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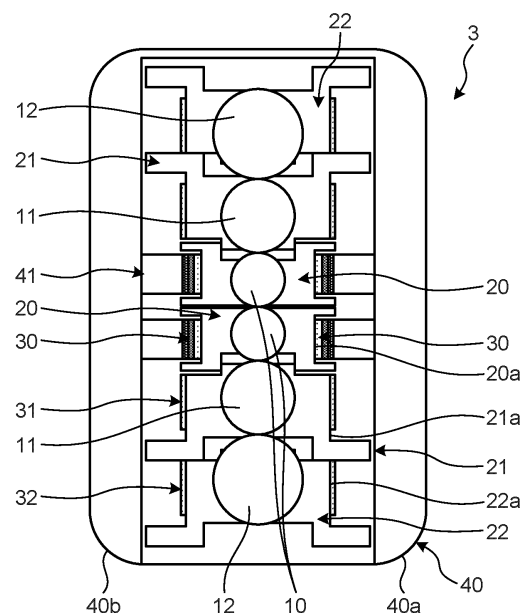
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(54) **ROLLING MILL, COLD ROLLING METHOD, AND METHOD FOR PRODUCING STEEL SHEET**

(57) A tandem cold rolling mill 1 (rolling mill) includes a plurality of stands 3 to 6 configured to roll a steel sheet 2 (material to be rolled), and at least one stand 3, among the stands 3 to 6, includes: at least one pair of work rolls 10 (rolling rolls); a work roll chock 20 (roll chock) that rotatably support the work rolls 10; and a work roll chock liner 30 (roll chock liner) that includes a first liner plate 36 mounted on the work roll chock 20, a second liner plate 38 stacked on the first liner plate 36 in the rolling direction X, and an elastic member 37 interposed between the first liner plate 36 and the second liner plate 38.

FIG.2



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Description

Field

[0001] The present invention relates to a rolling mill, a cold rolling method, and a steel sheet manufacturing method.

Background

[0002] In production lines such as those for cold-rolled steel sheets, sometimes vibrations occur during a cold-rolling process, due to various factors. Such vibrations could cause a cyclic change in the thickness of a steel sheet that is a material to be rolled, and therefore, when such vibrations occur, it is important to suppress vibrations so as to prevent the vibrations from affecting the material to be rolled.

[0003] As an example, Patent Literature 1 discloses a cold-rolling facility and a cold rolling method capable of suppressing chattering (vibrations) in the horizontal direction, with the use of rolling oil supplied to a stand in the rolling mill.

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Patent No. 7020530

Summary

Technical Problem

[0005] For this type of rolling mill, there has been some disclosures pertinent to, as a method for suppressing vibrations during a rolling process, a method for mounting an elastic member such as a vibration-insulating rubber on the roll chock liner included in a stand, in addition to the conventional method of suppressing vibration using roll oil, as described above.

[0006] However, in a structure in which such an elastic member is stacked and mounted on the roll chock liner in the rolling direction, an exposed surface of the elastic member, facing the opposite side of the roll chock, wears out, and thus it could be difficult to put such an elastic member into industrial use.

[0007] The present invention is made in consideration of the challenges described above, and an object of the present invention is to provide a rolling mill, a cold rolling method, and a steel sheet manufacturing method capable of suppressing vibration during a rolling process while suppressing wearing of a roll chock liner.

Solution to Problem

[0008] To solve the problem and achieve the object, a

rolling mill according to the present invention includes a plurality of stands configured to roll a material to be rolled, wherein at least one stand, among the stands, includes: at least one pair of rolling mill rolls; a roll chock that rotatably support the rolling mill rolls; and a roll chock liner that includes a first liner plate mounted on the roll chock, a second liner plate stacked on the first liner plate in a rolling direction, and an elastic member interposed between the first liner plate and the second liner plate.

[0009] Moreover, each stands may be provided with the roll chock liner including the first liner plate, the second liner plate, and the elastic member.

[0010] Moreover, the first liner plate may be fastened to the roll chock with a fastener passed through the first liner plate in the rolling direction, and each of the second liner plate and the elastic member may have an opening in which a head of the fastener is housed.

