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(54) **Apparatus for automatically emptying bags**

(57) An apparatus for emptying bags comprising a gripping unit (60) in which a gripper is incorporated for gripping bags and carrying bags to and from a slitting and emptying device, gripper comprising at least two arrays of pointed gripping elements or PGEs (44, 46; 62, 63), wherein each such gripping element having two ends; one end free and tipped, whereas the other end of each PGE is pivoted (50) or connected to axles (65, 65A) or to shafts (78, 80, 82); said at least two arrays of PGEs are grouped such that in each array the pointed ends point in the same direction; the ends of the GPEs of one array are pivoted, movable between two extreme positions, one extreme position is a fully drawn position while the other extreme position is a fully withdrawn position; for gripping, the PGEs of one array of said at least two arrays are withdrawn in a direction, whereas the PGEs of the other array of said at least two arrays are withdrawn in opposing direction, and a controller (104) for at least controlling the activation of the gripping unit at least a portion of said PGEs of said two arrays into accessible bags.

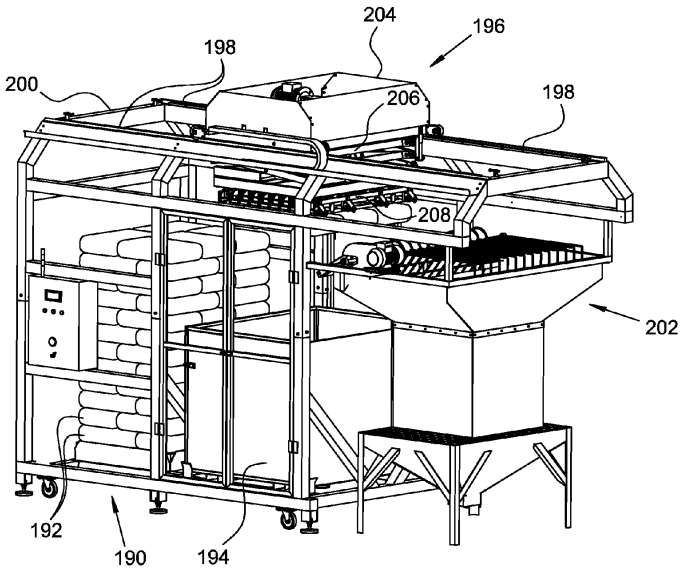

Fig. 7

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to automatic machinery for bag emptying. More particularly, the present invention relates to an automatic gripping, splitting and emptying bags.

BACKGROUND OF THE INVENTION

[0002] In most of the industries in fields such as polymers, pharmaceuticals, food, and chemistry, raw material is delivered in medium to large sized bags. Typically, the bags are arranged on pallets. Typically, discharging the bags' content is achieved by manual unloading and slitting the bags employing a knife and transferring the material to a receiver such as a funnel. Since the bags are relatively heavy, emptying the material into the processing machine by the worker that lifts the bags one after the other constitute a "bottle neck" in the progress of the processing. Moreover, raw material, which can be very expensive, is being lost throughout the process of emptying the bags into a receiver since a worker has to carry the sliced bag and shake it over above an opening of a receiver or a funnel.

[0003] Common automatic machinery such as a bags' splitter and a bag splitter and shredder have inherent drawbacks. A splitter system does not avoid the need for manual emptying which is costly both in labor and in the loss of material. In common splitting and shredding systems a bag full of raw material is inserted into the machine that shreds the bag so as to allow all the raw material to be dispensed into the processing apparatus. Due to the form of shredding, small pieces of shredded bag may enter the processing apparatus along with the raw material. Moreover, the process does not eliminate the need of the worker that places the bags in the machine.

[0004] Therefore an apparatus that will quickly, mechanically slit the bags and empty them into a receiver of the processing apparatus is beneficial.

