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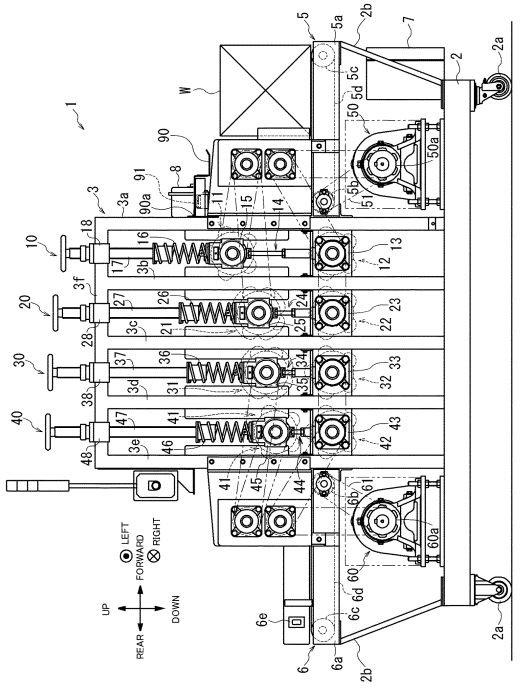
(54) DEVICE FOR LOOSENING SOLIDIFIED MATERIAL

(57) A conventional device for loosening a solidified material has not been capable of loosening and pulverizing or granulating an aggregated material accommodated in a bag having a large thickness. Therefore, the present invention is a loosening device 1 for conveying, while compressing, a bag W for accommodating a mass in which a powdered or granular material is accumulated through use of roller pairs having lower rollers 12, 22, 32, 42 and upper rollers 11, 21, 31, 42 in which recesses and projections are formed on the surfaces thereof, the loosening device 1 being provided with a plurality of rollers pairs arranged along the conveyance direction of the bag W, and the loosening device 1 being configured so that the interval between the upper rollers 21, 31, 42 and the lower rollers 22, 32, 42 in at least one roller pair among the rollers pairs of second through fourth roller units 20, 30, 40 positioned downstream relative to the roller pair of a first roller unit 10 positioned furthest upstream in the conveyance direction of the bag W is smaller than the interval between the upper roller 11 and the lower roller 12 of the roller pair positioned furthest upstream.

[Fig.1]



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Description

TECHNICAL FIELD

[0001] The present invention relates to a solidified material loosening device that loosens an aggregate material by compressing a bag body accommodating an aggregate formed by collecting a powdery or granular material.

BACKGROUND ART

[0002] Generally, powdery or granular materials such as salt, citric acid, boric acid, resin pellets, and cement are laminated and stored in a storage location such as a warehouse while accommodated in a bag body until the powdery or granular materials are used. In many cases, the material in the bag body is solidified into an aggregate by absorption of moisture or compression during the storage.

[0003] During the use of the material solidified into the aggregate in the bag body, it is necessary to loosen the solidified material to return the solidified material to powdery or granular state.

[0004] When work to loosen the solidified material to return the solidified material to the powdery or granular state is manually performed, it is necessary to lift and drop the heavy-weight bag body or to hit the bag body many times with a hammer, and tremendous labor is required. For this reason, a solidified material loosening device has been devised as described in Patent Literature 1 in order to save the work to pulverize or granulate the solidified material.

[0005] In the solidified material loosening device described in Patent Literature 1, a plurality of roller pairs each of which includes an upper roller and a lower roller are arranged side by side in a conveyance direction of the bag body, and the bag body is conveyed while compressed by the upper roller and the lower roller, whereby the material solidified into an aggregate is loosened and pulverized or granulated.

CITATIONS LIST

PATENT LITERATURE

[0006] Patent Literature 1: JP-B 5938490 Gazette

SUMMARY OF INVENTION

TECHNICAL PROBLEMS

[0007] In the solidified material loosening device described in Patent Literature 1, because the bag body that accommodates the material of 20 kg to 25 kg and has a thin rectangular shape is frequently used as the bag body accommodating the material, an interval between the upper roller and the lower roller is set small according to the thickness of the bag body. The interval between the upper roller and the lower roller cannot be adjusted, but is set to a constant interval. The interval between the upper roller and the lower roller in each roller pair is set to the same interval.

[0008] However, not only a bag body having a small thickness but also a bag body having a large thickness and a substantially rectangular parallelepiped shape or a bag having a columnar shape exist as the bag body in which the material is accommodated.

[0009] Because the bag body having the large thickness cannot be drawn in between the upper roller and the lower roller having a small interval and compressed by the upper roller and the lower roller, the aggregate material accommodated in the bag body cannot be pulverized or granulated by loosening the aggregate material using the solidified material loosening device.

[0010] The present invention provides a solidified material loosening device that can appropriately compress even the bag body having the large thickness and pulverize or granulate the solidified aggregate material by efficiently loosening the solidified aggregate material.

SOLUTIONS TO PROBLEMS

[0011] The solidified material loosening device that solves the above problems has the following features.

[0012] That is, according to the present invention, there is provided a solidified material loosening device that conveys a bag body accommodating an aggregate formed by collecting powdery or granular materials while compressing the bag body using a roller pair including an upper roller and a lower roller each having a surface provided with irregularities, the solidified material loosening device includes a plurality of the roller pairs arranged side by side along a conveyance direction of the bag body, wherein an interval between the upper roller and the lower roller in at least one of the roller

pairs located on a downstream side of the roller pair located on a most upstream side in the conveyance direction of the bag body is smaller than an interval between the upper roller and the lower roller in the roller pair located on the most upstream side.

[0013] Consequently, even the bag body W having the large thickness can appropriately be compressed by the upper roller 11 and the lower roller 12, and the solidified aggregate material can be pulverized or granulated by efficiently loosening the solidified aggregate material.

[0014] Preferably, the interval between the upper roller and the lower roller in the roller pair located on the most upstream side in the conveyance direction of the bag body is larger than the interval between the upper roller and the lower roller in the roller pairs located on the downstream side of the roller pair located on the most upstream side.

[0015] Consequently, even the bag body W having the large thickness can appropriately be compressed by the upper roller 11 and the lower roller 12, and the solidified aggregate material can be pulverized or granulated by efficiently loosening the solidified aggregate material.

[0016] Preferably, the interval between the upper roller and the lower roller in each roller pair decreases sequentially from the upstream side to the downstream side in the conveyance direction of the bag body.

[0017] Consequently, the pressing force applied to the bag body can be set to appropriate magnitude according to a degree of powdery or granular state of the material, and the aggregate material in the bag body can gradually be loosened and efficiently be pulverized or granulated.

[0018] Preferably, a difference between the interval between the upper roller and the lower roller in the roller pair located on the most upstream side in the conveyance direction of the bag body and the interval between the upper roller and the lower roller in the roller pair adjacent to the roller pair located on the most upstream side is maximized with respect to a difference between the interval between the upper roller and the lower roller in the roller pair located on the most upstream side in the conveyance direction of the bag body and the interval between the upper roller and the lower roller in other adjacent roller pairs.

[0019] Consequently, the interval between the roller pair on the most upstream side can be set significantly larger than the interval between the roller pair on the downstream side. After the roller pair on the most upstream side decreases the thickness of the bag body by drawing in the bag body having the large thickness to divide the aggregate material in the bag body into a plurality of small aggregates, the roller pair on the downstream side finely loosens the aggregate material into powdery or granular state, which allows the material to be efficiently pulverized or granulated.

[0020] Preferably, the solidified material loosening device further includes: a lower bearing supporting the lower roller; an upper bearing supporting the upper roller; and a support member that is disposed between the lower bearing and the upper bearing to support the upper bearing from below. A vertical length of the support member located on the upstream side in the conveyance direction of the bag body is larger than a vertical length of the support member located on the downstream side.

[0021] Consequently, the interval between each roller pair can be set so as to be smaller from the upstream side toward the downstream side in the conveyance direction of the bag body with a simple configuration.

[0022] Preferably, a vertical length of the support member is adjustable.

[0023] Consequently, the interval between each roller pair can individually be set according to the thickness of the bag body and the characteristic of the material in the bag body, the appropriate pressing force is applied to various bag bodies, and the material in the bag body can efficiently be pulverized or granulated.

[0024] Preferably, the solidified material loosening device further includes a frame that vertically movably supports the upper bearing while supporting the lower bearing. The support member includes: a nut fixed to the frame; and a bolt that is screwed in the nut and detachably abuts on the upper bearing, the vertical length of the support member can be adjusted by rotating the bolt with respect to the nut, and the support member located on the upstream side in the conveyance direction of the bag body is larger than the support member located on the downstream side in an extension length of the bolt from the nut.

[0025] Consequently, the length of the support member can be adjusted by a simple operation.

[0026] Preferably, the support member includes a lock nut screwed the bolt to regulate rotation of the bolt relative to the nut.

[0027] Consequently, the vertical length of the support member can be fixed, and the interval between each roller pair can be prevented from changing abruptly.

[0028] Preferably, the solidified material loosening device further includes: a frame that vertically movably supports the upper bearing while supporting the lower bearing; a screw cylinder screwed in the frame above the upper bearing; and a biasing member interposed between the upper bearing and the screw cylinder to bias the upper bearing toward the lower bearing. The upper bearing includes a first receiver on which the biasing member abuts, the screw cylinder includes a second receiver on which the biasing member abuts, the second receiver being provided with an engagement portion that engages with the biasing member, a direction of the biasing member intersecting with a biasing direction of the upper bearing is positioned by the engagement portion, and the engagement portion is formed to have a length capable of engaging with the biasing member in a state in which an interval between the first receiver and the second

receiver is larger than a natural length of the biasing member.

[0029] Consequently, an excessive pressing force is not applied to the bag body, and damage to the bag body can be prevented.

ADVANTAGEOUS EFFECTS OF INVENTION

[0030] According to the present invention, the bag body having the large thickness can appropriately be compressed by the roller pair, and the solidified aggregate material can be pulverized or granulated by efficiently loosening the solidified aggregate material.

BRIEF DESCRIPTION OF DRAWINGS

[0031]

FIG. 1 is a side view illustrating a loosening device.
FIG. 2 is a plan view illustrating the loosening device.
FIG. 3 is a front view illustrating the loosening device.
FIG. 4 is a rear view illustrating the loosening device.
FIG. 5 is an enlarged side view illustrating a first roller unit and a second roller unit.
FIG. 6 is an enlarged side view illustrating a third roller unit and a fourth roller unit.
FIG. 7 is a side view illustrating the first roller unit in a state where a screw cylinder moves upward and an interval between a spring receiver of the screw cylinder and an upper bearing spring receiver becomes larger than a natural length of a push spring.

DESCRIPTION OF EMBODIMENT

[0032] A solidified material loosening device according to the present invention will be described below with reference to accompanying drawings.

[0033] A loosening device 1 that is a solidified material loosening device according to an embodiment of the present invention is a solidified material loosening device that conveys a bag body W accommodating a powdery or granular material solidified and aggregated while compressing the bag body W using a plurality of roller pairs including upper rollers 11, 21, 31, 41 and lower rollers 12, 22, 32, 42 each having a surface provided with irregularities, thereby loosening the aggregate material to pulverize or granulate the aggregate material.

[0034] Examples of the powdery or granular material accommodated in the bag body W include salt, citric acid, boric acid, resin pellets, and cement. When such a powdery or granular material is stored in a storage place such as a warehouse while accommodated in the bag body, the powdery or granular material is often solidified into an aggregate by absorbing moisture or being compressed during storage. In this way, the material solidified during the storage in the bag body W is loosened by the loosening device 1 to be pulverized or granulated.