[0011] Moreover, a cold rolling method according to the present invention includes a step of cold-rolling a material to be rolled using the rolling mill according to the present invention.

[0012] Moreover, a steel sheet manufacturing method according to the present invention includes a step of manufacturing a steel sheet as a material to be rolled, using the cold rolling method according to the present invention.

Advantageous Effects of Invention

[0013] According to the present invention, by interposing an elastic member between a first liner plate and a second liner plate that are stacked in the rolling direction, it is possible to suppress the elastic member from becoming exposed and wearing out on a side facing the opposite side of the roll chock. With such a configuration, it is possible to provide a rolling mill, a cold rolling method, and a steel sheet manufacturing method capable of suppressing vibration during a rolling process while suppressing wearing of the roll chock liner.

Brief Description of Drawings

[0014] FIG. 1 is an exemplary and schematic diagram of a rolling mill according to an embodiment. FIG. 2 is an exemplary and schematic sectional view of a stand included in the rolling mill according to the embodiment. FIG. 3 is an enlarged view of the roll chock liner illustrated in FIG. 2.

Description of Embodiments

[0015] An exemplary embodiment of the present invention is disclosed below. Configurations according to the embodiment and actions and advantageous effects achieved thereby are described below only for illustrative purposes. The present invention may also be implemented in configurations other than those described below in the embodiment. Furthermore, according to the present

invention, at least one of various advantageous effects (including secondary effects) achieved by the configurations can be achieved.

[0016] In the description herein, ordinal numbers given to parts, members, portions, positions, directions, and the like are only for the purpose of distinguishing such parts, members, portions, positions, directions, and the like from one another, and are not intended to indicate any order or priorities.

[Embodiment]

[0017] FIG. 1 is an exemplary and schematic diagram of a configuration of a tandem cold rolling mill 1 according to an embodiment. The tandem cold rolling mill 1 is one example of a rolling mill. In the description hereunder, a steel sheet 2 is used as an example of a material to be rolled that is rolled by the tandem cold rolling mill 1; however, the material to be rolled is not limited thereto, and the tandem cold rolling mill 1 may also be applied to an aluminum sheet, or a sheet made from any other metal, for example. The steel sheet 2, such as a magnetic steel sheet, a stainless steel sheet, and a high-carbon steel sheet, is of a steel type that is generally highly likely to vibrate.

[0018] As illustrated in FIG. 1, the tandem cold rolling mill 1 includes a plurality of stands 3 to 6 cold-rolling a steel sheet 2, for example. The plurality of stands 3 to 6 are arranged along a rolling direction X (conveying direction) of the steel sheet 2. The number of the stands 3 to 6 is not limited to four, and may also be one, two, three, or five or more.

[0019] Each of the stands 3 to 6 includes a pair of work rolls 10, a pair of intermediate rolls 11, and a pair of backup rolls 12. The work rolls 10, the intermediate rolls 11, and the backup rolls 12 are arranged along an up-down direction intersecting the rolling direction X. Each of the stands 3 to 6 is what is called a 6-high mill stand having the intermediate roll 11 between the work roll 10 and the backup roll 12.

[0020] In the tandem cold rolling mill 1, elements such as a tension roll, a deflector roll, a thickness meter, and a shape meter, not illustrated, are installed between adjacent two of the stands 3 to 6. The configuration of the tandem cold rolling mill 1 and the conveyor configured to convey the steel sheet 2 are not limited to any particular configuration or conveyor, and any known technologies may be used as appropriate.

[0021] FIG. 2 is an exemplary and schematic diagram of the stand 3 included in the tandem cold rolling mill 1 according to the embodiment. As illustrated in FIG. 2, the stand 3 also includes, for example, work roll chocks 20, work roll chock liners 30, intermediate roll chocks 21, intermediate roll chock liners 31, backup roll chocks 22, backup roll chock liners 32, and a mill housing 40.

[0022] The work roll chocks 20 are provided to both ends of the pair of work rolls 10 in the axial direction (the direction perpendicular to the paper surface of FIG. 2).

