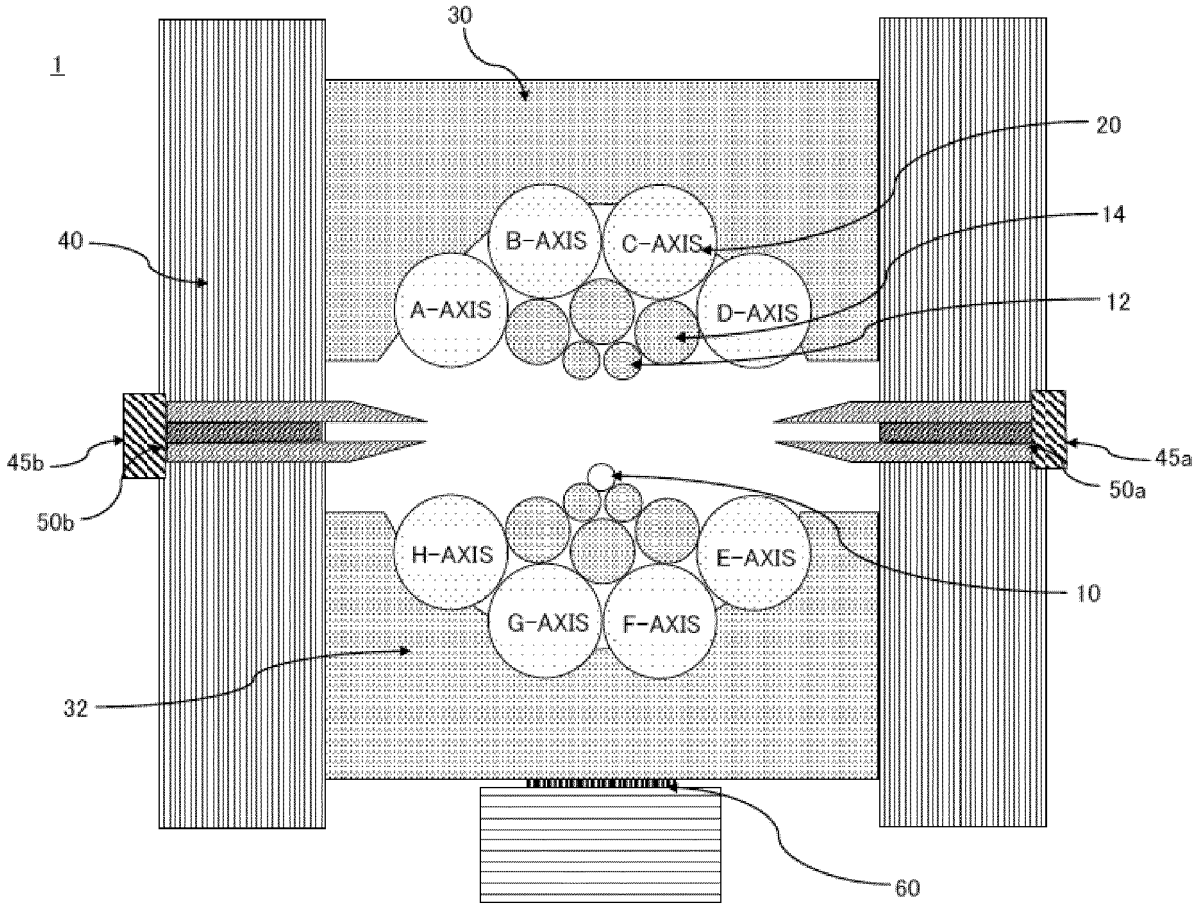
Fig. 3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F-AXIS
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Fig. 4