[0035] In the following description, a "right side", a "left side", a "near side", and a "depth side" in FIG. 1 are defined as a "front side", a "rear side", a"left side," and a "right side" of the loosening device 1, respectively. An "upper side" and a "lower side" in FIG. 1 are defined as an "upper side" and a "lower side" of the loosening device 1, respectively.

[0036] As illustrated in FIGS. 1 to 4, the loosening device 1 includes a rectangular base frame 2 that is long in a front-rear direction. Casters 2a are attached to four corners of the base frame 2, and the loosening device 1 can be moved by the casters 2a.

[0037] Support rods 2b extend obliquely upward from the four corners of the base frame 2. Support frames 3 are erected on left and right sides in a center portion in the front-rear direction of the base frame 2. The support frame 3 includes a horizontal frame 3f that is horizontally mounted on upper ends of vertical frames 3a, 3b, 3c, 3d, 3e extending upward from the base frame 2 and the support frame 3, and couples the upper ends of the vertical frames 3a, 3b, 3c, 3d, 3e.

[0038] The vertical frame 3a, the vertical frame 3b, the vertical frame 3c, the vertical frame 3d, and the vertical frame 3e are sequentially disposed from the front toward the rear in the support frame 3.

[0039] The support frame 3 is an example of a frame that vertically movably supports the upper bearings 15, 25, 35, 45 while supporting the lower bearings 13, 23, 33, 43.

[0040] A front-side conveyor 5 is disposed in front of the support frame 3. The front-side conveyor 5 is supported above the base frame 2 by the support rod 2b and the vertical frame 3a of the support frame 3.

[0041] The front-side conveyor 5 includes support frames 5a that are disposed on the left and right and supported by the support rod 2b and the vertical frame 3a, a driving roller 5b rotatably supported by the left and right support frames 5a, a driven roller 5c that is disposed on the front of the driving roller 5b and is rotatably supported by the left and right support frames 5a, and a belt 5d entrained about the driving roller 5b and the driven roller 5c.

[0042] A motor 50 is installed in the base frame 2 below the front-side conveyor 5. A rotating body 50a such as a sprocket is integrally and rotatably provided on the rotating shaft of the motor 50, and a rotating body (not illustrated) such as a sprocket is integrally and rotatably provided on the driving roller 5b. An endless transmission body 51 such as a chain is entrained between the rotating body 50a of the motor 50 and the rotating body of the driving roller 5b, and the driving roller 5b is rotated by the motor 50 through the transmission body 51. When the driving roller 5b is rotated, the front-side conveyor 5 is driven to convey the bag body W placed on the front-side conveyor 5.

[0043] A rear-side conveyor 6 is disposed behind the support frame 3. The rear-side conveyor 6 is supported at the same height as the front-side conveyor 5 by the support rod 2b and the vertical frame 3a of the support frame 3 above the base frame 2.

[0044] The rear-side conveyor 6 includes support frames 6a that are disposed on the left and right and supported by the support rod 2b and the vertical frame 3a, a driving roller 6b rotatably supported by the left and right support frames 6a, a driven roller 6c that is disposed on the rear of the driving roller 6b and is rotatably supported by the left and right support frames 6a, and a belt 6d entrained about the driving roller 6b and the driven roller 6c.

[0045] A motor 60 is installed on the base frame 2 below the rear-side conveyor 6. A rotating body 60a such as a sprocket is integrally and rotatably provided on the rotating shaft of the motor 60, and a rotating body (not illustrated) such as a sprocket is integrally and rotatably provided on the driving roller 6b. An endless transmission body 61 such as a chain is entrained between the rotating body 60a of the motor 60 and the rotating body of the driving roller 6b, and the driving roller 6b is rotated by the motor 60 through the transmission body 61. When the driving roller 6b is rotated, the rear-side conveyor 6 is driven to convey the bag body W placed on the rear-side conveyor 6.

[0046] A position sensor 6e is provided at the rear end of the rear-side conveyor 6. The position sensor 6e is a sensor that detects the position of the bag body W conveyed by the rear-side conveyor 6, and is constructed with, for example, a photoelectric sensor.

[0047] A first roller unit 10, a second roller unit 20, a third roller unit 30, and a fourth roller unit 40 are arranged between the front-side conveyor 5 and the rear-side conveyor 6. The first roller unit 10, the second roller unit 20, the third roller unit 30, and the fourth roller unit 40 are sequentially disposed from the front toward the rear.

[0048] As illustrated in FIG. 5, the first roller unit 10 is disposed between the vertical frame 3a and the vertical frame 3b, and includes an upper roller 11 and a lower roller 12. In the upper roller 11 and the lower roller 12, a left-right direction is set to a rotation axis direction. The upper roller 11 is disposed above the lower roller 12 at a predetermined interval. The upper roller 11 and the lower roller 12 constitute a first roller pair.

[0049] A plurality of protrusions 12a are formed on an outer circumferential surface of the lower roller 12, and a recess 12b is formed between the adjacent protrusions 12a. The protrusion 12a and the recess 12b constitute the irregularities on the surface of the lower roller 12.

[0050] Lower bearings 13 are disposed at both ends in the axial direction of the lower roller 12, and the lower roller 12 is rotatably supported by the lower bearings 13 located at both the ends.

[0051] The lower bearing 13 is supported by the vertical frame 3a and the vertical frame 3b between the vertical frame 3a and the vertical frame 3b.

[0052] A rotating body 13a such as a sprocket is disposed at the left end of the lower roller 12 so as to be rotatable integrally with the lower roller 12.

[0053] A plurality of protrusions 11a are formed on the outer circumferential surface of the upper roller 11, and a recess 11b is formed between the adjacent protrusions 11a. The protrusions 11a and the recesses 11b constitute the irregularities on the surface of the upper roller 11.

[0054] Upper bearings 15 are disposed at both ends in the axial direction of the upper roller 11, and the upper roller 11 is rotatably supported by the upper bearings 15 located at both the ends.

[0055] A rotating body 15a such as a sprocket is disposed at the left end of the upper roller 11 so as to be rotatable integrally with the upper roller 11.

[0056] A guide plate 19 is formed on each of the vertical frame 3a and the vertical frame 3b. The guide plate 19 formed on the vertical frame 3a protrudes rearward from the rear side surface of the vertical frame 3a, and extends in the vertical direction. The guide plate 19 formed on the vertical frame 3b protrudes forward from the front side surface of the vertical frame 3b, and extends in the vertical direction.

[0057] Engagement grooves (not illustrated) that engage with the guide plate 19 are formed at the front end and the rear end of the upper bearing 15, and the engagement groove of the upper bearing 15 and the guide plate 19 are engaged with each other, which allows the upper bearing 15 to be vertically slidably supported by the vertical frame 3a and the vertical frame 3b.

[0058] A support member 14 is disposed between the lower bearing 13 and the upper bearing 15. The support member 14 is supported by the vertical frame 3a and the vertical frame 3b, and abuts on the lower end of the upper bearing 15 to regulate the downward movement of the upper bearing 15. That is, the support member 14 acts as a receiving member that receives the upper bearing 15.

[0059] The support member 14 includes a long nut 14a fixed to the vertical frame 3a and the vertical frame 3b, a bolt

14b screwed in the long nut 14a, and an abutment portion 14c that is attached to a head of the bolt 14b to abut on the lower end of the upper bearing 15.

[0060] The bolt 14b of the support member 14 abuts on the upper bearing 15 with the abutment portion 14c interposed therebetween to regulate the downward movement of the upper bearing 15, whereby an interval Sa between the upper roller 11 and the lower roller 12 is maintained.

[0061] In the support member 14, a vertical length of the support member 14 is adjusted by changing a screwing amount of the bolt 14b in the long nut 14a, namely, an extension length of the bolt 14b from the long nut 14a, and the size of the interval Sa can be changed. The vertical length of the support member 14 refers to a length from the lower end to the upper end of the support member 14. In the embodiment, the length from the lower end of the long nut 14a to the upper end of the abutment portion 14c is the vertical length of the support member 14.

[0062] The support member 14 includes a lock nut 14d that regulates the rotation of the bolt 14b with respect to the long nut 14a to fix the screwing amount of the bolt 14b with respect to the long nut 14a. The interval Sa between the upper roller 11 and the lower roller 12 can be prevented from changing abruptly by regulating the rotation of the bolt 14b with respect to the long nut 14a using the lock nut 14d.

[0063] In the embodiment, the support member 14 is configured such that the vertical length can be adjusted by screwing the bolt 14b in the long nut 14a. However, the present invention is not limited to this configuration, and the support member 14 may be constructed with other members, such as a hydraulic cylinder and an air cylinder, which can expand and contract.

[0064] A nut 18 is formed in a portion between the vertical frame 3a and the vertical frame 3b in the horizontal frame 3f. In the nut 18, the vertical direction is set to the axial direction. The nut 18 pierces the horizontal frame 3f. A screw cylinder 17 in which a screw is formed on the outer circumferential surface is screwed in the nut 18. A spring receiver 17a is formed at the lower end of the screw cylinder 17, and a handle 17b is provided at the upper end of the screw cylinder 17. The screw cylinder 17 can vertically be moved by rotating the screw cylinder 17 with respect to the nut 18 using the handle 17b. The spring receiver 17a is an example of the second receiver on which a push spring 16 abuts.

[0065] A spring receiver 15b is formed at the upper end of the upper bearing 15. The spring receiver 15b is an example of the first receiver on which the push spring 16 abuts.

[0066] The push spring 16 is interposed between the spring receiver 15b and the spring receiver 17a, and the upper bearing 15 is biased downward by the push spring 16. The push spring 16 is constructed with a compression coil spring.

[0067] An engagement portion 17b, which is inserted into the push spring 16 to engage with the push spring 16, is formed in the spring receiver 17a. The positioning of the push spring 16 in a direction intersecting with a biasing direction with respect to the upper bearing 15 is performed by engaging the engagement portion 17b with the push spring 16.

[0068] When the bag body W is conveyed between the upper roller 11 and the lower roller 12 to apply force larger than combined force of biasing force of the push spring 16 and a weight of the upper roller 11 from the bag body W to the upper roller 11, the lower roller 12 moves upward from the position abutting the support member 14, and appropriate pressing force due to the biasing force of the push spring 16 is provided to the bag body W through the upper roller 11.

[0069] The magnitude of the biasing force applied to the upper bearing 15 by the push spring 16 can be adjusted by rotating the screw cylinder 17 to vertically move the screw cylinder 17 using the handle 17b.

[0070] An upper rotating body 52 and a lower rotating body 53 are vertically disposed side by side above the motor 50 and in front of the support frame 3. In the upper rotating body 52 and the lower rotating body 53, the left-right direction is set to the rotation axis direction. A spur gear (not illustrated) in which the left-right direction is set to the rotation axis direction is integrally and rotatably provided in each of the upper rotating body 52 and the lower rotating body 53, and the spur gear of the upper rotating body 52 engages with the spur gear of the lower rotating body 53.

[0071] An endless transmission body 54 such as a chain is entrained between the rotating body 50a of the motor 50 and the lower rotating body 53, and the lower rotating body 53 is rotated by the motor 50 through the transmission body 54.

[0072] An endless transmission body 55 such as a chain is entrained between the upper rotating body 52 and the rotating body 15a of the upper roller 11, and an endless transmission body 56 such as a chain is entrained between the lower rotating body 53 and the rotating body 13a of the lower roller 12.