Each pair of the work roll chocks 20 rotatably supports the corresponding work roll 10, about the axis extending in the direction perpendicular to the paper surface of FIG. 2. Recesses 20a each recessed toward the center in the rolling direction X (toward the work roll 10) are provided to both ends of each of the work roll chocks 20 in the rolling direction X. In each of the recesses 20a, a work roll chock liner 30, to be described later, is disposed. In this embodiment, the work roll 10 is one example of the rolling mill roll; the work roll chock 20 is one example of a roll chock; and the work roll chock liner 30 is one example of the roll chock liner.

[0023] The intermediate roll chocks 21 are provided to both ends of the pair of intermediate rolls 11 in the axial direction (the direction perpendicular to the paper surface of FIG. 2). Each pair of the intermediate roll chocks 21 rotatably supports the corresponding intermediate roll 11 about the axis. Recesses 21a each recessed toward the center in the rolling direction X (toward the intermediate roll 11) are provided to both ends of each of the intermediate roll chocks 21 in the rolling direction X. In each of the recesses 21a, the intermediate roll chock liner 31 is disposed.

[0024] The backup roll chocks 22 are provided to both ends of the pair of backup rolls 12 in the axial direction (the direction perpendicular to the paper surface of FIG. 2). Each pair of the backup roll chocks 22 rotatably supports the corresponding backup roll 12 about the axis. Recesses 22a each recessed toward the center in the rolling direction X (toward the backup roll 12) are provided to both ends of each of the backup roll chocks 22 in the rolling direction X. In each of the recesses 22a, the backup roll chock liner 32 is disposed.

[0025] The mill housing 40 has a pair of side walls 40a, 40b that are disposed on both sides of the work roll chocks 20, the intermediate roll chocks 21, and the backup roll chocks 22, in the rolling direction X. A very small clearance is ensured between the pair of side walls 40a, 40b and each of the work roll chocks 20, the intermediate roll chocks 21, and the backup roll chocks 22 so as to make it easy to replace the roll chocks 20, 21, 22.

[0026] The mill housing 40 also has a plurality of project blocks 41 projecting from the pair of side wall 40a, 40b toward the center in the rolling direction X (toward the work rolls 10, respectively). Each of the project blocks 41 has a project block liner or the like that comes into abutment against the work roll chock liner 30, absorbing the looseness (clearance) between the mill housing 40 and the work roll chock 20.

[0027] The project blocks 41 may also be positioned between the mill housing 40 and the intermediate roll chock 21, and between the mill housing 40 and the backup roll chock 22, respectively, for example.

[0028] FIG. 3 is an enlarged view of the work roll chock liner 30 illustrated in FIG. 2. As illustrated in FIG. 3, the work roll chock liner 30 includes a first liner plate 36, a second liner plate 38, and an elastic member 37, for example. The elastic member 37 and the second liner

plate 38 are stacked on the first liner plate 36 in the rolling direction X.

[0029] The first liner plate 36 has a rectangular plate-like shape extending along the bottom of the recess 20a on the work roll chock 20. The first liner plate 36 has openings 36a through which shafts 50b of fasteners 50 are passed, respectively, in the rolling direction X. The fasteners 50 are fixing members such as bolts or screws, and the work roll chock liner 30 and the work roll chock 20 are fixed therewith. The first liner plate 36 and the second liner plate 38 are made of a metal material, for example.

[0030] In this embodiment, the thickness W1 of the first liner plate 36 is set greater than the thickness W2 of the second liner plate 38 and the thickness of the elastic member 37. Specifically, the thickness W1 of the first liner plate 36 is set to approximately a half the thickness of the entire work roll chock liner 30, to ensure stiffness and strength for fastening the fasteners 50. In this embodiment, the thickness of the elastic member 37 is set to substantially the same as the thickness W2 of the second liner plate 38.

[0031] The second liner plate 38 is positioned on the opposite side of the work roll chock 20 with respect to the first liner plate 36, in the rolling direction X. The second liner plate 38 has a rectangular plate-like shape extending along the first liner plate 36. The second liner plate 38 has openings 38a in which the heads 50a of the respective fasteners 50 are housed. Each of the openings 38a is a circular hole (relief cut) having a size slightly larger than the head 50a of the fastener 50, as an example.