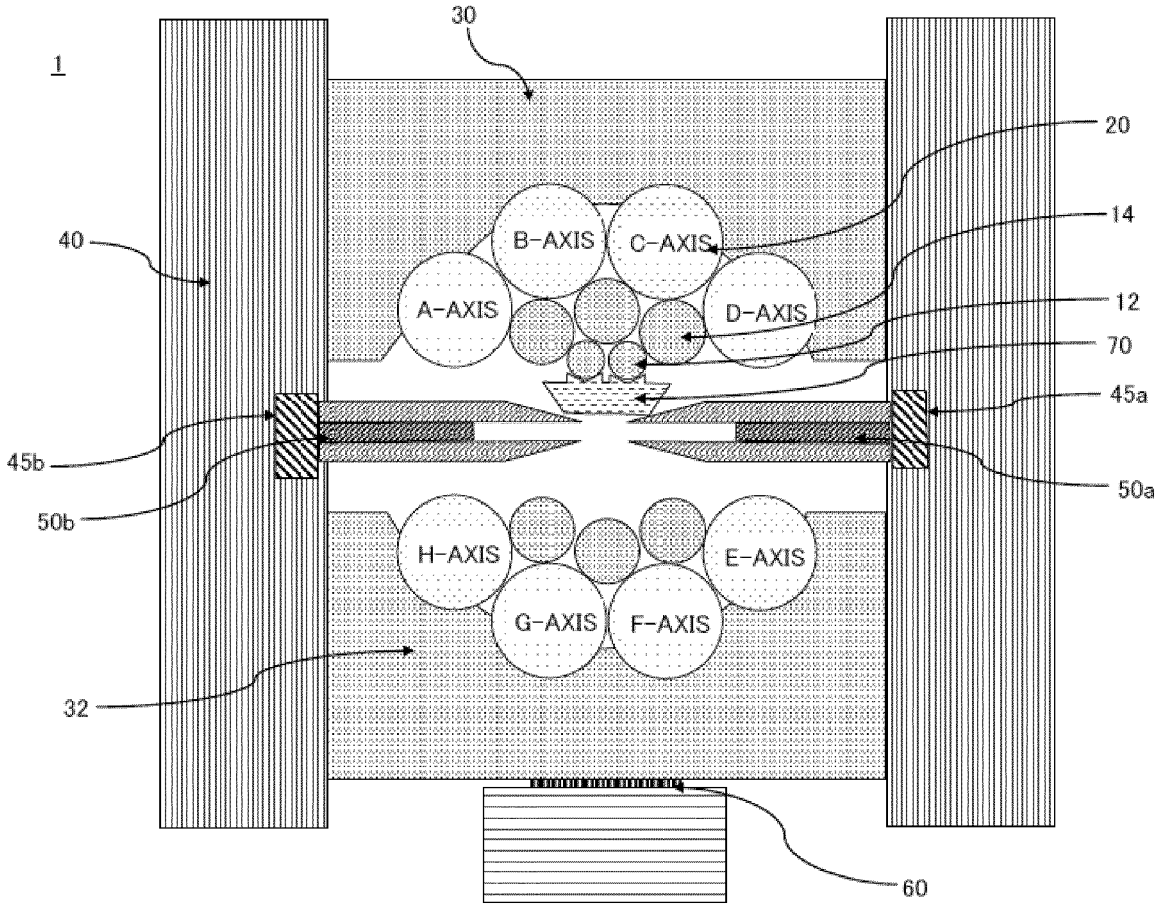
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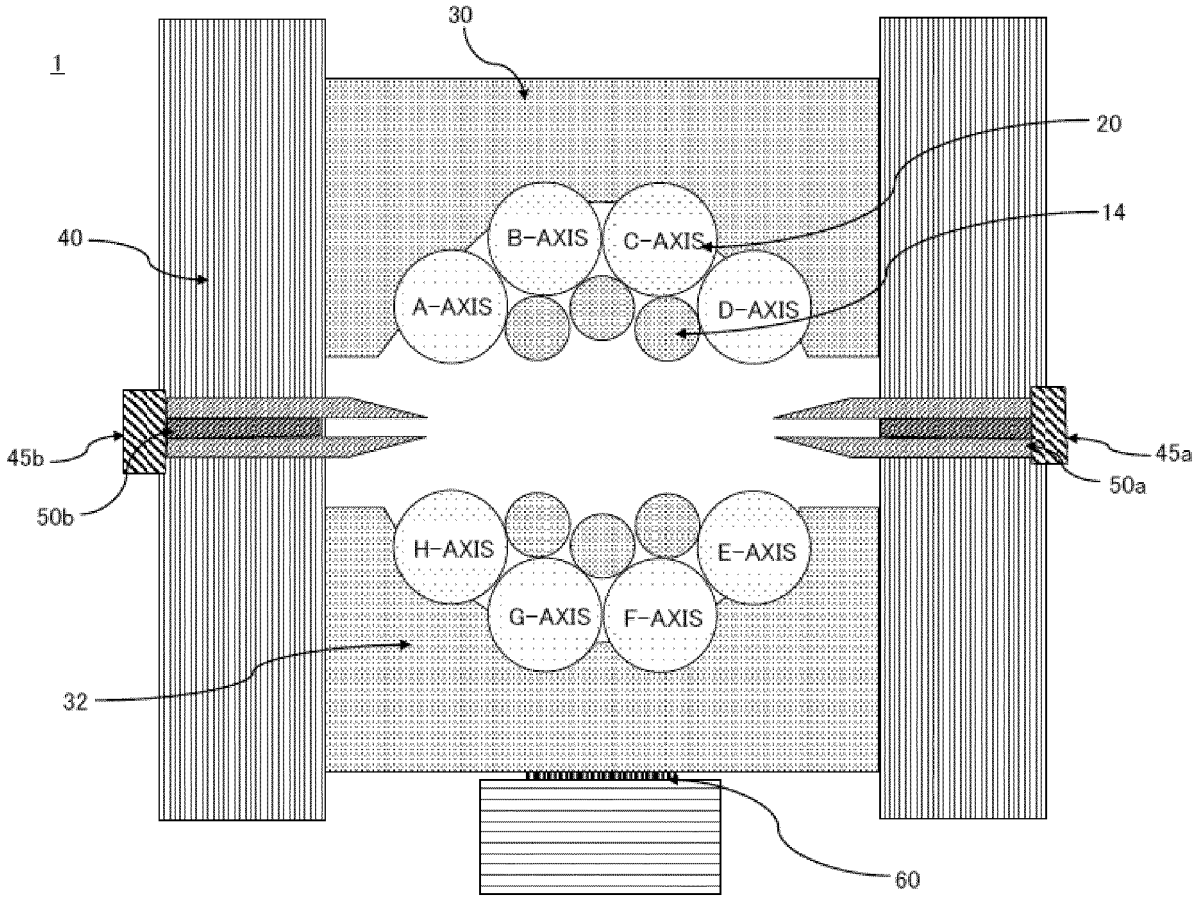
Fig. 5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G-AXIS