[0073] When the lower rotating body 53 is rotated by the motor 50, the lower roller 12 is rotated through the transmission body 56 by the lower rotating body 53. When the lower rotating body 53 is rotated, the upper rotating body 52 rotates to the side opposite to the lower rotating body 53, and the upper roller 11 is rotated through the transmission body 55 by the rotation of the upper rotating body 52.

[0074] The upper roller 11 and the lower roller 12 rotate such that the protrusion 11a of the upper roller 11 engages with the recess 12b of the lower roller 12, and such that the protrusion 12a of the lower roller 12 engages with the recess 11b of the upper roller 11.

[0075] The second roller unit 20 is disposed between the vertical frame 3b and the vertical frame 3c, and located adjacent to the rear of the first roller unit 10. The second roller unit 20 includes an upper roller 21 and a lower roller 22.

[0076] The upper roller 21 and the lower roller 22 are configured in the same manner as the upper roller 11 and the lower roller 12, respectively. A protrusion 21a and a recess 21b are formed in the upper roller 21, and a protrusion 22a

and a recess 22b are formed in the lower roller 22.

[0077] However, the shapes of the protrusion 21a and the recess 21b of the upper roller 21 and the protrusion 22a and the recess 22b of the lower roller 22 can be different from the shapes of the protrusion 11a and the recess 11b of the upper roller 11 and the protrusion 12a and the recess 12b of the lower roller 12.

[0078] Lower bearings 23 are disposed at both ends in the axial direction of the lower roller 22, and the lower roller 22 is rotatably supported by the lower bearings 23 located at both the ends.

[0079] The lower bearing 23 is supported by the vertical frame 3b and the vertical frame 3c between the vertical frame 3b and the vertical frame 3c.

[0080] A rotating body 23a such as a sprocket is disposed at the left end of the lower roller 22 so as to be rotatable integrally with the lower roller 22.

[0081] Upper bearings 25 are disposed at both ends in the axial direction of the upper roller 21, and the upper roller 21 is rotatably supported by the upper bearings 25 located at both the ends.

[0082] A rotating body 25a such as a sprocket is disposed at the left end of the upper roller 21 so as to be rotatable integrally with the upper roller 21.

[0083] A guide plate 29 is formed on each of the vertical frame 3b and the vertical frame 3c. The guide plate 29 formed on the vertical frame 3b protrudes rearward from the rear side surface of the vertical frame 3b, and extends in the vertical direction. The guide plate 29 formed on the vertical frame 3c protrudes forward from the front side surface of the vertical frame 3c, and extends in the vertical direction.

[0084] The upper bearing 25 is configured in the same manner as the upper bearing 15, and the upper bearing 25 is slidably supported in the vertical direction by the vertical frame 3b and the vertical frame 3c by engaging the engagement groove of the upper bearing 25 with the guide plate 29.

[0085] A support member 24 is disposed between the lower bearing 23 and the upper bearing 25. The support member 24 is supported by the vertical frame 3b and the vertical frame 3c, and abuts on the lower end of the upper bearing 25 to regulate the downward movement of the upper bearing 25. That is, the support member 24 acts as a receiving member that receives the upper bearing 25.

[0086] The support member 24 is configured in the same manner as the support member 14, and includes a long nut 24a fixed to the vertical frame 3b and the vertical frame 3c, a bolt 24b screwed in the long nut 24a, and an abutment portion 24c that is attached to the head of the bolt 24b to abut on the lower end of the upper bearing 25.

[0087] The bolt 24b of the support member 24 abuts on the upper bearing 25 with the abutment portion 24c interposed therebetween to regulate the downward movement of the upper bearing 25, whereby an interval Sb between the upper roller 21 and the lower roller 22 is maintained. The interval Sb is set smaller than the interval Sa.

[0088] In the support member 24, the vertical length of the support member 14 is adjusted by changing the screwing amount of the bolt 24b in the long nut 24a, namely, the extension length of the bolt 24b from the long nut 24a, and the size of the interval Sb can be changed. The vertical length of the support member 14 refers to a length from the lower end to the upper end of the support member 14. In the embodiment, the length from the lower end of the long nut 14a to the upper end of the abutment portion 14c is the vertical length of the support member 14.

[0089] The support member 24 includes a lock nut 24d that regulates the rotation of the bolt 24b with respect to the long nut 24a to fix the screwing amount of the bolt 24b with respect to the long nut 24a.

[0090] A nut 28 configured in the same manner as the nut 18 is formed in a portion between the vertical frame 3b and the vertical frame 3c in the horizontal frame 3f. A screw cylinder 27 configured in the same manner as the screw cylinder 17 is screwed in the nut 28. The screw cylinder 27 includes a spring receiver 27a and a handle 27b. The spring receiver 27a is an example of the second receiver on which a push spring 26 abuts.

[0091] A spring receiver 25b is formed at the upper end of the upper bearing 25. The spring receiver 25b is an example of the first receiver on which the push spring 26 abuts.

[0092] The push spring 26 is interposed between the spring receiver 25b and the spring receiver 27a, and the upper bearing 25 is biased downward by the push spring 26. The push spring 26 is constructed with a compression coil spring.

[0093] An engagement portion 27b that is inserted into the push spring 26 to engage with the push spring 26 is formed in the spring receiver 27a. The positioning of the push spring 26 in the direction intersecting with the biasing direction with respect to the upper bearing 25 is performed by engaging the engagement portion 27b with the push spring 26.

[0094] When the bag body W is conveyed between the upper roller 21 and the lower roller 22 to apply force larger than combined force of the biasing force of the push spring 26 and the weight of the upper roller 21 from the bag body W to the upper roller 21, the lower roller 22 moves upward from the position abutting the support member 24, and the appropriate pressing force due to the biasing force of the push spring 26 is provided to the bag body W through the upper roller 21.

[0095] The magnitude of the biasing force applied to the upper bearing 25 by the push spring 26 can be adjusted by vertically moving the screw cylinder 27.

[0096] An endless transmission body 57 such as a chain is entrained between the upper rotating body 52 and the rotating body 25a of the upper roller 21. An endless transmission body 58 such as a chain is entrained between the

rotating body 23a of the lower roller 22 and a rotating body (not illustrated) that rotates integrally with the rotating body 13a of the lower roller 12.

[0097] When the lower rotating body 53 is rotated by the motor 50, the lower roller 22 is rotated through the transmission body 58 by the lower rotating body 53. The upper roller 21 is rotated through the transmission body 57 by the rotation of the upper rotating body 52.

[0098] As illustrated in FIG. 6, the third roller unit 30 is disposed between the vertical frame 3c and the vertical frame 3d, and located adjacent to the rear of the second roller unit 20. The third roller unit 30 includes an upper roller 31 and a lower roller 32.

[0099] The upper roller 31 and the lower roller 32 are configured in the same manner as the upper roller 11 and the lower roller 12, respectively. A protrusion 31a and a recess 31b are formed in the upper roller 31, and a protrusion 32a and a recess 32b are formed in the lower roller 32.

[0100] However, the shapes of the protrusion 31a and the recess 31b of the upper roller 31 and the protrusion 32a and the recess 32b of the lower roller 32 can be different from the shapes of the protrusion 11a and the recess 11b of the upper roller 11 and the protrusion 12a and the recess 12b of the lower roller 12.

[0101] Lower bearings 33 are disposed at both ends in the axial direction of the lower roller 32, and the lower roller 32 is rotatably supported by the lower bearings 33 located at both the ends.

[0102] The lower bearing 33 is supported by the vertical frame 3c and the vertical frame 3d between the vertical frame 3c and the vertical frame 3d.

[0103] A rotating body 33a such as a sprocket is disposed at the left end of the lower roller 32 so as to be rotatable integrally with the lower roller 32.

[0104] Upper bearings 35 are disposed at both ends in the axial direction of the upper roller 31, and the upper roller 31 is rotatably supported by the upper bearings 35 located at both the ends.

[0105] A rotating body 35a such as a sprocket is disposed at the left end of the upper roller 31 so as to be rotatable integrally with the upper roller 31.

[0106] A guide plate 39 is formed on each of the vertical frame 3c and the vertical frame 3d. The guide plate 39 formed on the vertical frame 3c protrudes rearward from the rear side surface of the vertical frame 3c, and extends in the vertical direction. The guide plate 39 formed on the vertical frame 3d protrudes forward from the front side surface of the vertical frame 3d, and extends in the vertical direction.

[0107] The upper bearing 35 is configured in the same manner as the upper bearing 15, and the upper bearing 35 is slidably supported in the vertical direction by the vertical frame 3c and the vertical frame 3d by engaging the engagement groove of the upper bearing 35 with the guide plate 39.

[0108] A support member 34 is disposed between the lower bearing 33 and the upper bearing 35. The support member 34 is supported by the vertical frame 3c and the vertical frame 3d, and abuts on the lower end of the upper bearing 35 to regulate the downward movement of the upper bearing 35. That is, the support member 34 acts as a receiving member that receives the upper bearing 35.

[0109] The support member 34 is configured in the same manner as the support member 14, and includes a long nut 34a fixed to the vertical frame 3c and the vertical frame 3d, a bolt 34b screwed in the long nut 34a, and an abutment portion 34c that is attached to the head of the bolt 34b to abut on the lower end of the upper bearing 35.

[0110] The bolt 34b of the support member 34 abuts on the upper bearing 35 with the abutment portion 34c interposed therebetween to regulate the downward movement of the upper bearing 35, whereby an interval Sc between the upper roller 31 and the lower roller 32 is maintained. The interval Sc is set smaller than the interval Sb.

[0111] In the support member 34, the vertical length of the support member 14 is adjusted by changing the screwing amount of the bolt 34b in the long nut 34a, namely, the extension length of the bolt 34b from the long nut 34a, and the size of the interval Sc can be changed. The vertical length of the support member 14 refers to a length from the lower end to the upper end of the support member 14. In the embodiment, the length from the lower end of the long nut 14a to the upper end of the abutment portion 14c is the vertical length of the support member 14.

[0112] The support member 34 includes a lock nut 34d that regulates the rotation of the bolt 34b with respect to the long nut 34a to fix the screwing amount of the bolt 34b with respect to the long nut 34a.

[0113] A nut 38 configured in the same manner as the nut 18 is formed in a portion between the vertical frame 3c and the vertical frame 3d in the horizontal frame 3f. A screw cylinder 37 configured in the same manner as the screw cylinder 17 is screwed in the nut 38. The screw cylinder 37 includes a spring receiver 37a and a handle 37b. The spring receiver 37a is an example of the second receiver on which a push spring 36 abuts.

[0114] A spring receiver 35b is formed at the upper end of the upper bearing 35. The spring receiver 35b is an example of the first receiver on which the push spring 36 abuts.

[0115] The push spring 36 is interposed between the spring receiver 35b and the spring receiver 37a, and the upper bearing 35 is biased downward by the push spring 36. The push spring 36 is constructed with a compression coil spring.

[0116] An engagement portion 37b that is inserted into the push spring 36 to engage with the push spring 36 is formed in the spring receiver 37a. The positioning of the push spring 36 in the direction intersecting with the biasing direction

with respect to the upper bearing 35 is performed by engaging the engagement portion 37b with the push spring 36.

[0117] When the bag body W is conveyed between the upper roller 31 and the lower roller 32 to apply force larger than combined force of the biasing force of the push spring 36 and the weight of the upper roller 31 from the bag body W to the upper roller 31, the lower roller 32 moves upward from the position abutting the support member 34, and the appropriate pressing force due to the biasing force of the push spring 36 is provided to the bag body W through the upper roller 31.

