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(54) VERTICAL ROLLER MILL

(57) This vertical roller mill is provided with: a rotary table having a grinding surface; a grinding roller (3) for biting and grinding a material between the grinding surface and the same; and a scraper (13) for adjusting a layer thickness of the material supplied to the grinding roller (3). The scraper (13) has: a scraper body (15) separately arranged above the grinding surface of the rotary table; a mobilizing means (16) for allowing the scraper body (15) to move in a direction away from the grinding surface; and a resistance adding means (17) for adding a resistance force to the movement of the scraper body (15) in the direction away from the grinding surface. Even when the layer thickness of the material supplied onto the grinding surface of the rotary table fluctuates, a height position of the scraper is automatically adjusted according to the fluctuation in layer thickness.

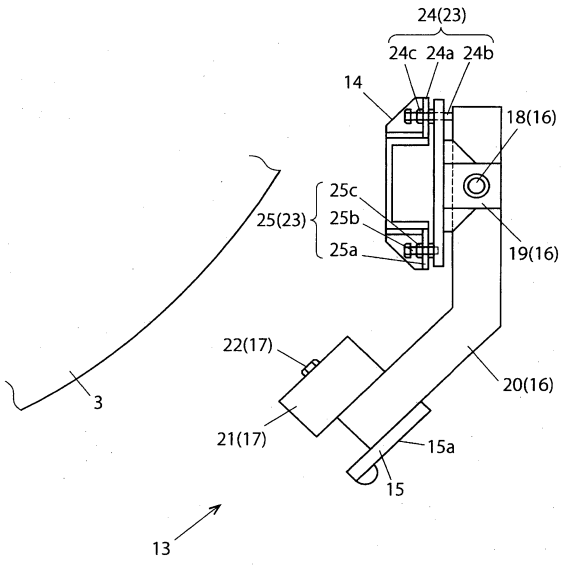

FIG. 4

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Description

Technical Field

[0001] The present invention relates to a vertical roller mill in which material is bitten and grinded between a grinding roller and a rotary table.

Background Art

[0002] Conventionally, a vertical roller mill in which material is bitten and grinded between a grinding roller and a rotary table has been used for grinding clinker, slag, and the like. In the vertical roller mill, material consisting of slag, clinker, and the like is supplied onto a center portion of the rotary table via a material charge chute. The rotary table is rotatively driven about a vertical rotation axis.

[0003] The material supplied on the center portion of the rotary table is moved outward in a radial direction by centrifugal force generated by rotation of the rotary table, and supplied onto an annular grinding surface formed on the rotary table.

[0004] Additionally, a separator is provided above the rotary table inside a mill casing, and material (coarse grain) whose grain size (grain diameter) is larger than a prescribed grain size is classified by the separator and recirculated onto the center portion of the rotary table. The material (coarse grain) recirculated on the center portion of the rotary table is supplied onto the grinding surface of the rotary table together with materials charged from the material charge chute by centrifugal force of the rotary table.

[0005] The material supplied on the annular grinding surface of the rotary table is rotatively moved by rotary operation of the rotary table and bitten between a plurality of grinding rollers and the rotary table. Each of the plurality of grinding rollers is elastically pressed against the grinding surface of the rotary table by a roller pressing mechanism having a hydraulic cylinder or the like. The material bitten between the grinding roller and the rotary table is grinded by the pressing force of the grinding roller.

[0006] Now, in a grinding process of cement, slag, and the like using the vertical roller mill, when thickness of the material to be grinded (layer thickness) on the annular grinding surface of the rotary table is not constant, the grinding roller is moved vertically due to fluctuation in layer thickness. The vertical movement of the grinding roller causes vibrations of the mill, which adversely affects a stable operation of the mill.

[0007] In order to cope with this problem, in a conventional vertical roller mill, a scraper is provided on the biting side of the grinding roller. The scraper is provided above the grinding surface of the rotary table at a predetermined distance and fixed to a support beam above the rotary table.

[0008] The scraper uniformizes the layer thickness by leveling the material before the material is bitten between the grinding roller and the rotary table, thereby reducing the mill vibration upon grinding caused by the fluctuation in layer thickness of the material.

Related Art Document

Patent Document ,

[0009] Patent Document 1: Japanese Patent Application Laid-open No. H03-174258

Summary of the Invention

Object to be Achieved by the Invention

[0010] Now, the layer thickness of the material supplied on the grinding surface of the rotary table fluctuates depending on production model, production quantity, and operation parameter (such as material charge quantity and the like), and the scraper has an optimal height according to the layer thickness.

[0011] However, since a conventional scraper is fixedly placed above the rotary table as stated above, work for changing its height needs to be performed during operation stop of the mill. Thus, operation efficiency of the mill is declined if the mill is temporarily stopped every time the layer thickness fluctuates for performing the adjustment work of scraper height.

[0012] The present invention is made considering the above-stated problems of the conventional technique, and its object is to provide a vertical roller mill in which a height position of the scraper is automatically adjusted according to fluctuation in layer thickness when the layer thickness of the material supplied on the grinding surface of the rotary table fluctuates.

Means for Achieving the Object

[0013] In order to achieve the above-mentioned object, a vertical roller mill according to a first aspect of the present invention comprises: a rotary table having a grinding surface; a grinding roller for biting and grinding a material between the grinding surface and the same; and a scraper for adjusting a layer thickness of the material supplied to the grinding roller, wherein the scraper has: a scraper body separately arranged above the grinding surface; a mobilizing means for allowing the scraper body to move in a direction away from the grinding surface; and a resistance adding means for adding a resistance force to a movement of the scraper body in the direction away from the grinding surface.

[0014] A second aspect of the present invention is that, in the first invention, the mobilizing means is configured to hang the scraper body so as to swing about a horizontal axis.

[0015] A third aspect of the present invention is that, in the first or second aspect, the scraper body has a contact surface with the material, and the contact surface is

oriented obliquely downward in a stationary state of the scraper body.

[0016] A fourth aspect of the present invention is that, in the third aspect, the contact surface of the scraper body forms an angle of 15 - 75 degrees with respect to a vertical surface.

[0017] A fifth aspect of the present invention is that, in any one of the first to fourth aspects, the resistance adding means has a weight for pressing the scraper body downward.

[0018] A sixth aspect of the present invention is that, in the fifth aspect, the weight is adjustable in weight.

[0019] A seventh aspect of the present invention is that, in any one of the first to sixth aspects, the scraper further has a movable range limit means for limiting an operable range of the scraper body.

[0020] An eighth aspect of the present invention is that, in the seventh aspect, the movable range limit means is configured to be able to adjust a lowest position and a highest position of the scraper body.