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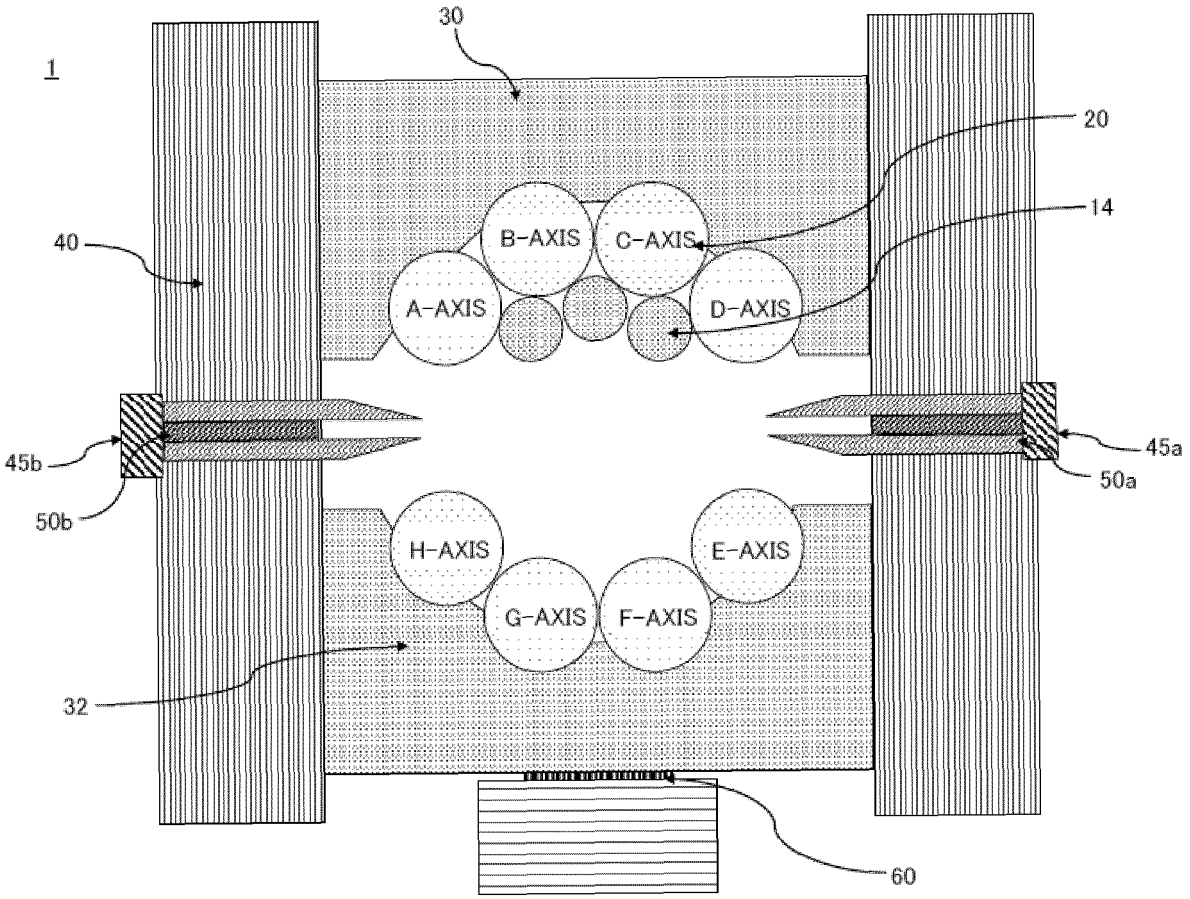
Fig. 6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G-AXIS
F-AXIS
32
60