[0032] The elastic member 37 is a vibration-insulating rubber, for example, and is positioned between the first liner plate 36 and the second liner plate 38 in the rolling direction X. The elastic member 37 has a rectangular plate-like shape extending along the first liner plate 36, and is fixed to the first liner plate 36 and the second liner plate 38 by bonding, for example. The elastic member 37 can absorb the vibrations in the rolling direction X by elastically deforming between the first liner plate 36 and the second liner plate 38.

[0033] The elastic member 37 has openings 37a in which the heads 50a of the respective fasteners 50 are housed. Each of the openings 37a is a circular hole (relief cut) having a size slightly larger than the head 50a of the fastener 50, as an example, and is in alignment with the corresponding opening 38a of the second liner plate 38 in the rolling direction X. In this embodiment, by fastening the fastener 50 only to the first liner plate 36, instead of the entire work roll chock liner 30, loosening of the fastened fastener 50 is suppressed by the elasticity of the elastic member 37.

[0034] In this embodiment, the total thickness of the elastic member 37 and the second liner plate 38 is set greater than thickness of the head 50a of the fasteners 50. In other words, the thickness of the elastic member 37 and the thickness of the second liner plate 38 are set such that the heads 50a of the fasteners 50 do not stick out from the respective openings 37a, 38a in the rolling

direction X.

[0035] Furthermore, described in the embodiment is an example in which the first liner plate 36, the second liner plate 38, and the elastic member 37 are provided to the work roll chock liner 30, but without limitation thereto, and the first liner plate 36, the second liner plate 38, and the elastic member 37 may also be provided to the intermediate roll chock liner 31 or the backup roll chock liner 32 illustrated in FIG. 2. In other words, the first liner plate 36, the second liner plate 38, and the elastic member 37 may be provided to at least one of the work roll chock liner 30, the intermediate roll chock liner 31, and the backup roll chock liner 32.

[0036] Furthermore, in this embodiment, the first liner plate 36, the second liner plate 38, and the elastic member 37 are provided to the work roll chock liner 30, for example, in each of the stands 4 to 6 other than the stand 3. Each of the other stands 4 to 6 has substantially the same configuration as that of the stand 3 described above. The number of the stands 3 to 6 provided with the first liner plate 36, the second liner plate 38, and the elastic member 37 is not limited to four, and may be one, two, or three, for example.

[0037] As described above, in this embodiment, the tandem cold rolling mill 1 (rolling mill) includes a plurality of stands 3 to 6 configured to roll a steel sheet 2 (material to be rolled), and at least one stand 3, among the stands 3 to 6, includes: at least one pair of the work rolls 10 (rolling mill rolls); the work roll chocks 20 (roll chocks) rotatably supporting the work rolls 10; and the work roll chock liners 30 (roll chock liners) that each include the first liner plate 36 mounted on the work roll chock 20, the second liner plate 38 stacked on the first liner plate 36 in the rolling direction X, and the elastic member 37 interposed between the first liner plate 36 and the second liner plate 38.

[0038] With such a configuration, for example, by disposing the elastic member 37 in a manner interposed between the first liner plate 36 and the second liner plate 38 that are stacked in the rolling direction X, it is possible to suppress a side of the elastic member 37 from becoming exposed and wearing out on a side facing the opposite side of the work roll chock 20 (on the side facing the project block 41 on the mill housing 40). With this, it is possible to provide the tandem cold rolling mill 1, the cold rolling method, and the manufacturing method of the steel sheet 2 capable of suppressing vibration during the rolling process, while suppressing wearing of the work roll chock liner 30.

[0039] Furthermore, in this embodiment, the stands 3 to 6 are each provided with the work roll chock liner 30 including the first liner plate 36, the second liner plate 38, and the elastic member 37.

[0040] With such a configuration, for example, the elastic members 37 provided to the work roll chock liners 30 in the respective stands 3 to 6 can suppress the vibrations during the rolling process, and therefore, it becomes possible to suppress a cyclic change in the thickness of the steel sheet 2 due to the vibrations during

the rolling process, more reliably.