[0021] A ninth aspect of the present invention further comprises, in any one of the first to eighth aspects, a dust cover provided around the mobilizing means.

[0022] A tenth aspect of the present invention is that, in any one of the first to ninth aspects, the scraper body has a contact surface with the material, and a lower portion of the contact surface is formed thick-walled.

Effect of the Invention

[0023] An object of the present invention is to provide a vertical roller mill in which a height position of the scraper is automatically adjusted according to the fluctuation in layer thickness even when the layer thickness of the material supplied onto the grinding surface of the rotary table fluctuates.

Brief Description of Drawings

[0024]

FIG. 1 is a longitudinal section view illustrating a schematic configuration of a vertical roller mill according to one embodiment of the present invention.
FIG. 2 is a plan view illustrating an arrangement of a movable scraper in the vertical roller mill in FIG. 1.
FIG. 3 is a front view illustrating the movable scraper in the vertical roller mill in FIG. 1.
FIG. 4 is a side view illustrating the movable scraper in the vertical roller mill in FIG. 1.
FIG. 5 is a side view illustrating operation of the movable scraper in the vertical roller mill in FIG. 1.
FIG. 6 is another side view illustrating operation of the movable scraper in the vertical roller mill in FIG. 1.
FIG. 7 is a perspective view illustrating a dust cover of the movable scraper in the vertical roller mill in FIG. 1.
FIG. 8 is a schematic view illustrating an effect of the movable scraper in the vertical roller mill in FIG. 1.
FIG. 9 is a schematic view illustrating an effect of a fixed scraper in a conventional vertical roller mill.

Embodiment of the Invention

[0025] Hereunder, a vertical roller mill according to one embodiment of the present invention will be described with reference to the drawings.

[0026] As illustrated in FIG.1, a vertical roller mill 1 according to this embodiment has a rotary table 2 to which material is supplied onto a top surface center portion of the same, and a plurality of (three in this example) grinding rollers 3 for biting and grinding the material between the rotary table 2 and the same. The rotary table 2 is rotatively driven about a vertical rotation axis L0.

[0027] The plurality of grinding rollers 3 are arranged at equal angular intervals on a virtual circumference about the vertical rotation axis L0 of the rotary table 2. Each of the plurality of grinding rollers 3 is pressed against an annular grinding surface 2a of the rotary table 2 illustrated in FIG. 2 by a roller pressing mechanism 4 comprising a driving source such as a hydraulic cylinder or the like.

[0028] The vertical roller mill 1 comprises a rotation driving source 5 and a reduction gear 6 for the rotary table 2, and the rotary table 2 is installed above the reduction gear 6.

[0029] The rotary table 2 and the grinding roller 3 are covered by a mill casing 7. Material is supplied to the rotary table 2 through a raw material supply chute 8 which is arranged such that it passes through the mill casing 7. In this example, the material supply chute 8 is extended along the vertical rotation axis L0 of the rotary table 2.

[0030] A separator 9 is provided above the rotary table 2. Among the material emitted outward in the radial direction from the rotary table 2 by centrifugal force, the material grinded so that its grain is smaller than a prescribed grain size (grain diameter) is blown up by hot air supplied inside the mill casing 7 through a hot air duct (not illustrated) and is transferred to the separator 9.

[0031] The separator 9 is rotatively driven by a separator driving device 10 which is composed of an electric machinery or the like, and discharges, among the material blown by the hot air, only the material (refined grain) whose grain is smaller than a prescribed grain size (grain diameter) from a refined grain discharge duct (not illustrated) which is provided to an upper portion of the mill casing 7. On the other hand, the material (coarse grain) whose grain is larger than the prescribed grain size (grain diameter) is classified by the separator 9 and returned onto the rotary table 2 through a funnel shaped member (inner cone) 11 so as to be bitten and ground again by the grinding roller 3 and the rotary table 2.

[0032] The vertical roller mill 1 comprises a collection casing 12 for collecting, among the material emitted around the rotary table 2 by the centrifugal force accompanied with the rotation of the rotary table, the material

which was not blown up by the hot air. The collection casing 12 has a larger diameter than the rotary table 2, and assumes an annular form as a whole. The material collected by the collection casing 12 is returned onto the rotary table 2 through an external circulation line (not illustrated) and grinded again.

[0033] As illustrated in FIG. 2, the vertical roller mill 1 according to this embodiment comprises three grinding rollers 3, and a scraper 13 for adjusting layer thickness of the material supplied to the grinding roller 3 is installed to each of the three grinding rollers 3. The scraper 13 is provided to a support beam 14 installed inside the mill casing 7.

[0034] FIG. 3 and FIG. 4 illustrate the enlarged scraper 13. The scraper 13 comprises a scraper body (scraper plate) 15 separately arranged above the grinding surface 2a of the rotary table 2, a mobilizing means 16 for allowing the scraper body 15 to move in a direction away from the grinding surface 2a when the material on the grinding surface 2a comes into contact with the scraper body 15, and a resistance adding means 17 (FIG. 4) for adding resistance force to the movement of the scraper body 15 in the direction away from the grinding surface 2a.

[0035] The mobilizing means 16 is configured so as to hang the scraper body 15 so that it can swing about a horizontal axis. Thus, the mobilizing means 16 has a turning shaft 18 extending in the horizontal direction, and the turning shaft 18 is turnably supported by a bearing 19 provided to the support beam 14. A plurality of movable support members (movable body) 20 extending in a vertical direction are provided to the turning shaft 18, and the movable support member 20 can swing about the turning shaft 18. The scraper body 15 is provided to a lower end of the movable support member 20, and the scraper body 15 can swing together with the movable support member 20.

[0036] As illustrated in FIG. 4, a contact surface 15a with the material of the scraper body 15 is oriented obliquely downward in a stationary state (state in the lowest position)of the scraper body 15. Specifically, the contact surface 15a of the scraper body 15 forms an angle of 15 - 75 degrees, preferably 45 degrees with respect to the vertical surface. Considering wear due to contact with the material, a lower portion of the contact surface 15a of the scraper body 15 is formed thick-walled.

[0037] The resistance adding means 17 of the scraper 13 has a weight 21 pressing the scraper body 15 downward. The weight 21 is detachably mounted to a lower end portion of the movable support member 20 by a bolt 22. The weight 21 is configured by superposing a plurality of plates, and weight of the weight 21 can be adjusted by changing the number and kind of the plates.

[0038] The scraper 13 further has a movable range limit means 23 for limiting an operable range of the scraper body 15. The movable range limit means 23 has a first stopper member 24 for defining a lowest position of the scraper 15 and a second stopper member 25 for defining a highest position of the scraper 15.