Fig. 7

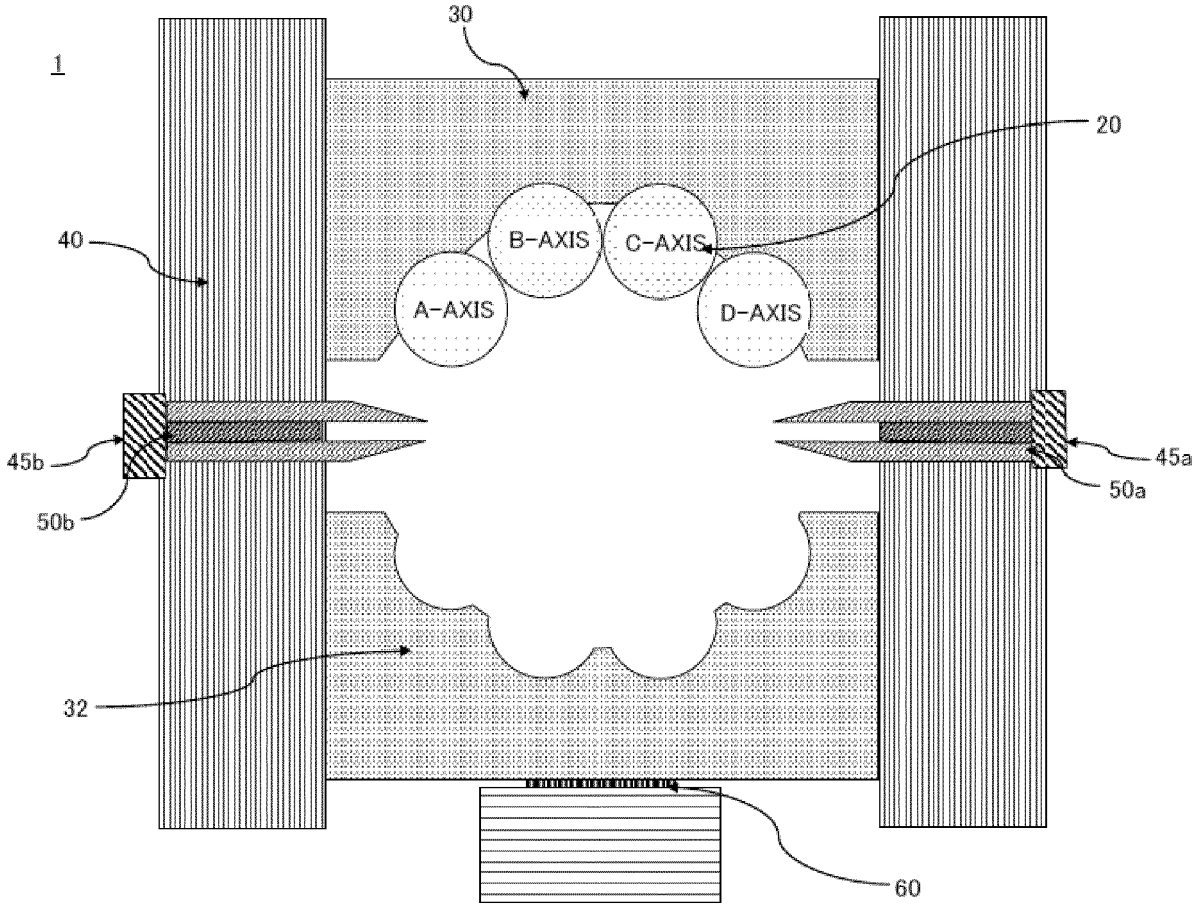