SUMMARY OF THE INVENTION

[0005] In accordance with the present invention, an apparatus for emptying stacked bags is provided. The apparatus has a gripper having a plurality of pointed gripping elements and a slitting and emptying device. The gripper is capable of gripping one or more bags ordered or heaped in disorder. The gripping elements are arranged in two arrays such that a bag is gripped by a number of gripping elements disregarding the bags' arrangement in a layer. Gripping is accomplished by forcing a number of pointed gripping elements into one or more bags. The gripper is incorporated in a gripping unit, which also lifts the gripped bags and carries them to the bag slitting and emptying device. The bag slitting and emptying device simultaneously slits and empties the bags by means of a plurality of blades aligned with rods. A cyclic displacement of either the rods relative to the slitted bags, or the slitted bags relative to the rods, discharges leftovers of the contents of the bags.

BRIEF DESCRIPTION OF THE FIGURES

[0006]

Fig. 1 is a schematic description of the main subsystems of an apparatus for emptying bags of the invention wherein the gripping unit is loaded;

Fig. 2A is a schematic description of an array of gripping elements pivotally connected to a suspension shaft;

Fig. 2B is a schematic description of an array of gripping elements pivotally connected to a suspension shaft in an extended position;

Fig. 2C is a description of another array of gripping elements pivotally connected to a suspension shaft inan extended position;

Fig. 3A is a front side view of a section of a gripper having its PGEs retracted according to a preferred embodiment of the present invention;

Fig. 3B is a front side view of a section of the same gripper shown in Fig. 2A, with extended PGEs;

Fig. 3C is a bottom view of a section of a gripper according to another preferred embodiment of the invention;

Fig. 4 is a frontal view of a section of an apparatus for emptying bags, before starting a step of slitting bags, according to a preferred embodiment of the present invention.

Fig. 5 is an isometric view of a section of a slitting and emptying device according to a preferred embodiment of the present invention;

Fig. 6 is an isometric view of a section of an apparatus for slitting and emptying bags in accordance with another preferred embodiment of the present invention;

Fig. 7 is an isometric view of an apparatus for emptying bags in accordance with the present invention;

Fig. 8 is a side view of the apparatus for emptying bags implementing debris compression;

Fig. 9 is an isometric view of a section of an apparatus for emptying bags, in which a lift is incorporated according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0007] The present invention provides a novel apparatus for emptying bags as for example to discharge a raw material into a receiver of a processing system. The apparatus of the present invention simultaneously grips and lifts a plurality of bags from an upper layer of stacked bags, slits the bags and discharges their contents. The apparatus of the invention is an assembly of several subsystems, each performing a certain task in the overall process.

[0008] Reference is first made to **Fig. 1,** which describes schematically the main structural units of an apparatus for emptying bags of the invention and the functional relationships between them. In **Fig. 1** gripping unit **12** picks up one or more bags **14** from stack **16.** The bags are brought to the emptying unit **18** for slitting and emptying. When emptying has finished, the gripping unit **12** disposes of the debris of the empty bags **14.** The griping unit **12** resumes its position at stack **16** and picks again one or more bags. The function of the gripping subsystem is therefore repetitive, moving cyclically between two extreme positions.

The gripping unit

[0009] This unit includes a gripper, an actuator and an extendible arm. The role of the actuator is to move the gripping unit between the two extreme positions as described above. The gripper according to the invention employs pointed gripping elements (PGEs) such as hooks or stakes. One end of each gripping element is connected to an axis whereas the tipped end is free. The PGEs are grouped in two arrays in each of which each of the PGEs point in the same direction. The PGEs of both arrays are movable between two extreme positions respectively. The extreme positions are a fully extended position and a fully retracted position. All the PGEs of an array move in the same direction when changing from one extreme position to the other. Conversely, PGEs of different arrays move in different directions from one extreme position to the other. Reference is now made to **Fig**s. **2A - 2C** in which PGEs of both arrays are schematically described. As can be seen in **Fig**s. **2A -2C,** exemplary two PGEs of an array **40** are pivotally attached to a PGE suspension shaft **42.** PGEs **44** and **46** are inclined towards shaft **42.** In an extended positioning, PGE **44** is designated **44A,** and PGE **46** as PGE **46A,** in which position the free pointed tips are pointing substantially away from shaft **42,** more towards the bottom. The retracting - extending action is forced by one or more actuators (not shown) which actuate forcing shaft **48** to position **48A.** To draw the PGEs, the forcing shaft **48** is moved in the direction of arrow **50.** As shown in **Fig. 2B,** the two exemplary PGEs are fully extended, designated here as PGE **44A** and PGE **46A.** Forcing shaft **48A** is in a PGE drawing position. These PGEs are generally rotatable around pivots **52** but may be locked in a specific position. In **Fig. 2C** a portion of the other array of PGEs is shown extended, wherein all PGEs are pointing in an opposite direction that the PGEs in **Fig. 2B** point. Moving these PGEs to the fully extended position is similarly effected by moving forcing shaft **49B** in the direction of arrow **50B.**