[0039] The first stopper member 24 has a bolt support piece 24a provided to an upper surface of the support beam 14, a stopper bolt 24b screwed to a bolt hole formed in the bolt support piece 24a, and a bolt fixing nut 24c for releasably fixing the stopper bolt 24b.

[0040] A distal end portion of the stopper bolt 24b abuts on the upper end portion of the movable support member 20 positioned above the turning shaft 18, in the stationary state of the movable support member 20 as illustrated in FIG. 4. Thereby, the movable support member 20 is limited in rotatively moving in a counterclockwise direction in FIG. 4 about the turning shaft 18.

[0041] The limit position of the rotary movement of the movable support member 20 in the counterclockwise direction in FIG. 4 can be adjusted by adjusting a protruding amount of the stopper bolt 24b by loosening the bolt fixing nut 24c. Thereby, the lowest position of the scraper body 15 can be adjusted.

[0042] In this example, as illustrated in FIG. 4, the distal end portion of the stopper bolt 24b abuts on the upper end portion of the movable support member 20 and the movable support member 20 becomes stationary, in a state that the upper half portion of the movable support member 20 is oriented in the vertical direction. Thereby, the material contact surface 15a of the scraper body 15 is inclined at 15 - 75 degrees, preferably 45 degrees toward the grinding roller 3 side with respect to the vertical direction, when the movable support member 20 is in the stationary state.

[0043] The second stopper member 25 has a bolt support piece 25a provided to a lower surface of the support beam 14, a stopper bolt 25b screwed to a bolt hole formed in the bolt support piece 25a, and a bolt fixing nut 25c for releasably fixing the stopper bolt 25b.

[0044] As illustrated in FIG. 5, when the scraper body 15 is pushed up by contact with the material and the movable support member 20 rotates in a clockwise direction in FIG. 4 about the turning shaft 18, a center portion of the movable support member 20 positioned below the turning shaft 18 abuts on a distal end portion of the stopper bolt 25b. Thereby, the movable support member 20 is limited in rotatively moving in a clockwise direction in FIG. 4 about the turning shaft 18.

[0045] The limit position of the rotary movement of the movable support member 20 in the clockwise direction in FIG. 4 can be adjusted by adjusting a protruding amount of the stopper bolt 25b by loosening the bolt fixing nut 25c. Thereby, the highest position of the scraper body 15 can be adjusted.

[0046] Note that, even when the lower stopper bolt 25b and the bolt support piece 25a are broken by a pressing force of the material, the movable support member 20 abuts on the support beam 14 and stops at the position, as illustrated in FIG. 6. Thereby, a movable portion (weight 21, for example) of the scraper 13 can be surely prevented from coming into contact with the grinding roller 3.

[0047] A dust cover 26 illustrated in FIG. 7 is provided

around the mobilizing means 16 (18, 19) of the scraper 13. By providing the dust cover 26, dust can be prevented from adhering to the circumference of the turning shaft 18 of the scraper 13, thereby malfunction of the scraper 13 can be prevented.

[0048] Next, an effect of the scraper 13 of the vertical roller mill 1 according to this embodiment will be described comparing with a conventional scraper.

[0049] As illustrated in FIG. 9, a scraper body 101 of a conventional scraper 100 is fixedly installed by a fixing bolt 103 via a fixed support member 102 on a biting side of the grinding roller 3. In this fixed scraper 100, a distance D between a lower end of the scraper body 101 and the grinding surface 2a of the rotary table 2 is always constant. Thus, even when a layer thickness T of the material on an upstream side of the scraper 100 fluctuates, the distance D between the lower end of the scraper body 101 and the grinding surface 2a of the rotary table 2 does not change.

[0050] In contrast, in the scraper 13 of the vertical roller mill 1 according to this embodiment, the scraper body 15 is hanged so as to swing about the turning shaft 18 by the movable support member 20. Therefore, when the scraper body 15 is pressed by the material moving accompanied with the rotation of the rotary table 2, the scraper body 15 rotates about the turning shaft 18 together with the movable support member 20, if the pressing force exceeds the resistance force of the weight 21. By this rotation movement, the distance D between the lower end of the scraper body 15 and the grinding surface 2a of the rotary table 2 is expanded.

[0051] Thus, in the scraper 13 of the vertical roller mill 1 according to this embodiment, an angular displacement amount of the movable support member 20 and the scraper body 15 about the turning shaft 18 is increased by increase in layer thickness T of the material on the upstream side of the scraper 13, and the distance D between the lower end of the scraper body 15 and the grinding surface 2a of the rotary table 2 is further expanded.

[0052] As described above, in the vertical roller mill 1 according to this embodiment, the distance D between the lower end of the scraper body 15 and the grinding surface 2a of the rotary table 2 changes following fluctuation in layer thickness T of the material on the upstream side of the scraper 13. Thereby, the height position of the scraper body 15 is automatically adjusted to an optimal position corresponding to the layer thickness of the material.

[0053] Additionally, in the vertical roller mill 1 according to this embodiment, the material contact surface 15a of the scraper 15 is inclined with respect to the vertical surface, and thereby the material is pressed in a direction of the grinding surface 2a of the rotary table 2 by the material contact surface 15a and compressed. By this compression effect of the material by the material contact surface 15a, part of air included inside the material is driven out. By this deaeration and consolidation effect of the material, grinding work of the material by the grinding roller 3 can be stabilized and grinding efficiency can be increased.

[0054] It is preferable to determine an inclination angle of the material contact surface 15a of the scraper body 15 with respect to the vertical surface so as to achieve the above-mentioned deaeration and consolidation effect of the material and also to ensure a sufficient movable range of the scraper body 15 for keeping a necessary adjustment range.

[0055] Note that, although the vertical roller mill 1 having the three grinding rollers 3 is described in the above-stated embodiment, any number of grinding rollers may be employed and four or more grinding rollers may be employed in the present invention.

[0056] Additionally, although the weight 21 is used as the resistance adding means 17 of the scraper 13 in the above-stated embodiment, a resilient member such as a spring member, an air dumper, or the like also can be used instead of the weight 21.

[0057] Additionally, although the movable support member 20 in a bended shape is used in the above-stated embodiment, instead, a movable support member in a straight form may be used so that the material contact surface 15a of the scraper body 15 in a stationary state is oriented the vertical direction.

[0058] Also in this case, the material contact surface 15a of the scraper body 15 is inclined with respect to the vertical surface since the scraper body 15 is rotated together with the movable support member by the pressing force from the material, and therefore the deaeration from the material and consolidation effect resulting from the compression effect of the material by the material contact surface 15a can be expected.