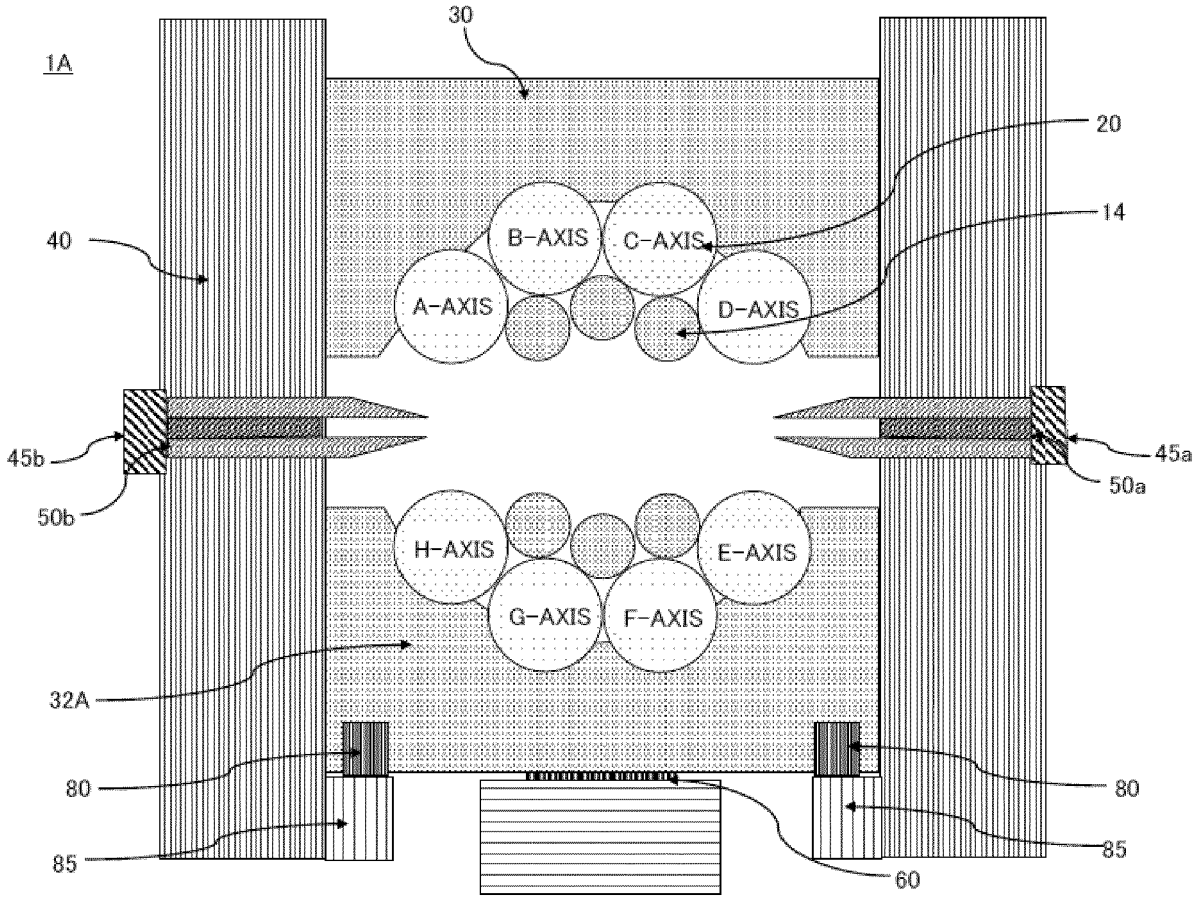