[0010] For gripping, the extendable arm lowers the gripper to the upper layer of bags. Then, the PGEs are extended, forcing their tipped ends into the accessible bags. PGEs of one array are extended in one direction whereas the PGEs of the other array are extended in an opposing direction as described above. The spacing between the individual PGEs of an array and the spacing between two adjacent PGEs of different arrays are typically changeable and are a matter of consideration of the bags, size and order. Typically it is required that the bags when gripped and lifted should not be torn by their own weight. The number of PGEs pointing in one direction of an array does not necessarily equal to the number of PGEs pointing oppositely of the other array.

[0011] Reference is now made to **Figs 3A** and **3B** in which a frontal view of a section of a gripper according to a preferred embodiment of the invention is shown. In **Fig. 3A** PGEs are shown in a fully retracted position. Gripper **60** includes a plurality of rotatable PGEs. As described above PGEs of two different arrays are rotatable between two positions. PGEs **62** belong to one array and PGEs **63** belong to the other array. PGEs **62** are pivotally attached to suspension shaft **64** by means of axles **65** whereas PGEs **63** are attached by means of axles **65A.** PGEs of both arrays are moved into a fully extended position by counterclockwise rotating PGEs **62** and rotating PGEs **63** clockwise. Rotating all PGEs in the opposite directions brings them back to the fully extended position. These rotations are effected by means of a pneumatic actuator **66** and connecting shafts. Typically, PGEs of one array are interleaved with PGEs of the other array. PGEs of each array are arranged in rows according to this preferred embodiment of the invention wherein rows of different arrays are interleaved.

[0012] As shown in **Fig. 3B** the PGEs of both arrays are fully extended out and PGEs of both arrays are in the fully extended position such that tipped ends of PGEs of different arrays such as **62B** and **63B,** point one towards the other The pneumatic actuator **66** is attached to a frame of the gripper perpendicular to the rows of PGEs of both arrays. Typically the rows of PGEs are arranged in pairs such that one pair member is of different array than the other pair member. Thus PGE **62B** is the extreme PGE in a row perpendicular to the plane of the drawing and PGE **63B** is the extreme PGE in another row perpendicular to the plane of the drawing. All PGEs of a row have a common axis of rotation. A gear set, not shown, attached to each PGEs' axel, rotationally connects two adjacent PGEs, one of each row in a pair of rows. Therefore when all the PGEs of row **62B** are rotated clockwise, by moving shaft **66A,** PGEs of row **63B** are rotated in the opposite direction. The forceful drawing of the PGEs punches the bags accessed by the PGEs, forcing the PGEs into those bags.

[0013] A proper selection of spacing between the PGEs in a row as well as the spacing between the rows can insure that each of the bags in the upper layer of stacked bags is gripped by a number of PGEs of both arrays. A bag is characterized by a certain length, width and depth. The depth is typically significantly smaller than its width, which is smaller than its length. For example, the spacing between two adjacent pairs of rows of different arrays is such that the distance between the tipped ends of adja-

cent PGEs of different rows when PGEs are fully retracted, is smaller than the a typical depth of a bag; the spacing between two adjacent pairs of the same rows is smaller than a typical length of a bag; and the spacing between two adjacent PGEs in a row is smaller than a typical width of a bag. Such a gripper is capable of gripping bags of an upper layer arranged in any direction relative to its lower face. Furthermore a layer of bags need not be leveled in order to be gripped and lifted. However when the bags are laid out in disorder, only a portion of the number of bags in the top layer may be gripped at a time.