[0041] Furthermore, in this embodiment, the first liner plate 36 is fastened to the work roll chock 20 using a fastener 50 passed through the first liner plate 36 in the rolling direction X, and the second liner plate 38 and the elastic member 37 have openings 38a, 37a, respectively, in which the head 50a of the fastener 50 is housed.

[0042] With such a configuration, for example, it is possible to fasten only the first liner plate 36, but not the entire work roll chock liner 30, and therefore, loosening of the fastened fastener 50 can be suppressed by the elasticity of the elastic member 37.

[0043] One embodiment of the present invention has been described above as an example; however, the embodiment is merely one example, and is not intended to limit the scope of the present invention in any way. The embodiment may be implemented in other configurations, and various omissions, replacements, combinations, and modifications are still possible within the scope not deviating from the gist of the present invention. Furthermore, the embodiment may be implemented with appropriate changes in the configurations and specifications, such as the shapes (e.g., structures, types, directions, forms, sizes, length, width, thickness, height, numbers, arrangement, positions, and materials).

Industrial Applicability

[0044] According to the present invention, it is possible to provide a rolling mill, a cold rolling method, and a steel sheet manufacturing method capable of suppressing vibrations during a rolling process while suppressing wearing of a liner of the roll chock.

Reference Signs List

[0045]

1	tandem cold rolling mill (rolling mill)	
2	steel sheet (material to be rolled)	40
3 to 6	stand	
10	work roll (rolling mill roll)	
20	work roll chock (roll chock)	
30	work roll chock liner (roll chock liner)	
36	first liner plate	45
37	elastic member	
38	second liner plate	
50	fastener	
50a	head	
X	rolling direction	50

Claims

1. A rolling mill comprising a plurality of stands configured to roll a material to be rolled, wherein at least one stand, among the stands, includes:

at least one pair of rolling mill rolls;

a roll chock that rotatably support the rolling mill rolls; and

a roll chock liner that includes a first liner plate mounted on the roll chock, a second liner plate stacked on the first liner plate in a rolling direction, and an elastic member interposed between the first liner plate and the second liner plate.

2. The rolling mill according to claim 1, wherein the stands are each provided with the roll chock liner including the first liner plate, the second liner plate, and the elastic member.

3. The rolling mill according to claim 1, wherein

the first liner plate is fastened to the roll chock with a fastener passed through the first liner plate in the rolling direction, and each of the second liner plate and the elastic member has an opening in which a head of the fastener is housed.

4. The rolling mill according to claim 2, wherein

the first liner plate is fastened to the roll chock with a fastener passed through the first liner plate in the rolling direction, and each of the second liner plate and the elastic member has an opening in which a head of the fastener is housed.

5. A cold rolling method comprising a step of cold-rolling a material to be rolled using the rolling mill according to claim 1.

6. A steel sheet manufacturing method comprising a step of manufacturing a steel sheet as a material to be rolled, using the cold rolling method according to claim 5.