[0118] The magnitude of the biasing force applied to the upper bearing 35 by the push spring 36 can be adjusted by vertically moving the screw cylinder 37.

[0119] An upper rotating body 62 and a lower rotating body 63 are vertically disposed side by side above the motor 60 and behind the support frame 3. In the upper rotating body 62 and the lower rotating body 63, the left-right direction is set to the rotation axis direction. A spur gear (not illustrated) in which the left-right direction is set to the rotation axis direction is integrally and rotatably provided in each of the upper rotating body 62 and the lower rotating body 63, and the spur gear of the upper rotating body 62 engages with the spur gear of the lower rotating body 63.

[0120] An endless transmission body 64 such as a chain is entrained between the rotating body 60a of the motor 60 and the lower rotating body 63, and the lower rotating body 63 is rotated by the motor 60 through the transmission body 64.

[0121] An endless transmission body 65 such as a chain is entrained between the upper rotating body 62 and the rotating body 35a of the upper roller 31.

[0122] An endless transmission body 68 such as a chain is entrained between the lower rotating body 63 and the rotating body 43a of the lower roller 42 of the fourth roller unit 40 (to be described later), and an endless transmission body 66 such as a chain is entrained between a rotating body (not illustrated) that rotates integrally with the body 43a of the lower roller 42 and the rotating body 33a of the lower roller 32.

[0123] When the lower rotating body 63 is rotated by the motor 60, the lower roller 42 is rotated through the transmission body 68 by the lower rotating body 63. When the lower roller 42 is rotated, the lower roller 32 is rotated through the transmission body 66. When the lower rotating body 63 is rotated, the upper rotating body 62 rotates to the side opposite to the lower rotating body 63, and the upper roller 31 is rotated through the transmission body 65 by the rotation of the upper rotating body 62.

[0124] The fourth roller unit 40 is disposed between the vertical frame 3d and the vertical frame 3e, and located adjacent to the rear of the third roller unit 30. The fourth roller unit 40 includes an upper roller 41 and a lower roller 42.

[0125] The upper roller 41 and the lower roller 42 are configured in the same manner as the upper roller 11 and the lower roller 12, respectively. A protrusion 41a and a recess 41b are formed in the upper roller 41, and a protrusion 42a and a recess 42b are formed in the lower roller 42.

[0126] However, the shapes of the protrusion 41a and the recess 41b of the upper roller 41 and the protrusion 42a and the recess 42b of the lower roller 42 can be different from the shapes of the protrusion 11a and the recess 11b of the upper roller 11 and the protrusion 12a and the recess 12b of the lower roller 12.

[0127] Lower bearings 43 are disposed at both ends in the axial direction of the lower roller 42, and the lower roller 42 is rotatably supported by the lower bearings 43 located at both the ends.

[0128] The lower bearing 43 is supported by the vertical frame 3d and the vertical frame 3e between the vertical frame 3d and the vertical frame 3e.

[0129] A rotating body 43a such as a sprocket is disposed at the left end of the lower roller 42 so as to be rotatable integrally with the lower roller 42.

[0130] Upper bearings 45 are disposed at both ends in the axial direction of the upper roller 41, and the upper roller 41 is rotatably supported by the upper bearings 45 located at both the ends.

[0131] A rotating body 45a such as a sprocket is disposed at the left end of the upper roller 41 so as to be rotatable integrally with the upper roller 41.

[0132] A guide plate 49 is formed on each of the vertical frame 3d and the vertical frame 3e. The guide plate 49 formed on the vertical frame 3d protrudes rearward from the rear side surface of the vertical frame 3d, and extends in the vertical direction. The guide plate 49 formed on the vertical frame 3e protrudes forward from the front side surface of the vertical frame 3e, and extends in the vertical direction.

[0133] The upper bearing 45 is configured in the same manner as the upper bearing 15, and the upper bearing 45 is slidably supported in the vertical direction by the vertical frame 3d and the vertical frame 3e by engaging the engagement groove of the upper bearing 45 with the guide plate 49.

[0134] A support member 44 is disposed between the lower bearing 43 and the upper bearing 45. The support member 44 is supported by the vertical frame 3d and the vertical frame 3e, and abuts on the lower end of the upper bearing 45 to regulate the downward movement of the upper bearing 45. That is, the support member 44 acts as a receiving member that receives the upper bearing 45.

[0135] The support member 44 is configured in the same manner as the support member 14, and includes a long nut 44a fixed to the vertical frame 3d and the vertical frame 3e, a bolt 44b screwed in the long nut 44a, and an abutment portion 44c that is attached to the head of the bolt 44b to abut on the lower end of the upper bearing 45.

[0136] The bolt 44b of the support member 44 abuts on the upper bearing 45 with the abutment portion 44c interposed therebetween to regulate the downward movement of the upper bearing 45, whereby an interval Sd between the upper roller 41 and the lower roller 42 is maintained. The interval Sd is set smaller than the interval Sc.

[0137] In the support member 44, the vertical length of the support member 14 is adjusted by changing the screwing amount of the bolt 44b in the long nut 44a, namely, the extension length of the bolt 44b from the long nut 44a, and the size of the interval Sd can be changed. The vertical length of the support member 14 refers to a length from the lower end to the upper end of the support member 14. In the embodiment, the length from the lower end of the long nut 14a to the upper end of the abutment portion 14c is the vertical length of the support member 14.

[0138] The support member 44 includes a lock nut 44d that regulates the rotation of the bolt 44b with respect to the long nut 44a to fix the screwing amount of the bolt 44b with respect to the long nut 44a.

[0139] A nut 48 configured in the same manner as the nut 18 is formed in a portion between the vertical frame 3c and the vertical frame 3d in the horizontal frame 3f. A screw cylinder 47 configured in the same manner as the screw cylinder 17 is screwed in the nut 48. The screw cylinder 47 includes a spring receiver 47a and a handle 47b. The spring receiver 47a is an example of the second receiver on which a push spring 46 abuts.

[0140] A spring receiver 45b is formed at the upper end of the upper bearing 45. The spring receiver 45b is an example of the first receiver on which the push spring 46 abuts.

[0141] The push spring 46 is interposed between the spring receiver 45b and the spring receiver 47a, and the upper bearing 45 is biased downward by the push spring 46. The push spring 46 is constructed with a compression coil spring.

[0142] An engagement portion 47b, which is inserted into the push spring 46 to engage with the push spring 46, is formed in the spring receiver 47a. The positioning of the push spring 46 in the direction intersecting with the biasing direction with respect to the upper bearing 45 is performed by engaging the engagement portion 47b with the push spring 46.

[0143] When the bag body W is conveyed between the upper roller 41 and the lower roller 42 to apply force larger than combined force of the biasing force of the push spring 46 and the weight of the upper roller 41 from the bag body W to the upper roller 41, the lower roller 42 moves upward from the position abutting the support member 44, and the appropriate pressing force due to the biasing force of the push spring 46 is provided to the bag body W through the upper roller 41.

[0144] The magnitude of the biasing force applied to the upper bearing 45 by the push spring 46 can be adjusted by vertically moving the screw cylinder 47.

[0145] An endless transmission body 67 such as a chain is entrained between the upper rotating body 62 and the rotating body 45a of the upper roller 41. As described above, the endless transmission body 68 such as a chain is entrained between the lower rotating body 63 and the rotating body 43a of the lower roller 42. When the lower rotating body 63 is rotated by the motor 60, the lower roller 42 is rotated through the transmission body 68 by the lower rotating body 63. The upper roller 41 is rotated through the transmission body 67 by the rotation of the upper rotating body 62.

[0146] A control panel 7 and an operation panel 8 are provided in a front portion of the loosening device 1. The control panel 7 is installed at the front end of the base frame 2, and the operation panel 8 is attached to the front end of the support frame 3. The control panel 7 controls drive of the motors 50, 60. Specifically, the control panel 7 can control the drive of the motors 50, 60 such that the bag body W is conveyed from the front toward the rear of the loosening device 1 and that the bag body W is conveyed from the rear toward the front of the loosening device 1, by the roller pairs of the roller units 10, 20, 30, 40, the front-side conveyor 5, and the rear-side conveyor 6.

[0147] The operation panel 8 includes an operation switch, a stop switch, a reverse rotation switch, and an emergency stop switch. An on signal and an off signal of each switch are input to the control panel 7.

[0148] When the operation switch is turned on, the control panel 7 drives the roller pairs of the roller units 10, 20, 30, 40, the front-side conveyor 5, and the rear-side conveyor 6 such that the bag body W is conveyed from the front toward the rear of the loosening device 1. When the reverse rotation switch is turned on, the control panel 7 drives the roller pairs of the roller units 10, 20, 30, 40, the front-side conveyor 5, and the rear-side conveyor 6 such that the bag body W is conveyed from the rear toward the front of the loosening device 1. When the stop switch is turned on, the control panel 7 stops the roller pairs of the roller units 10, 20, 30, 40, the front-side conveyor 5, and the rear-side conveyor 6. When the emergency stop switch is turned on, the control panel 7 stops all the operations of the loosening device 1.

[0149] In the loosening device 1 configured as described above, the direction from the front toward the rear is a positive conveyance direction of the bag body W, the front-side conveyor 5 is driven by the motor 50 when a worker places the bag body W, in which the powdery or granular material solidified into a mass is accommodated, on the front-side conveyor 5 to turn on the operation switch of the operation panel 8, and the bag body W is conveyed rearward toward the first roller unit 10.

[0150] A cover member 90 that can be opened and closed by turning about an opening and closing center 90a is disposed in front of the first roller unit 10 in the loosening device 1. When the bag body W having a height dimension larger than a predetermined height dimension is conveyed on the front-side conveyor 5, the cover member 90 is opened and the operation of the loosening device 1 is stopped by the control panel 7. Specifically, an interlock switch 91, which

is turned off when the cover member 90 is closed and turned on when the cover member 90 is opened, is disposed below the cover member 90, and the control panel 7 stops the operation of the loosening device 1 when the interlock switch 91 is turned on.

[0151] With this configuration, the bag body W having a height that cannot properly be sandwiched between the upper roller 11 and the lower roller 12 of the first roller unit 10 is prevented from being conveyed to the first roller unit 10.

[0152] The upper roller 11 and the lower roller 12 of the first roller unit 10 are rotated by driving force from the motor 50, the bag body W is drawn in between the upper roller 11 and the lower roller 12 when the bag body W reaches the first roller unit 10, and the bag body W is conveyed rearward while compressed from above and below by the upper roller 11 and the lower roller 12.

[0153] When passing through between the upper roller 11 and the lower roller 12, the aggregate material in the bag body W is loosened by pressure applied from the upper roller 11 and the lower roller 12 and the irregularities on the surfaces of the upper roller 11 and the lower roller 12.

[0154] In this case, the interval Sa between the upper roller 11 and the lower roller 12 is set to a size that allows the bag body formed in a substantially rectangular parallelepiped shape with a large thickness or the bag body formed in a columnar shape to pass through, and the bag body W can be drawn in between the upper roller 11 and the lower roller 12 and compressed with the appropriate pressing force even if the bag body W has a large thickness.

[0155] The bag body W having passed through the first roller unit 10 reaches the second roller unit 20, is drawn in between the upper roller 21 and the lower roller 22, and is conveyed rearward while compressed from above and below by the upper roller 21 and the lower roller 22.

[0156] The aggregate material in the bag body W is similarly loosened by the upper roller 21 and the lower roller 22 when passing through between the upper roller 21 and the lower roller 22.