Fig. 8


1A
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D-AXIS
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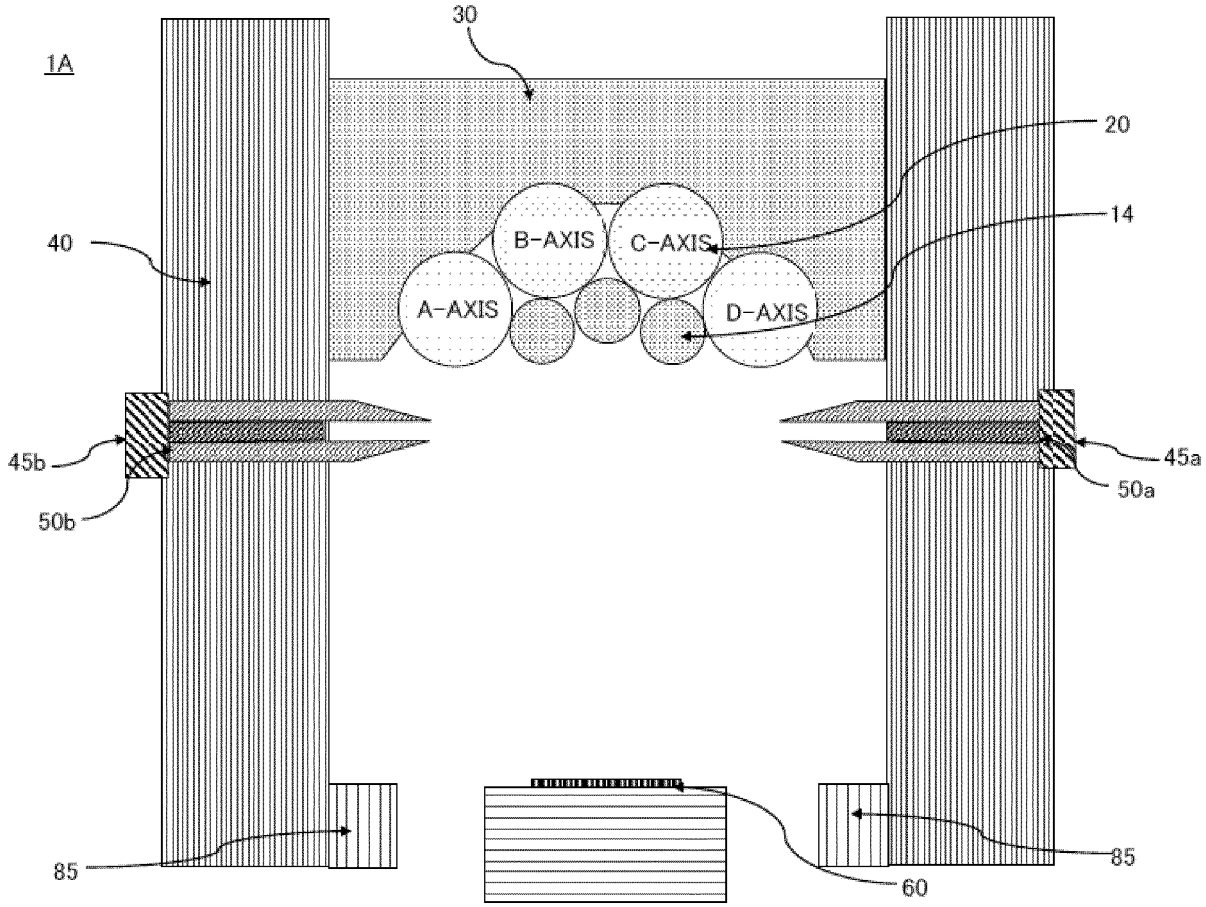
G-AXIS
F-AXIS
32A
80
80
85
85
60

Fig. 9



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# EUROPEAN SEARCH REPORT

Application Number
EP 24 15 2471

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| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 13 June 2024 | Frisch, Ulrich |

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EPO FORM 1503 03.82 (P04C01)

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13-06-2024

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