FIG.1

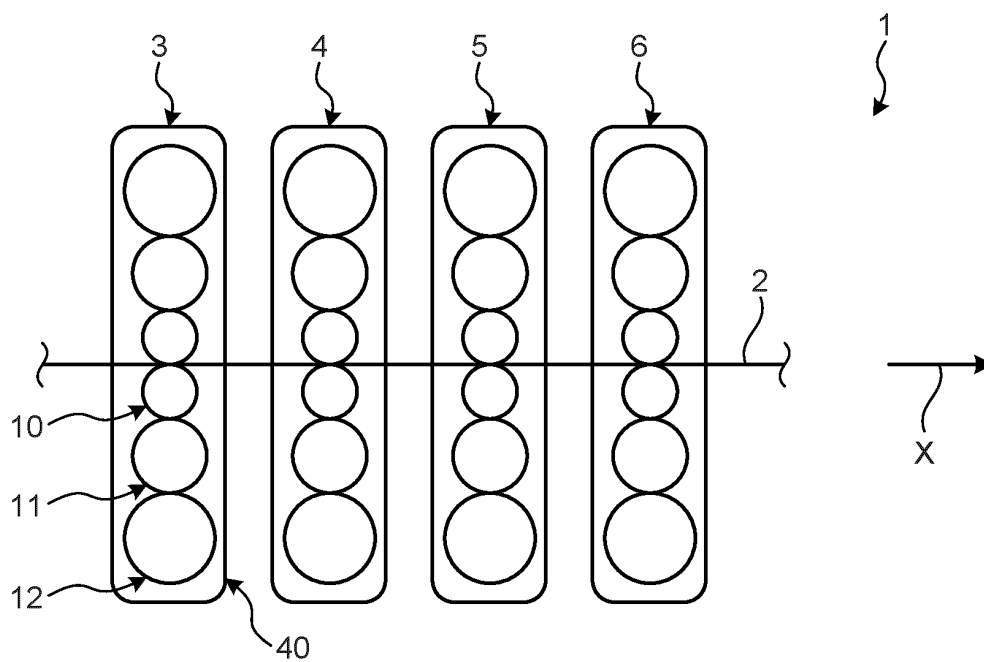


FIG.2

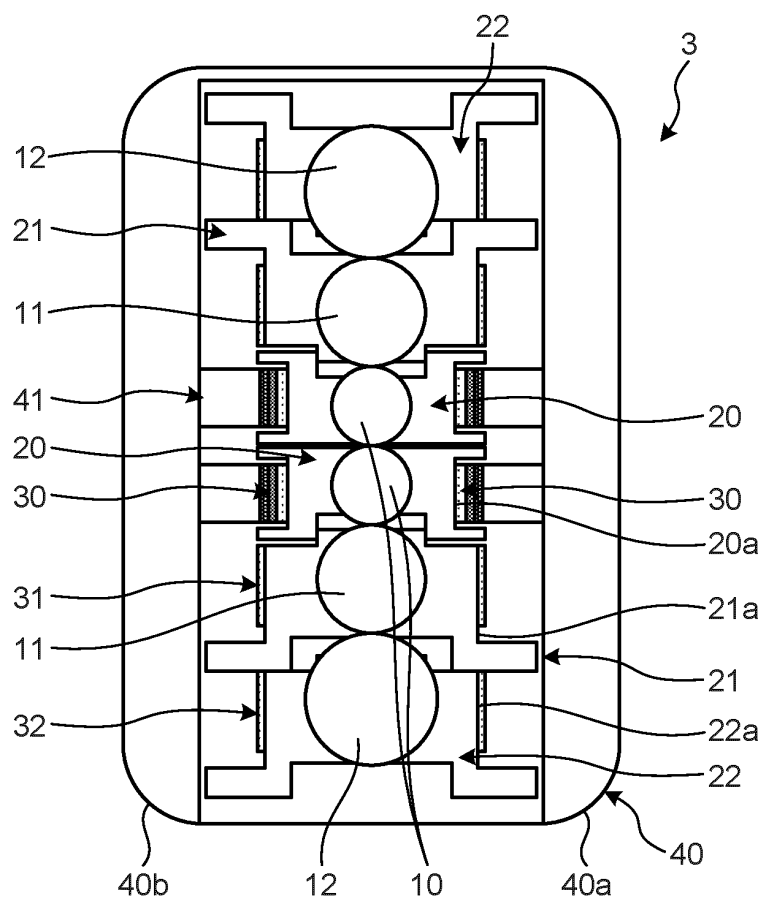
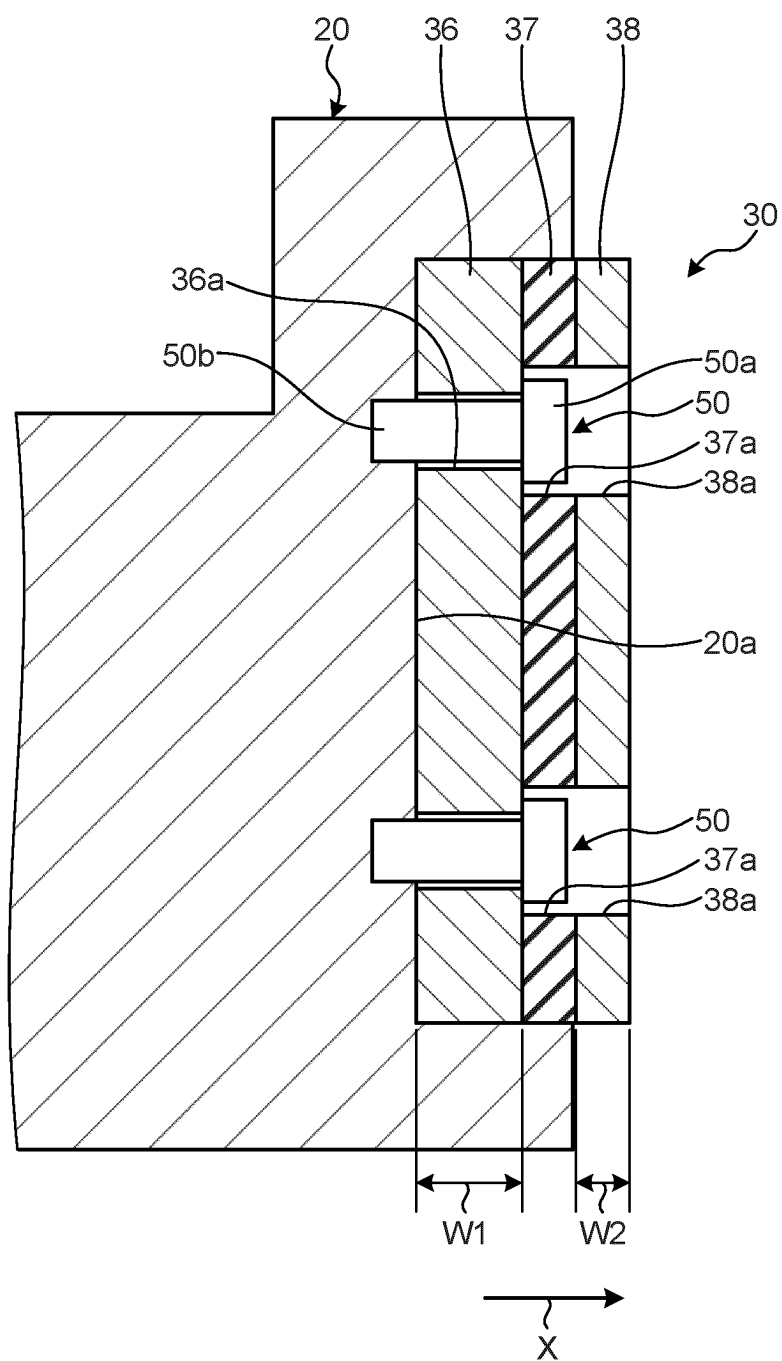