[0157] In this case, because the interval Sb between the upper roller 21 and the lower roller 22 is set to be smaller than the interval Sa, the upper roller 21 and the lower roller 22 can apply the appropriate pressing force to the bag body W in which the aggregate is loosened by the first roller unit 10, and the remaining aggregate material can effectively be loosened.

[0158] The bag body W having passed through the second roller unit 20 reaches the third roller unit 30, is drawn in between the upper roller 31 and the lower roller 32, and is conveyed rearward while compressed from above and below by the upper roller 31 and the lower roller 32.

[0159] The aggregate material in the bag body W is similarly loosened by the upper roller 31 and the lower roller 32 when passing through between the upper roller 31 and the lower roller 32.

[0160] In this case, because the interval Sc between the upper roller 31 and the lower roller 32 is set to be smaller than the interval Sb, the upper roller 31 and the lower roller 32 can apply the appropriate pressing force to the bag body W in which the aggregate is loosened by the second roller unit 20, and the remaining aggregate material can effectively be loosened.

[0161] The bag body W having passed through the third roller unit 30 reaches the fourth roller unit 40, is drawn in between the upper roller 41 and the lower roller 42, and is conveyed rearward while compressed from above and below by the upper roller 41 and the lower roller 42.

[0162] The aggregate material in the bag body W is similarly loosened by the upper roller 41 and the lower roller 42 when passing through between the upper roller 41 and the lower roller 42.

[0163] In this case, because the interval Sd between the upper roller 41 and the lower roller 42 is set to be smaller than the interval Sc, the upper roller 41 and the lower roller 42 can apply the appropriate pressing force to the bag body W in which the aggregate is loosened by the third roller unit 30, and the remaining aggregate material can effectively be loosened.

[0164] In this way, in the loosening device 1, the bag body W passes through the roller units 10, 20, 30, 40 to loosen the aggregate material accommodated in the bag body W. The interval Sa of the roller pair in the first roller unit 10 is larger than the intervals Sb, Sc, Sd of the roller pairs in the second to fourth roller units 20, 30, 40, and becomes the large interval corresponding to the bag body W having the large thickness, so that the bag body W reaching the first roller unit 10 can smoothly be drawn in between the upper roller 11 and the lower roller 12 to apply the appropriate pressing force to the bag body W.

[0165] Consequently, the bag body W having the large thickness can appropriately be compressed by the upper roller 11 and the lower roller 12, and the solidified material can be pulverized or granulated by efficiently loosening the solidified material.

[0166] As in the case where the interval Sa between the roller pair in the first roller unit 10 is set to be extremely small with respect to the thickness of the bag body W, the bag body W can be prevented from being drawn in between the upper roller 11 and the lower roller 12, or the bag body W can be prevented from being damaged due to the application of the excessive pressing force to the bag body W.

[0167] The interval Sa between the roller pair in the first roller unit 10 can be set to a size in which the pressing force is applied to an extent that the wholly aggregate material in the bag body W is divided into several aggregates.

[0168] In the embodiment, the interval Sa between the roller pair in the first roller unit 10 on the most upstream side is larger than the intervals Sb, Sc, Sd of the roller pairs in the second to fourth roller units 20, 30, 40 located on the downstream side of the first roller unit 10. However, the present invention is not limited to this configuration. For example, the interval Sb between the roller pair in the second roller unit 20 may be set equal to the interval Sa between the roller pair in the first roller unit 10, and the intervals Sc, Sd of the roller pairs in the third and fourth roller units 30, 40 may be set smaller than the interval Sa between the roller pair in the first roller unit 10. Even in this case, the bag body W having the large thickness can appropriately be compressed by the upper roller 11 and the lower roller 12 and the upper roller 21 and the lower roller 22, and the solidified material can be pulverized or granulated by efficiently loosening the solidified material.

[0169] As described above, in the loosening device 1, in at least one of the roller pairs in the second to fourth roller units 20, 30, 40 located on the downstream side of the roller pair in the first roller unit 10 located on the most upstream side in the conveyance direction of the bag body W, the interval between the upper rollers 21, 31, 42 and the lower rollers 22, 32, 42 can be set smaller than the interval between the upper roller 11 and the lower roller 12 in the roller pair of the first roller unit 10.

[0170] In this case, the interval Sb between roller pair of the second roller unit 20 can be set smaller than the interval Sa between roller pair of the first roller unit 10, the interval Sc between roller pair of the third roller unit 30 can be set smaller than the interval Sb between the roller pairs of the second roller unit 20, and the interval Sd between the roller pair of the fourth roller unit 40 can be set larger than the interval Sc between the roller pair of the third roller unit 30.

[0171] Because the interval between the roller pair in each of the roller units 10, 20, 30, 40 decreases in the order of the interval Sa, the interval Sb, the interval Sc, and the interval Sd along the conveyance direction of the bag body W, the pressing force applied to the bag body W in the roller units 10, 20, 30, 40 can be set to an appropriate magnitude according to the degree of powdery or granular state of the material, and the aggregate material in the bag body W can gradually be loosened and efficiently be pulverized or granulated.

[0172] In the loosening device 1, a difference between the interval Sa of the roller pair in the first roller unit 10 and the interval Sb of the roller pair in the second roller unit 20 can be set larger than a difference between the interval Sc of the roller pair in the second roller unit 20 and the interval Sc of the roller pair in the third roller unit 30 and a difference between the interval Sc of the roller pair in the third roller unit 30 and the interval Sd of the roller pair in the fourth roller unit 40.

[0173] With this configuration, the interval Sa between the roller pair on the most upstream side can be set significantly larger than the intervals Sb, Sc, Sd of the roller pairs on the downstream side. After the first roller unit 10 on the most upstream side decreases the thickness of the bag body W by drawing in the bag body W having the large thickness to divide the aggregate material in the bag body W into a plurality of small aggregates, the second to fourth roller units 20, 30, 40 on the downstream side finely loosen the aggregate material into powdery or granular state, which allows the material to be efficiently pulverized or granulated.

[0174] In the loosening device 1, the lower rollers 12, 22, 32, 42 in the roller units 10, 20, 30, 40 are disposed at the same height position, and the upper ends of the lower rollers 12, 22, 32, 42 and the upper surfaces of the front-side conveyor 5 and the rear-side conveyor 6 are disposed at substantially the same height position.

[0175] Further, each of the support members 14, 24, 34, 44 is supported by the support frame 3 such that the lower end positions of the support members 14, 24, 34, 44 are set at the same height position, the vertical lengths of the support members 14, 24, 34, 44 are decreased in the order of the support member 14, the support member 24, the support member 34, and the support member 44.

[0176] Thus, the height positions of the upper rollers 11, 21, 31, 41 supported from below by the support members 14, 24, 34, 44 are decreased in the order of the upper roller 11, the upper roller 21, the upper roller 31, and the upper roller 41, and the intervals Sa, Sb, Sc, Sd of the roller pairs are decreased in the order of the interval Sa, the interval Sb, the interval Sc, and the interval Sd.

[0177] That is, the vertical lengths of the support members 14, 24, 34, 44 is configured such that the support member on the upstream side in the conveyance direction of the bag body W is larger than the support member on the downstream side, which allows the intervals Sa, Sb, Sc, Sd of the roller pairs to be set so as to decrease from the upstream side to the downstream side in the conveyance direction of the bag body W with a simple configuration.

[0178] The support members 14, 24, 34, 44 are configured such that the vertical length is adjustable. Thus, in the loosening device 1, the intervals Sa, Sb, Sc, Sd of the roller pairs are individually set according to the thickness of the bag body W and material characteristics such as a type of material in the bag body W, a degree of solidification, and ease of loosening, by adjusting the vertical lengths of the support members 14, 24, 34, 44, and the appropriate pressing force is applied to various bag bodies W to efficiently pulverize or granulate the material in the bag body W.

[0179] In particular, in the loosening device 1, the support member 14 includes the nut 14a fixed to the support frame 3 and the bolt 14b that is screwed in the nut 14a and detachably abuts on the upper bearing 15. The length of the support member 14 in the vertical direction can be adjusted by rotating the bolt 14b with respect to the nut 14a to change the extension length of the bolt 14b from the nut 14a, which allows the vertical length of the support member 14 to be

adjusted. Consequently, the vertical length of the support member 14 can be adjusted by a simple operation. The same applies to the support members 24, 34, 44.

[0180] In this case, because the intervals Sa, Sb, Sc, Sd of the roller pairs change according to the extension lengths of the bolts 14b, 24b, 34b, 44b from the nuts 14a, 24a, 34a, 44a, the extension lengths of bolts 14b, 24b, 34b, 44b from nuts 14a, 24a, 34a, 44a may be adjusted so as to decrease in the order of the bolt 14b, the bolt 24b, the bolt 34b, and the bolt 44b when the intervals Sa, Sb, Sc, Sd are set smaller in the order of the interval Sa, the interval Sb, the interval Sc, and the interval Sd.

[0181] The support member 14 includes the lock nut 14d that regulates the rotation of the bolt 14b with respect to the nut 14a. The lock nut 14d is screwed in the bolt 14b, the rotation of the bolt 14b with respect to the nut 14a is regulated by tightening the lock nut 14d until the lock nut 14d abuts on the upper end of the nut 14a, and the extension length of the bolt 14b from the nut 14a can be fixed. Consequently, the vertical length of the support member 14 can be fixed, and the interval Sa between the roller pair in the first roller unit 10 can be prevented from changing abruptly.

[0182] The same applies to the support members 24, 34, 44.

[0183] In the first roller unit 10 of the loosening device 1, when the push spring 16 interposed between the spring receiver 17a and the spring receiver 15b of the upper bearing 45 is compressed to bias the upper bearing 45 downward, the engagement portion 47b formed on the spring receiver 17a of the screw cylinder 17 engages with the push spring 16 to position the push spring 16 in a direction intersecting with the biasing direction of the upper bearing 45.

[0184] As illustrated in FIG. 7A, the engagement portion 47b of the spring receiver 17a is formed to have the length engageable with push spring 16 even in the state, in which the screw cylinder 17 moves upward by the operation of the handle 17b and an interval Lw between the spring receiver 17a and the spring receiver 15b becomes longer than a natural length Ls of the push spring 16. That is, the engagement portion 47b engages with the push spring 16 over a range of a plurality of turns from the upper end of the push spring 16, and the engagement portion 47b and the push spring 16 can engage with each other to position the push spring 16 in the direction intersecting with the biasing direction of the upper bearing 45 even in the state in which the spring receiver 17a moves upward to separate the spring receiver 17a from the upper end of the push spring 16 by a dimension Ld.

[0185] As described above, when the upper roller 11 moves upward while the spring receiver 17a and the upper end of the push spring 16 are separated from each other, the upper roller 11 does not receive the biasing force from the push spring 16 until a movement amount of the upper roller 11 reaches the dimension Ld, and the upper roller 11 receives the biasing force from the push spring 16 at a point of time the movement amount of the upper roller 11 exceeds the dimension Ld as illustrated in FIG. 7B.

[0186] When the bag body W having the thickness exceeding the thickness corresponding to the interval Sa between the upper roller 11 and the lower roller 12 is conveyed to the first roller unit 10, the upper roller 11 moves relatively largely upward due to the thickness of the bag body W. However, the upper roller 11 can move upward without receiving the biasing force from the push spring 16 by setting the spring receiver 17a and the push spring 16 to the state in which the spring receiver 17a and the push spring 16 are separated from each other. Thus, the excessive pressing force is not applied to the bag body W, and the bag body W can be prevented from being damaged.