Description of Reference Numerals

[0059]

1 ... vertical roller mill
2 ... rotary table
2a ... grinding surface of rotary table
3 ... grinding roller
4 ... roller pressing mechanism
5 ... rotation driving source for rotary table
6 ... reduction gear for rotary table
7 ... mill casing
8 ... material supply chute
9 ... separator
10 .. separator driving device
11 ... funnel shaped member (inner cone)
12 ... collection casing
13 ... scraper
14 ... support beam
15 ... scraper body
15a ... material contact surface
16 ... mobilizing means
17 ... resistance adding means
18 ... turning shaft

19 ... bearing
20 ... movable support member
21 ... weight (resistance adding means)
22 ... bolt (for fixing weight)
23 ... movable range limit means
24 ... first stopper member
24a ... bolt support piece
24b .. stopper bolt
24c ... bolt fixing nut
25 ... second stopper member
25a ... bolt support piece
25b ... stopper bolt
25c ... bolt fixing nut
26 ... dust cover
100 ... conventional scraper
101 ... scraper body of conventional scraper
102 ... fixed support member of conventional scraper
103 .. fixing bolt of conventional scraper
D ... distance between lower end of scraper body and grinding surface of rotary table
L0 ... rotation axis of rotary table
T ... layer thickness of material

Claims

1. A vertical roller mill, comprising:

a rotary table having a grinding surface;
a grinding roller for biting and grinding a material between the grinding surface and the grinding roller; and
a scraper for adjusting a layer thickness of the material supplied to the grinding roller,
wherein the scraper has:

a scraper body separately arranged above the grinding surface;
a mobilizing means for allowing the scraper body to move in a direction away from the grinding surface; and
a resistance adding means for adding a resistance force to a movement of the scraper body in the direction away from the grinding surface.

2. The vertical roller mill according to claim 1, wherein the mobilizing means is configured to hang the scraper body so as to swing about a horizontal axis.

3. The vertical roller mill according to claim 1 or 2,
wherein the scraper body has a contact surface with the material, and
wherein the contact surface is oriented obliquely downward in a stationary state of the scraper body.

4. The vertical roller mill according to claim 3, wherein the contact surface of the scraper body forms an angle of 15 - 75 degrees with respect to a vertical surface.

5. The vertical roller mill according to any one of claims 1 to 4, wherein the resistance adding means has a weight for pressing the scraper body downward.

6. The vertical roller mill according to claim 5, wherein the weight is adjustable in its weight.

7. The vertical roller mill according to any one of claims 1 to 6, wherein the scraper further has a movable range limit means for limiting an operable range of the scraper body.

8. The vertical roller mill according to claim 7, wherein the movable range limit means is configured to be able to adjust a lowest position and a highest position of the scraper body.

9. The vertical roller mill according to any one of claims 1 to 8, further comprising a dust cover provided over the mobilizing means.

10. The vertical roller mill according to any one of claims 1 to 9,
wherein the scraper body has a contact surface with the material, and
wherein a lower portion of the contact surface is formed thick-walled.