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/048282

A. CLASSIFICATION OF SUBJECT MATTER**B21B 31/02**(2006.01)i; **B21B 1/22**(2006.01)i; **B21B 38/00**(2006.01)i

FI: B21B31/02 B; B21B38/00 D; B21B1/22 K

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)

B21B31/02; B21B1/22; B21B38/00

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

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2023
 Registered utility model specifications of Japan 1996-2023
 Published registered utility model applications of Japan 1994-2023

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2004-314174 A (JFE STEEL KK) 11 November 2004 (2004-11-11) paragraphs [0001]-[0061], fig. 1, 7, 16	1-2, 5-6
Y		2-6
X	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 185926/1980 (Laid-open No. 106504/1982) (ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES CO., LTD.) 01 July 1982 (1982-07-01), pp. 1-6, fig. 1, 5, 8-13	1, 3-4
Y		2-6
X	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 048662/1977 (Laid-open No. 142534/1978) (SHINNIHON SEITETSU KK) 10 November 1978 (1978-11-10), pp. 1-18, fig. 1-10	1
Y		2-6

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

* Special categories of cited documents:

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Date of the actual completion of the international search

06 February 2023

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Name and mailing address of the ISA/JP

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/048282

Patent document cited in search report			Publication date (day/month/year)		Patent family member(s)		Publication date (day/month/year)	
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					pp. 1-23, fig. 1, 7, 16			
					KR	10-0632768	B1	
.....								
JP	57-106504	U1	01 July 1982		(Family: none)			
.....								
JP	53-142534	U1	10 November 1978		(Family: none)			
.....								

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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