[0187] The same applies to the second to fourth roller units 20, 30, 40.

[0188] As described above, the bag body W having passed through the first to fourth roller units 10, 20, 30, 40 is conveyed rearward by the rear-side conveyor 6.

[0189] When all the materials in the bag body W conveyed to the rear-side conveyor 6 are pulverized or granulated, the operation to loosen the material in the bag body W can be completed.

[0190] On the other hand, when the aggregate material remains at the point of time the bag body W is conveyed to the rear-side conveyor 6, or when the bag body W is to be returned to the front-side conveyor 5, the conveyance directions of the front-side conveyor 5, the first to fourth roller units 10, 20, 30, 40, and the rear-side conveyor 6 are reversed, the bag body W is conveyed in the reverse conveyance direction from the rear toward the front of the loosening device 1, and the operation to loosen the bag body W can be performed again by the fourth to first roller units 40, 30, 20, 10.

[0191] Specifically, when the bag body W conveyed rearward by the rear-side conveyor 6 reaches the position sensor 6e, the position sensor 6e detects the bag body W. When the position sensor 6e detects the bag body W, the control panel 7 reverses rotation directions of the motors 50, 60, and the bag body W is conveyed from the back toward the front of the loosening device 1.

[0192] The bag body W conveyed from the rear to the front is loosened by pressing the bag body W using the roller pairs of the roller units 40, 30, 20, 10 when the bag body W passes through the roller units 40, 30, 20, 10. In particular, the intervals Sd, Sc, Sb of the roller pairs in the fourth to second roller units 40, 30, 20 are smaller than the interval Sa of the roller pair in the first roller unit 10, so that the material in the bag body W can efficiently be loosened.

[0193] For example, the thickness of the bag body W pressed by the roller pair of the fourth roller unit 40 increases when the bag body W is released from the pressing state of the roller pair, so that the bag body W can be loosened by the roller pairs of the roller units 40, 30, 20, 10 even if the bag body W having passed through the fourth roller unit 40 and conveyed to the rear-side conveyor 6 is conveyed forward.

[0194] Further, as described above, the interval Sb between the roller pair of the second roller unit 20 is set smaller than the interval Sa between the roller pair of the first roller unit 10, and the interval Sc between the roller pair of the third roller unit 30 is set smaller than the roller pair interval Sb between roller pair of the second roller unit 20, and the interval Sd between the roller pair of the fourth roller unit 40 is set larger than the interval Sc between the roller pair of the third roller unit 30, which allows the bag body W that is released from the pressing state to increase the thickness to be reliably compressed by the roller unit 40 when the bag body W is conveyed forward from the rear-side conveyor 6 toward the roller unit 40.

[0195] In the loosening device 1, the bag body W conveyed from the front-side conveyor 5 to the first roller unit 10 can be conveyed so as to be reciprocated between the first roller unit 10 and the second roller unit 20.

[0196] Specifically, the first roller unit 10 and the second roller unit 20 can be reciprocated between the first roller unit 10 and the second roller unit 20 such that the bag body W is conveyed rearward while pressed by the roller pair of the first roller unit 10, the conveyance direction is reversed to convey the bag body W forward after the bag body W is pressed while sandwiched by the roller pair of the second roller unit 20, and the bag body W is sandwiched by the roller pair of the first roller unit 10 again.

[0197] In this way, when the bag body W is conveyed so as to be reciprocated between the first roller unit 10 and the second roller unit 20, the aggregate material can be loosened until it is suitable for loosening using the roller units after the third roller unit 30 even if the material in the bag body W has a high degree of solidification, for example, which allows the aggregate material to be reliably pulverized or granulated.

[0198] The operation to reciprocate the bag body W between the roller units can be performed not only between the first roller unit 10 and the second roller unit 20, but also between appropriate roller units such as between the second roller unit 20 and the third roller unit 30 and between the second roller unit 20 and the fourth roller unit 40.

INDUSTRIAL APPLICABILITY

[0199] The present invention can be used for the solidified material loosening device that loosens the aggregate material by compressing the bag body accommodating the aggregate formed by collecting the powdery or granular materials, and particularly for the solidified material loosening device provided with a plurality of roller pairs including the upper roller and the lower roller.

REFERENCE SIGNS LIST

[0200]

1	Loosening device
3	Support frame
10	First roller unit
20	Second roller unit
30	Third roller unit
40	Fourth roller unit
11, 21, 31, 41	Upper roller
12, 22, 32, 42	Lower roller
13, 23, 33, 43	Lower bearing
14, 24, 34, 44	Support member
14a, 24a, 34a, 44a	Long nut
14b, 24b, 34b, 44b	Bolt
14d, 24d, 34d, 44d	Lock nut
15, 25, 35, 45	Upper bearing
15a, 25a, 35a, 45a	Spring receiver
16, 26, 36, 46	Push spring
17, 27, 37, 47	Screw cylinder
17a, 27a, 37a, 47a	Spring receiver
17b, 27b, 37b, 47b	Engagement portion
W	Bag body
Sa, Sb, Sc, Sd	Interval

Claims

1. A solidified material loosening device that conveys a bag body accommodating an aggregate formed by collecting powdery or granular materials while compressing the bag body using a roller pair including an upper roller and a lower roller each having a surface provided with irregularities, the solidified material loosening device comprising a plurality of the roller pairs arranged side by side along a conveyance direction of the bag body,
wherein an interval between the upper roller and the lower roller in at least one of the roller pairs located on a downstream side of the roller pair located on a most upstream side in the conveyance direction of the bag body is smaller than an interval between the upper roller and the lower roller in the roller pair located on the most upstream side.

2. The solidified material loosening device according to claim 1, wherein the interval between the upper roller and the lower roller in the roller pair located on the most upstream side in the conveyance direction of the bag body is larger than the interval between the upper roller and the lower roller in the roller pairs located on the downstream side of the roller pair located on the most upstream side.

3. The solidified material loosening device according to claim 1 or 2, wherein the interval between the upper roller and the lower roller in each roller pair decreases sequentially from the upstream side to the downstream side in the conveyance direction of the bag body.

4. The solidified material loosening device according to any one of claims 1 to 3, wherein a difference between the interval between the upper roller and the lower roller in the roller pair located on the most upstream side in the conveyance direction of the bag body and the interval between the upper roller and the lower roller in the roller pair adjacent to the roller pair located on the most upstream side is maximized with respect to a difference between the interval between the upper roller and the lower roller in the roller pair located on the most upstream side in the conveyance direction of the bag body and the interval between the upper roller and the lower roller in other adjacent roller pairs.

5. The solidified material loosening device according to any one of claims 1 to 4, further comprising:

    a lower bearing supporting the lower roller;
    an upper bearing supporting the upper roller; and
    a support member that is disposed between the lower bearing and the upper bearing to support the upper bearing from below,
    wherein a vertical length of the support member located on the upstream side in the conveyance direction of the bag body is larger than a vertical length of the support member located on the downstream side.

6. The solidified material loosening device according to claim 5, wherein the vertical length of the support member is adjustable.

7. The solidified material loosening device according to claim 6, further comprising a frame that vertically movably supports the upper bearing while supporting the lower bearing,
wherein the support member includes:

    a nut fixed to the frame; and
    a bolt that is screwed in the nut and detachably abuts on the upper bearing,
    the vertical length of the support member can be adjusted by rotating the bolt with respect to the nut, and
    the support member located on the upstream side in the conveyance direction of the bag body is larger than the support member located on the downstream side in an extension length of the bolt from the nut.

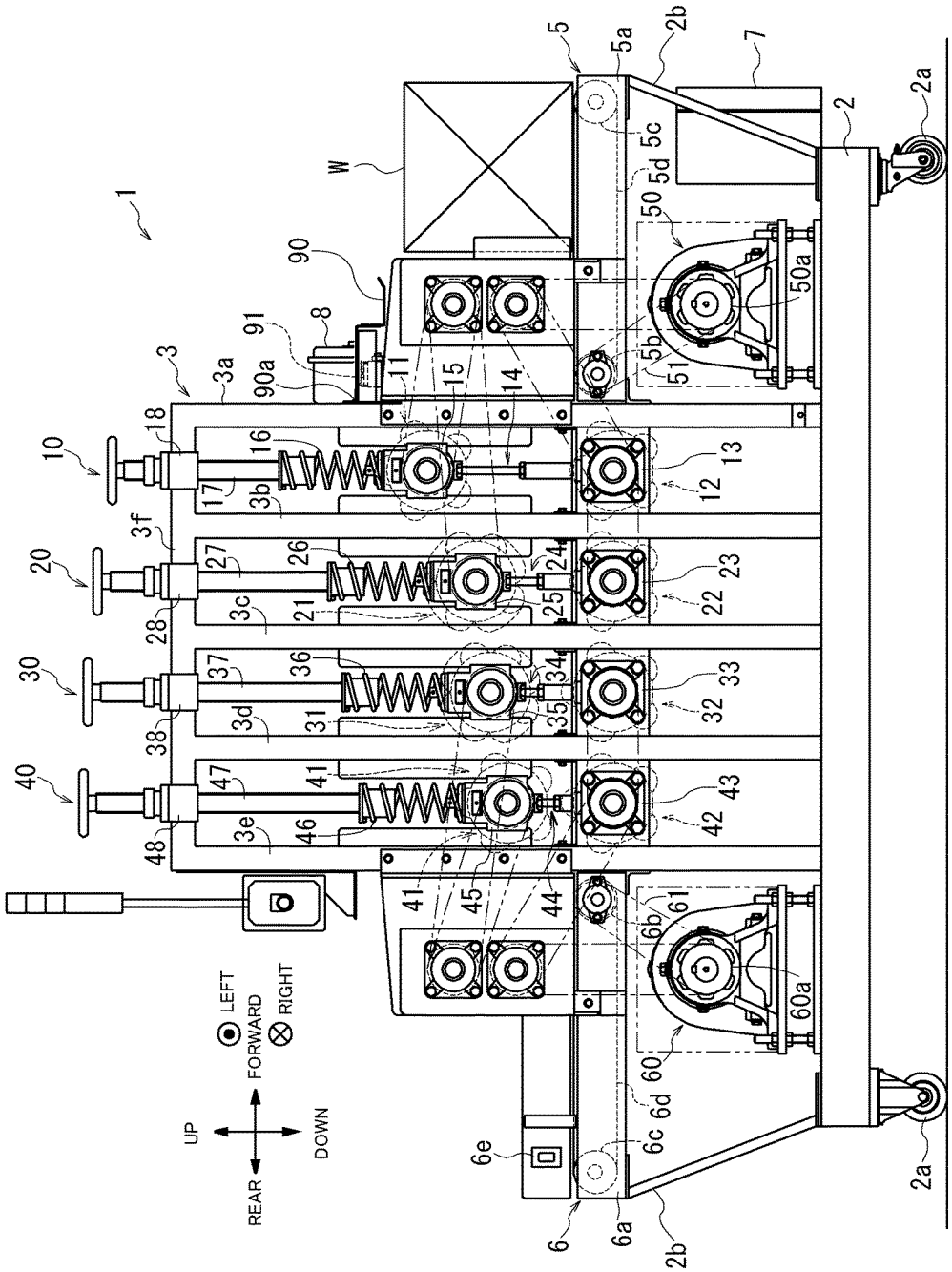
8. The solidified material loosening device according to claim 7, wherein the support member includes a lock nut screwed to the bolt to regulate rotation of the bolt relative to the nut.