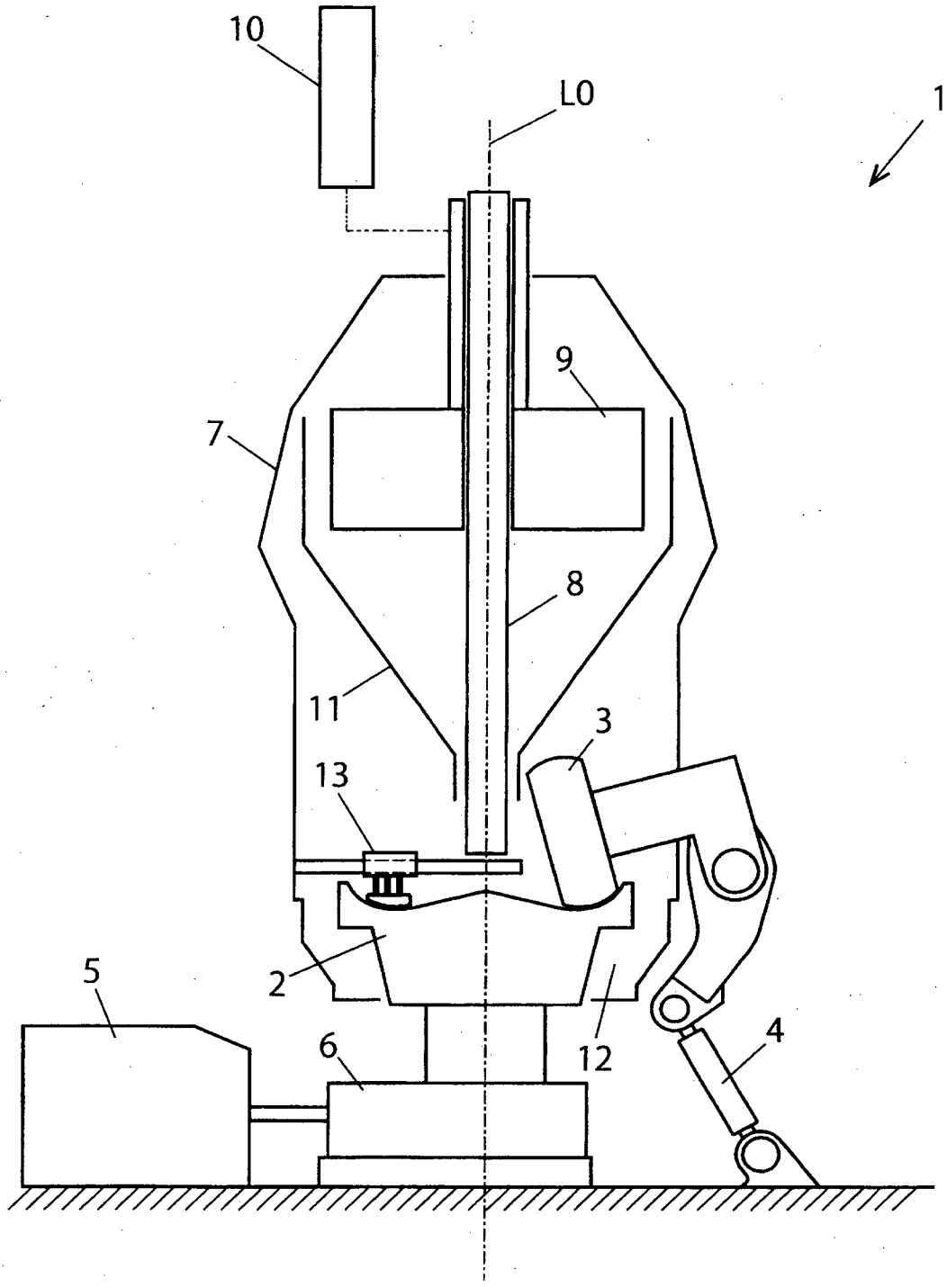


FIG. 1

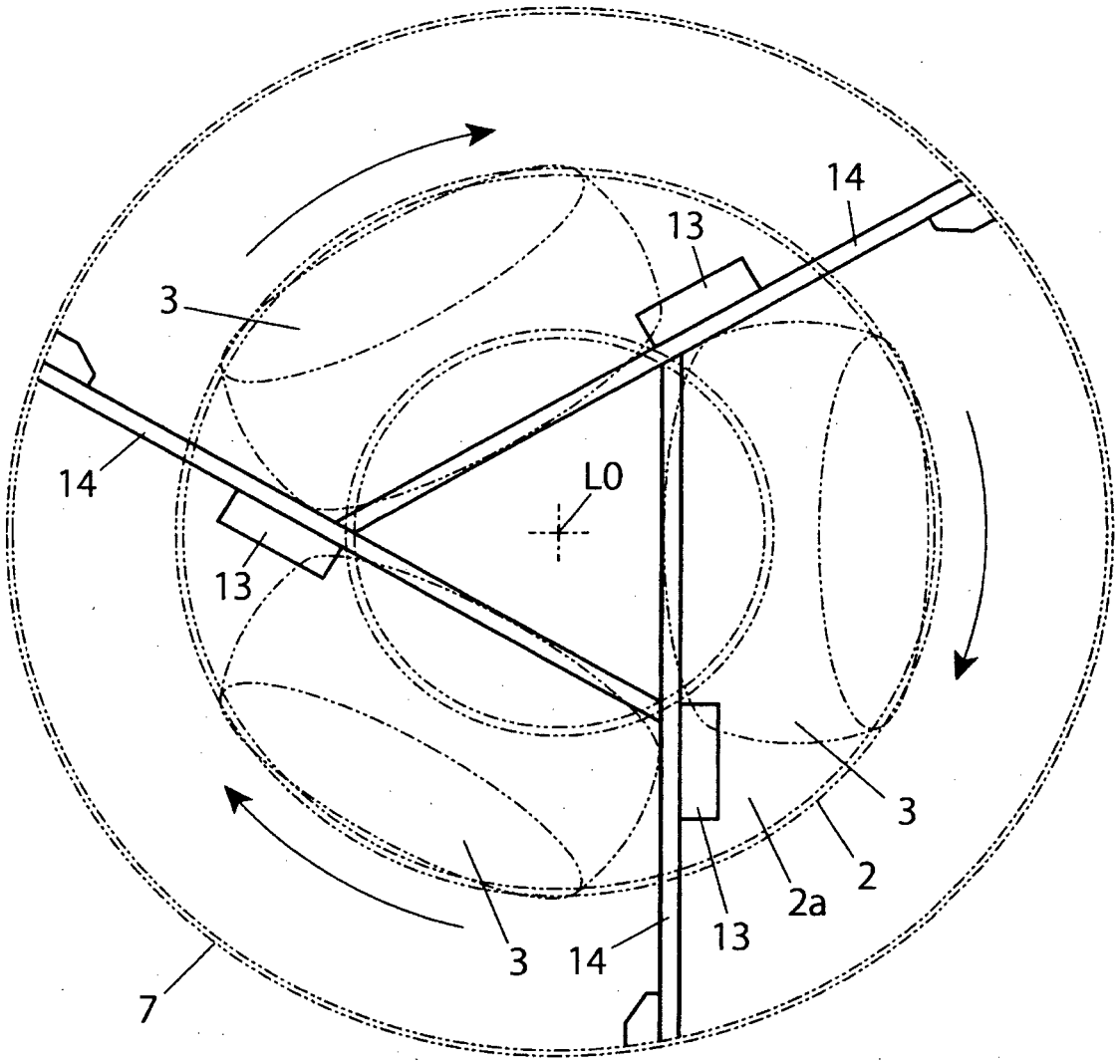


FIG. 2

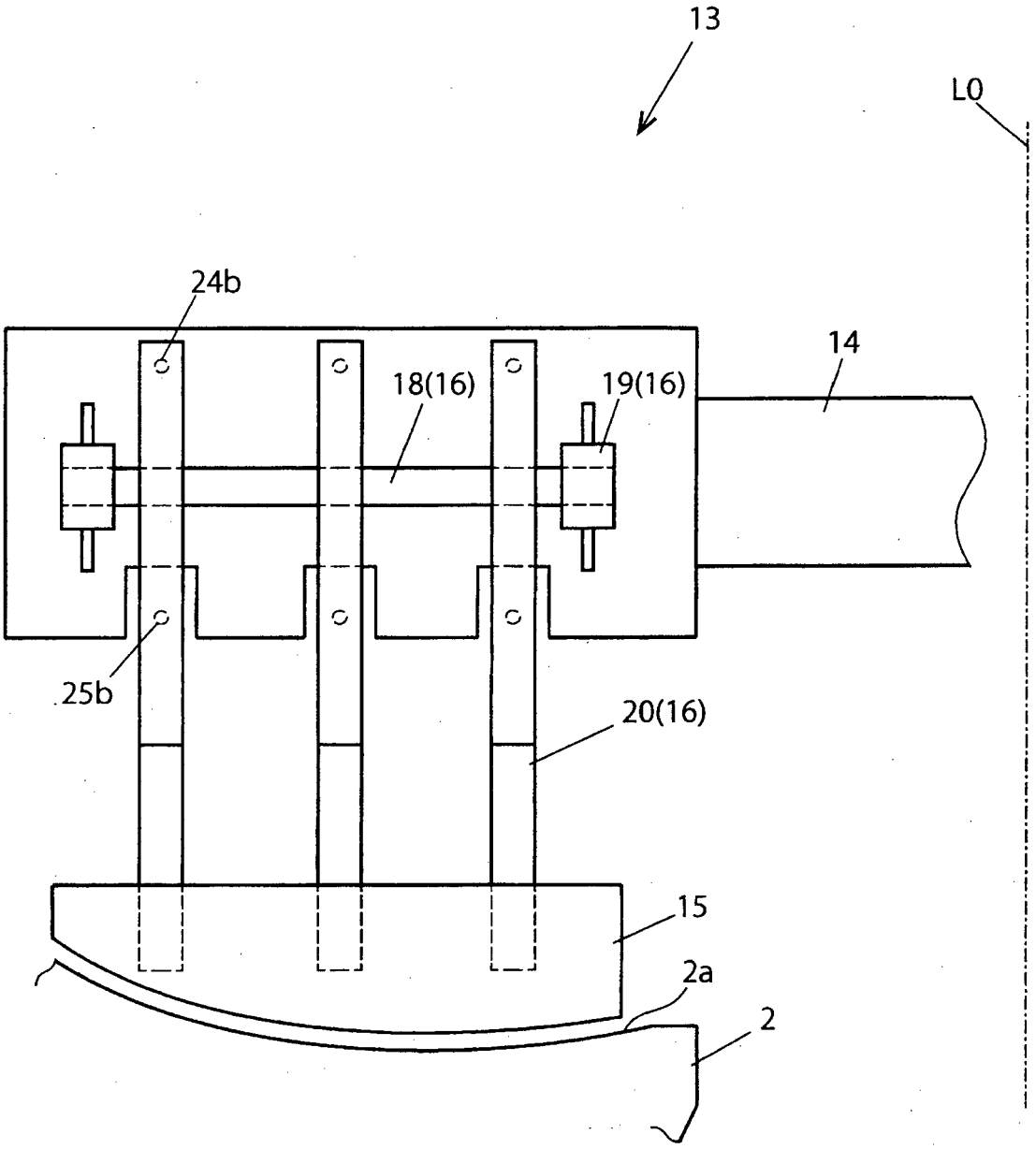
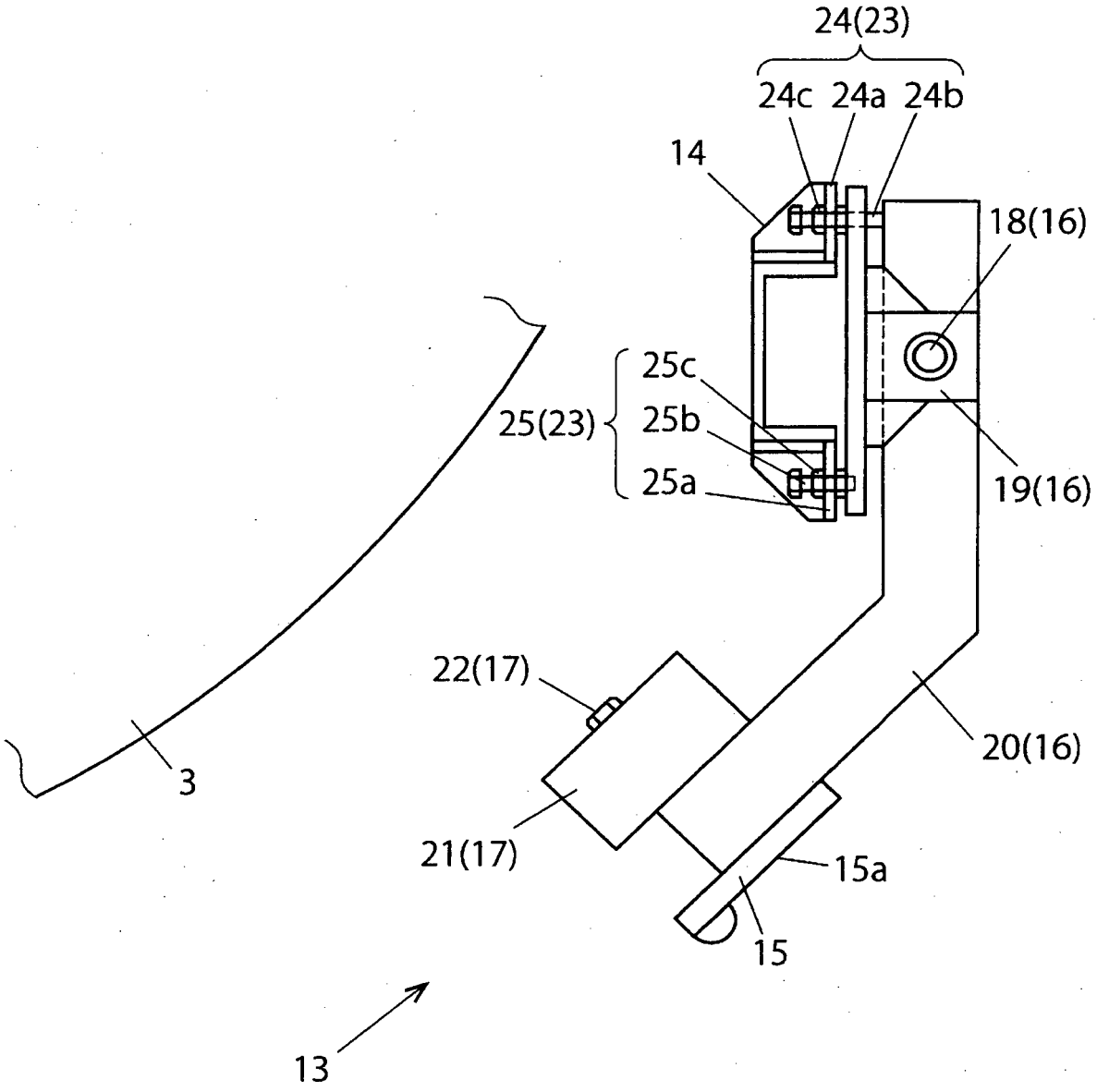


FIG. 3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24b
14
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25b
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22(17)
20(16)
3
21(17)
15a
15
13