9. The solidified material loosening device according to any one of claims 5 to 8, further comprising:

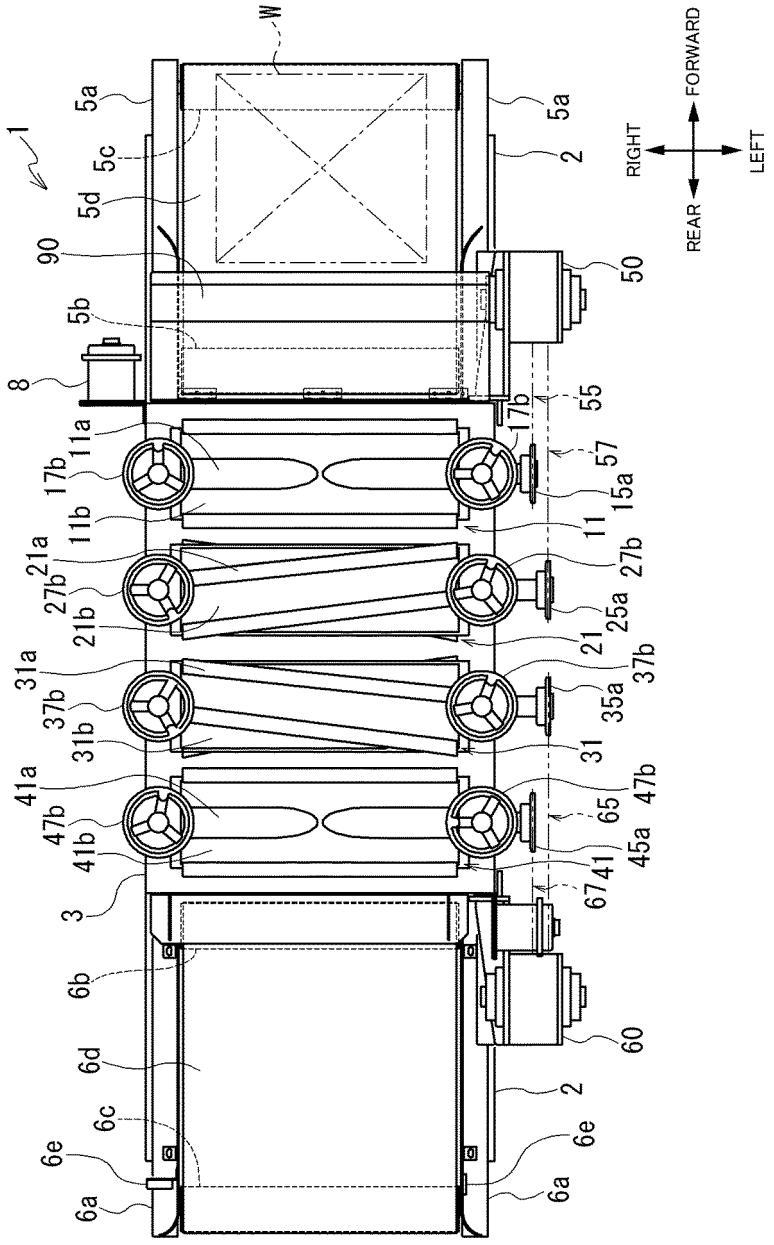
    a frame that vertically movably supports the upper bearing while supporting the lower bearing;
    a screw cylinder screwed in the frame above the upper bearing; and
    a biasing member interposed between the upper bearing and the screw cylinder to bias the upper bearing

toward the lower bearing,
wherein the upper bearing includes a first receiver on which the biasing member abuts,
the screw cylinder includes a second receiver on which the biasing member abuts,
the second receiver being provided with an engagement portion that engages with the biasing member,
a direction of the biasing member intersecting with a biasing direction of the upper bearing is positioned by the engagement portion, and
the engagement portion is formed to have a length capable of engaging with the biasing member in a state in which an interval between the first receiver and the second receiver is larger than a natural length of the biasing member.

[Fig.1]



[Fig.2]


W
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5c
5d
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5b
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11a
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21a
27b
21b
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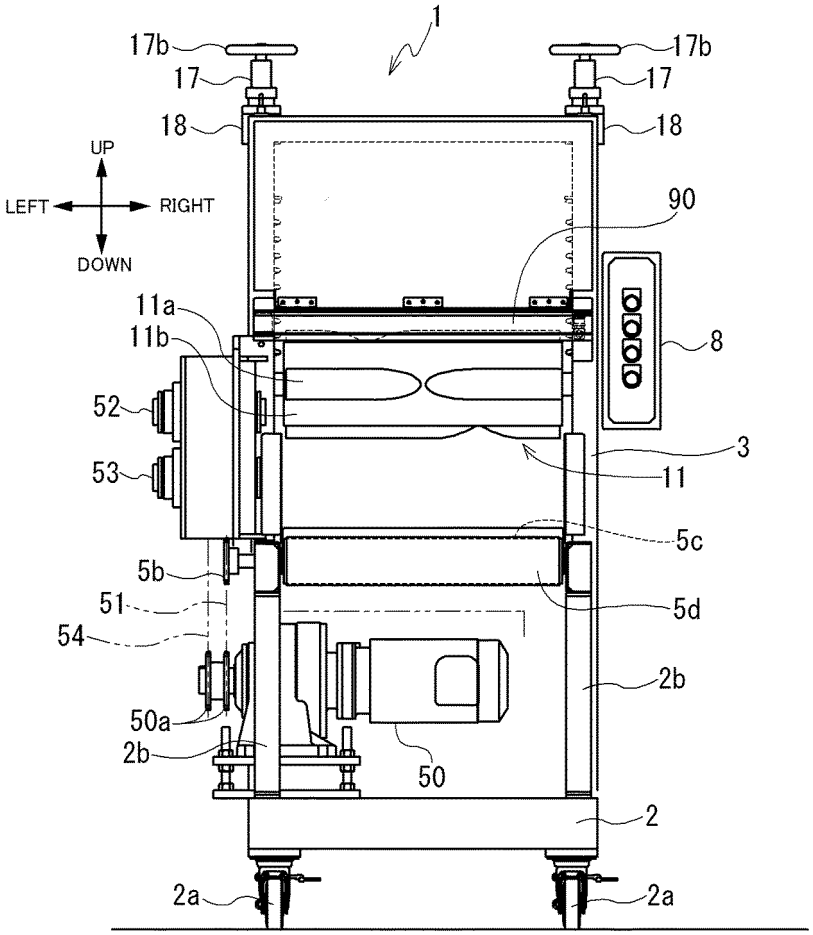
31b
41a
47b
41b
3
6b
6d
6c
6e
6a
2
50
55
57
15a
11
27b
25a
21
37b
35a
31
47b
65
45a
41
67
60
FORWARD
RIGHT
LEFT
REAR

[Fig.3]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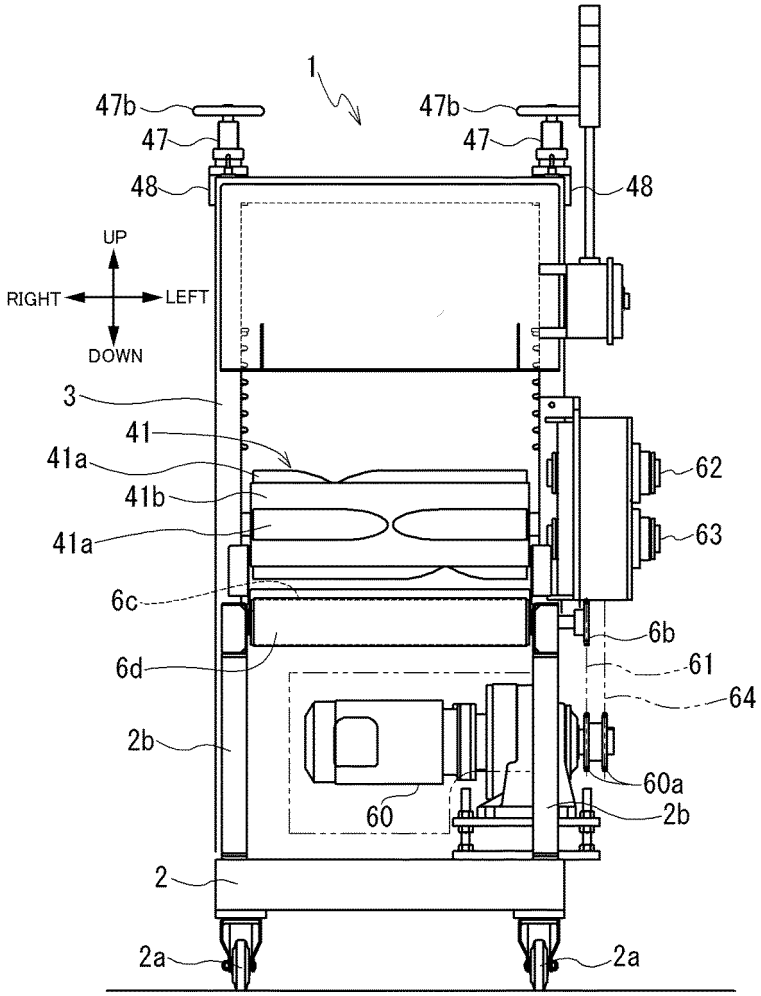
2b
50
2
2a
2a

[Fig.4]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63
6b
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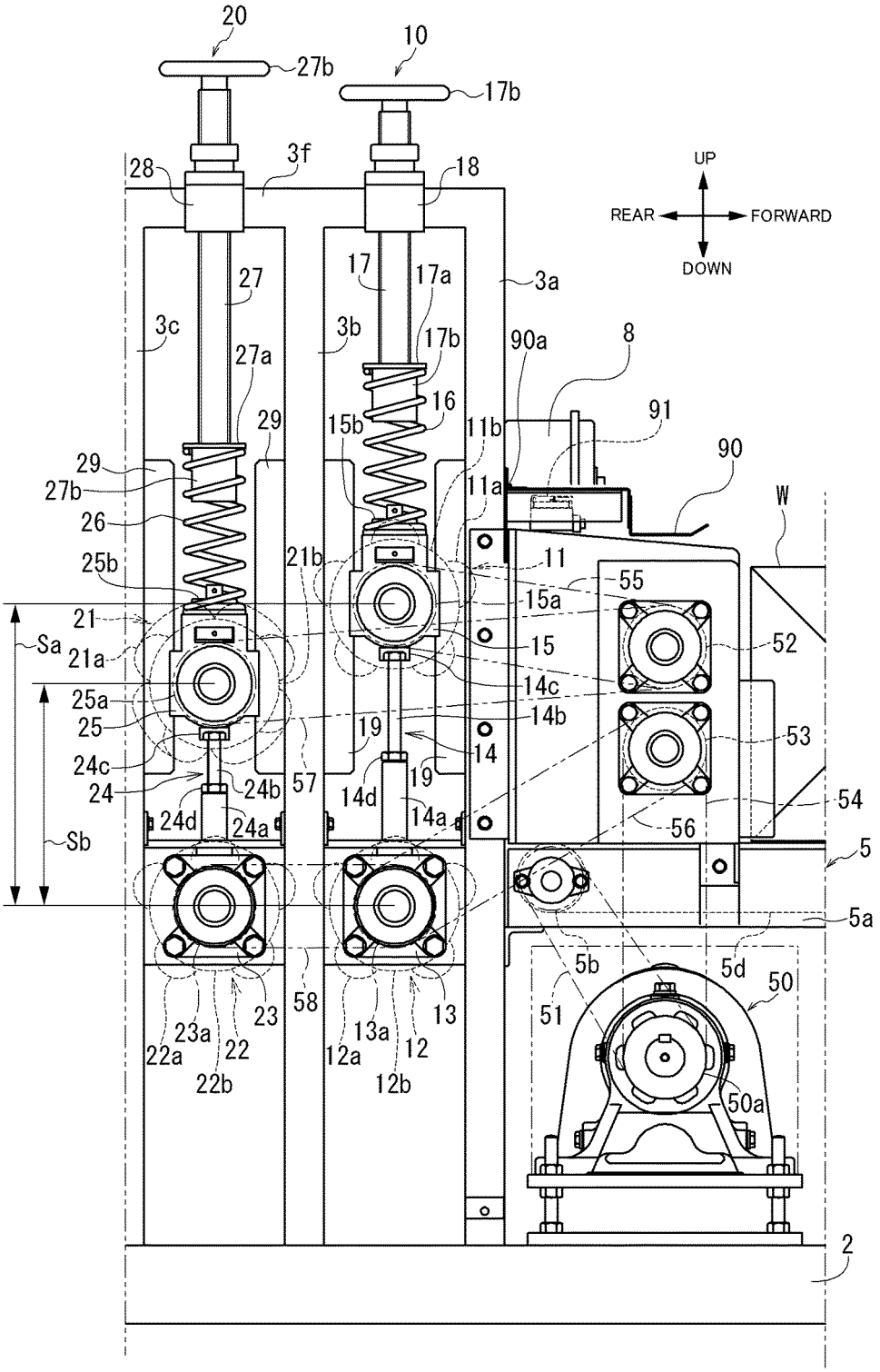
60a
2b
60

[Fig.5]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3c
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90a
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15b
11b
29
90
27b
11a
W
26
25b
21b
11
55
15a
21
Sa
21a
15
52
25a
14c
25
14b
19
53
24c
14
19
24
24b
57
14d
14a
54
24d
24a
56
Sb
5
5a
5b
5d
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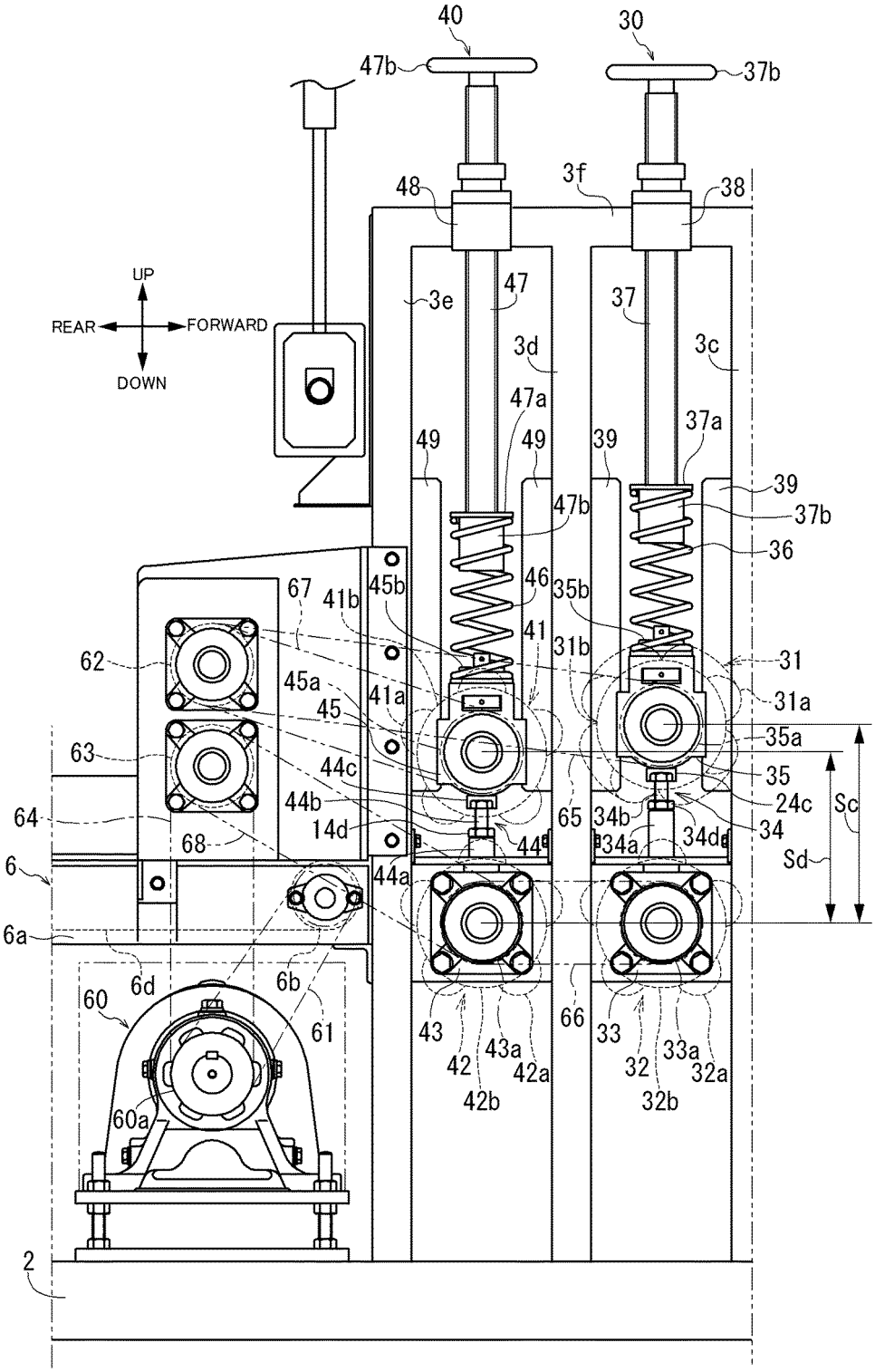
12
22
12b
22b
50a
2

[Fig.6]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3f
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REAR
FORWARD
DOWN
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47
37
3d
3c
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49
39
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47b
37b
36
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41b
45b
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45a
41a
31a
45
35a
63
44c
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24c
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44b
65
34b
34
14d
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44
34a
34d
Sd
6
44a
6a
6d
6b
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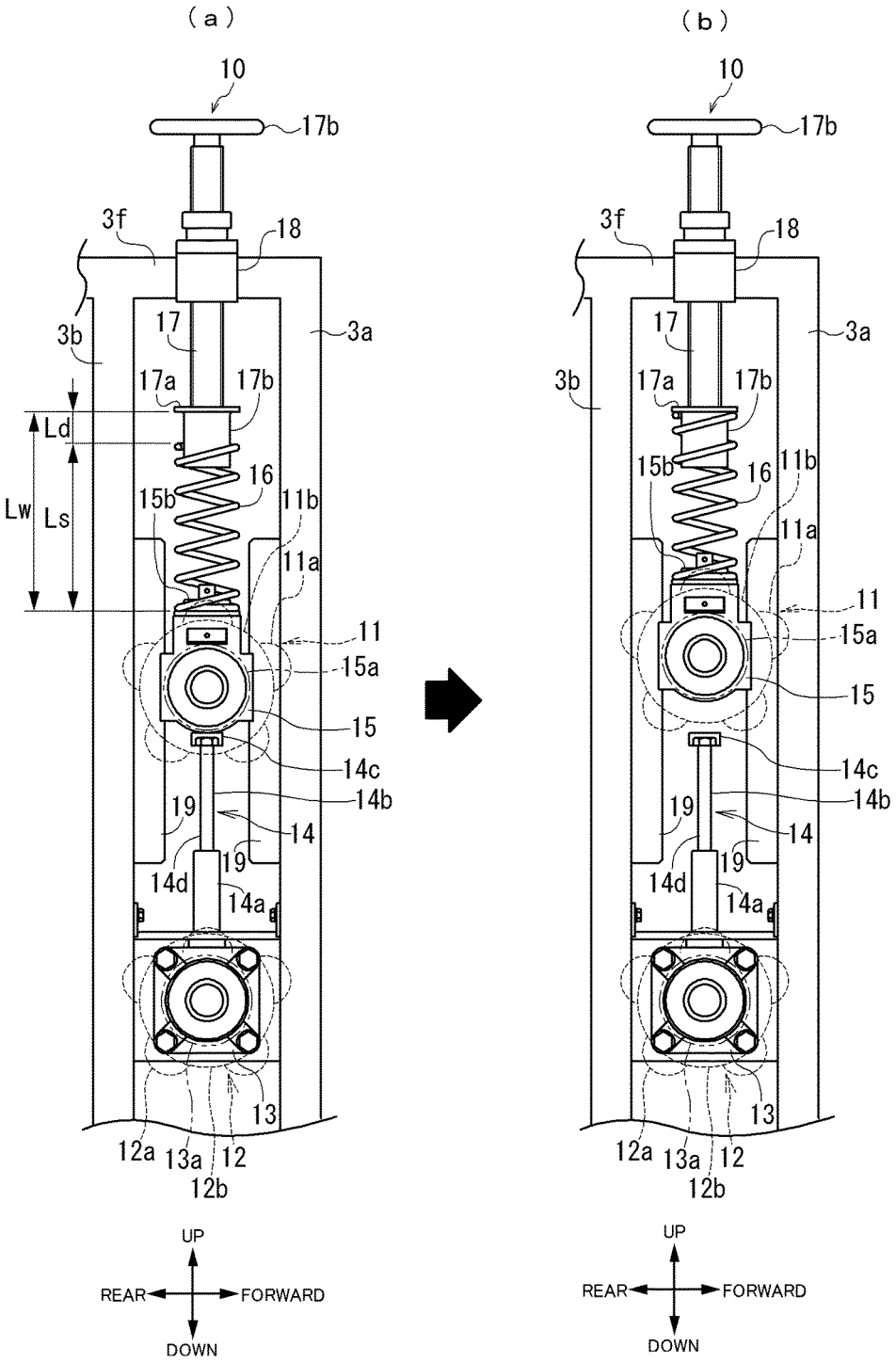
42b
32b
60a
2

[Fig.7]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(b)
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3f
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3a
17a
17b
Ld
Lw
Ls
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11a
11
15a
15
14c
14b
19
14
14d
14a
13
12a
13a
12
12b
UP
REAR
FORWARD
DOWN

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/019433

A. CLASSIFICATION OF SUBJECT MATTER
B65G13/00(2006.01)i, *B02C4/02*(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)
B65G13/00, B02C4/02

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 1996-2017
Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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.
Y A	JP 5938490 B1 (Hirano Seiki Kogyo Kabushiki Kaisha), 22 June 2016 (22.06.2016), paragraphs [0017] to [0079]; fig. 1 to 7 (Family: none)	1-2,5-6 3-4,7-9
Y A	CN 104117403 A (ZHANGJIAGANG LANHANG MACHINERY CO., LTD.), 29 October 2014 (29.10.2014), fig. 1 to 2 (Family: none)	1-2,5-6 3-4,7-9

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

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Date of the actual completion of the international search	Date of mailing of the international search report
27 July 2017 (27.07.17)	08 August 2017 (08.08.17)
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/JP2017/019433

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 016887/1993(Laid-open No. 071407/1994) (Anritsu Shoji Co., Ltd.), 07 October 1994 (07.10.1994), fig. 1 (Family: none)	1-2,5-6
Y	JP 2005-27622 A (Yukihiro TSUNEZAWA), 03 February 2005 (03.02.2005), fig. 1 (Family: none)	1-2,5-6

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Patent documents cited in the description

- JP 5938490 B **[0006]**