FIG. 4

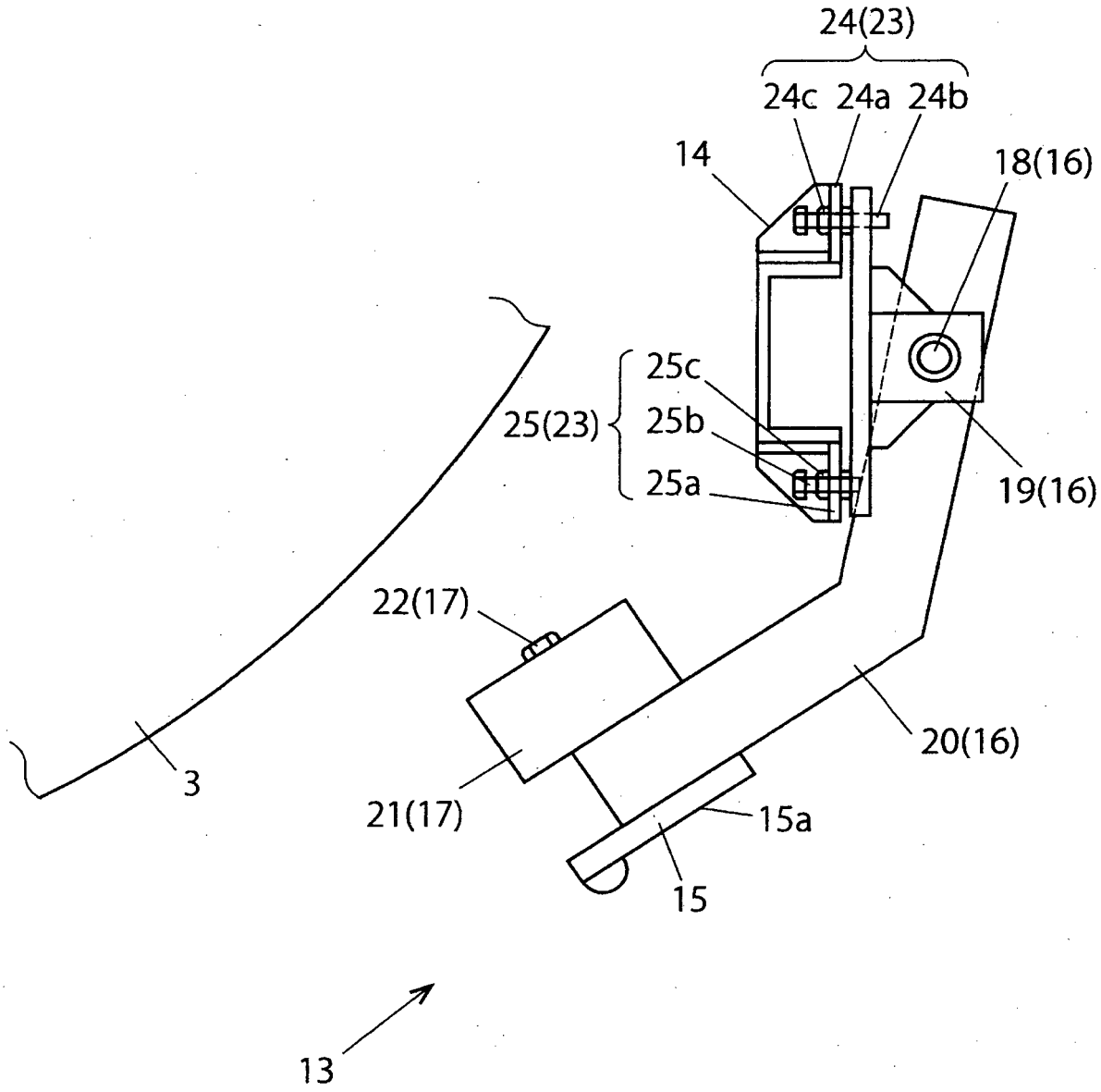
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FIG. 5

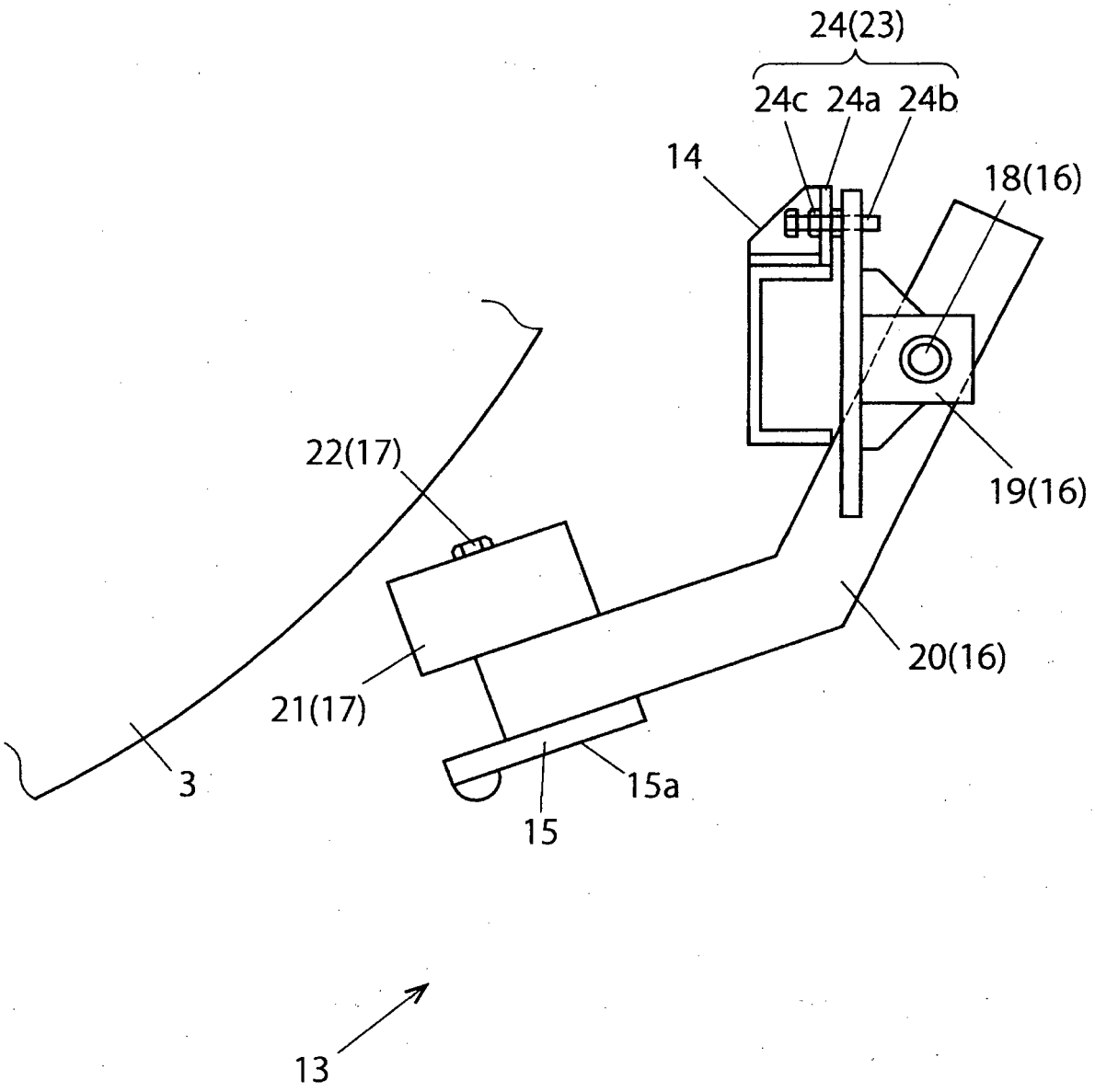

FIG. 6

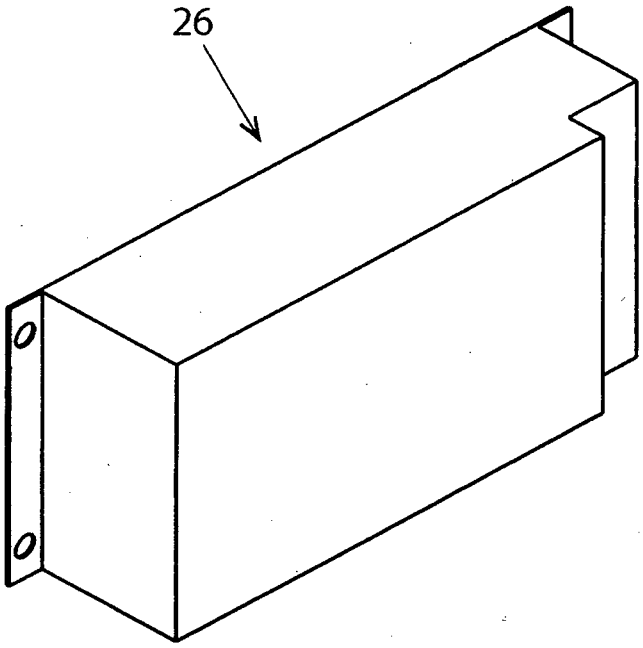

FIG. 7

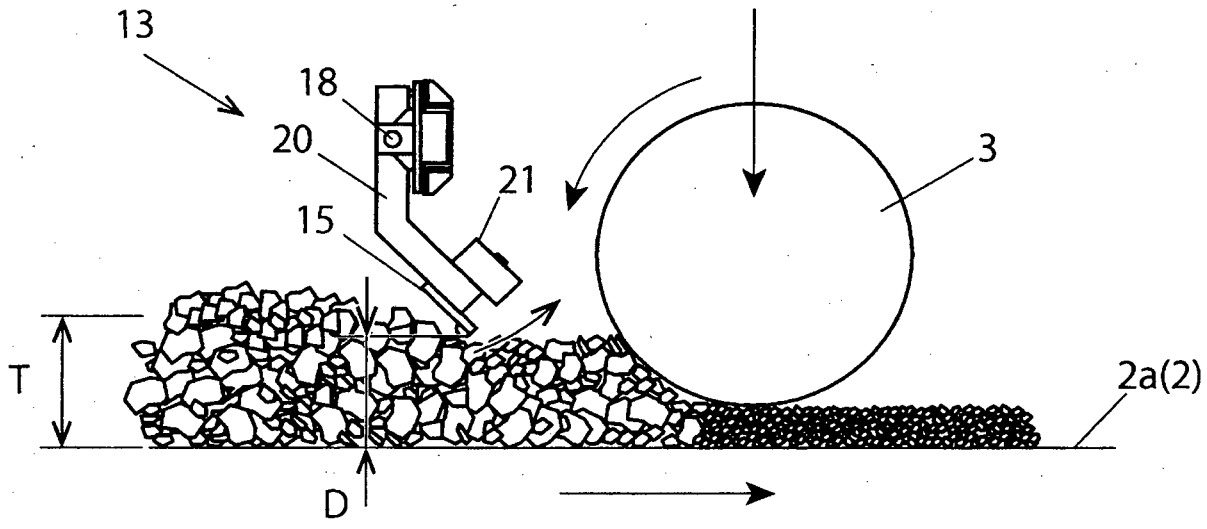

FIG. 8

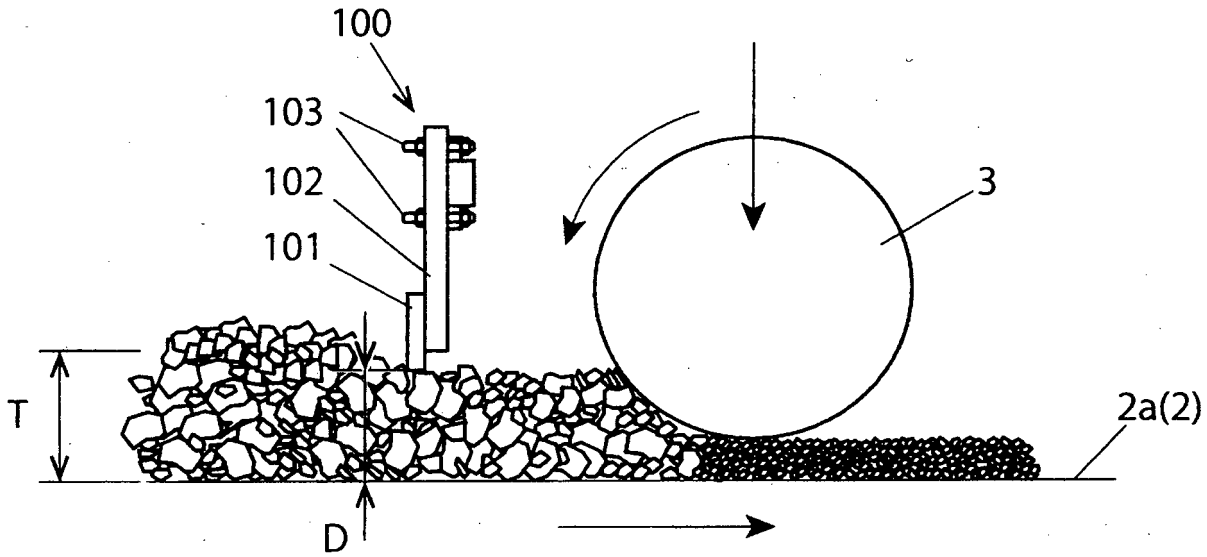

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/084962

A. CLASSIFICATION OF SUBJECT MATTER
B02C15/04(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)
B02C15/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016
Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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 Y	JP 3-254842 A (Ube Industries, Ltd.), 13 November 1991 (13.11.1991), page 3, lower right column, line 10 to page 4, lower right column, line 8; fig. 1 to 2 (Family: none)	1-6 7-10
Y	JP 10-118509 A (Kurimoto Ltd.), 12 May 1998 (12.05.1998), paragraph [0020] (Family: none)	7-10
Y	JP 2014-91109 A (Mitsubishi Heavy Industries, Ltd.), 19 May 2014 (19.05.2014), paragraphs [0032] to [0033], [0040] (Family: none)	7-10

☒ 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	Date of mailing of the international search report
03 March 2016 (03.03.16)	15 March 2016 (15.03.16)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/084962

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 9-103697 A (Babcock-Hitachi Kabushiki Kaisha), 22 April 1997 (22.04.1997), paragraph [0031]; fig. 2 (Family: none)	9-10
Y	JP 61-4549 A (Kawasaki Heavy Industries, Ltd.), 10 January 1986 (10.01.1986), page 3, upper left column, lines 5 to 10; fig. 1 (Family: none)	10

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H03174258 B **[0009]**