[0014] The tipped end section of the PGE moves along a circular path as it draws/withdraws. The tip section is arcuate conforming with their rotation along a circular path. Therefore the hole punched in a bag by a PGE, is kept to a minimal size and the bags are not torn excessively by the rotating PGEs. This allows for a minimal loss in contents along the path from the stack to the emptying position. The shafts **64** to which the PGEs are attached are optionally suspended from a weighing device, not shown, which is connected to frame **68** of the gripper. To accomplish weighing, a load cell or preferably four load cells are employed. The measured weights are optionally further reported to a computer system carrying out tasks of process control and or material and stock management.

[0015] Optionally, gripper **60** when located above the stacked bags, finely adjusts its positioning above the stack of bags to conform with the position of the upper layer of the stack, to be able to grip as much of the layer as possible. To manage such fine positioning above the layers, at least one sensor **70** is employed. Other grasping mechanisms may also be employed instead of, or in addition to, the PGEs of the gripper as described herein above. Such are for example vacuum nipples mounted on the bottom of the gripper's frame.

[0016] Reference is now made to **Fig. 3C** in which a bottom side view of a section of a gripper according to another preferred embodiment of the present invention is shown. The PGEs are pegs such as **72, 74** and **76.** All PGEs point in a general downward direction. However PGEs of different arrays are tilted aside in opposite directions. PGEs **72** which belong to one array of PGEs are attached to a horizontal shaft **78** forming a row whereas PGEs **74** which belong to the other array are attached to shaft **80** forming another row of PGEs. PGEs **76** which are attached to shaft **82** belong to same array as PGEs **72** as they point in the same direction. The numbers of PGEs of both arrays need not be equal and the number of rows need not be even. The PGEs of both arrays are shown in a fully retracted position. Shafts **78, 80** and **82** are linearly movable along the directions shown by the double arrows **84** and **86** correspondingly, between the fully extended and fully retracted positions. For gripping stacked bags the gripper having its PGEs retracted is placed on top of an upper layer of bags. At this stage all PGEs are forced into the fully extended position by moving shafts such as **76, 78** and **80,** in a general downward direction along the arrows **84** and **86** as shown in **Fig. 3C.** The upper surfaces of bags of the upper layer are punched by the tipped ends of the PGEs being forced into the bags while moving to a fully extended position.

[0017] Five parameters define a configuration of a gripper according to this embodiment. The parameters are i. the tilting angles of the PGEs; ii. the number of PGEs in a row; iii. the spacing between PGEs in a row; iv. the spacing between adjacent rows in which its PGEs are tilted towards each other such as rows of PGEs **72** and **74,** and v. the spacing between rows in which its PGEs are tilted away from each other such as rows of PGEs **74** and **76.** These parameters are determined with reference to the dimensions of a layer of bags and the dimensions of an individual bag, such that a bag is gripped by a number of PGEs of at least two different rows.

Slitting and emptying device

[0018] After having gripped the available bags, gripping unit moves loaded towards the slitting and emptying device. Reference is now made to **Fig. 4** illustrating a frontal view of a section of an apparatus for emptying bags while cutting the gripped bags. Gripping unit **90** advances in a path along a rail, not shown, located on top of the upper frame **92** towards the rotating blades **94.** The main frame **96** of the gripper is attached to the extendible arm **98** located at the bottom of the gripping unit **90.** The curved PGEs **100** which are at a fully extended position hold bags **102** of which only three are shown. Rods **104,** which are aligned with the rotating blades **94** penetrate the slits in the bags and help disrupt the bags and separate between suspended stripes of the slitted wrapping of the bags as they advance. The bags' contents fall down into receiver **106,** positioned beneath the rods and blades.

[0019] Reference is now made to **Fig. 5** in which an isometric view of a section of a slitting and emptying device according to a preferred embodiment of the present invention is shown. Rods **160** are disposed in parallel and aligned continuous with the rotary blades **162.** Rotary blades **162** having a common drive axis **163,** actuated by a motor **164.** A portion of the debris of the bags, which are suspended pieces of cut bags, not shown, are forced by the weight of some of the bags' content and therefore are curved downwards into spaces between any two adjacent rods. Rods **160** are leveled at such a height above the axis around which the blades rotate, that a considerable portion of these downwardly curved debris of bags reach down substantially below the rods. A horizontal displacement of the upper faces of the gripped bags in both perpendicular directions to rods **160** pulls aside and tilts these debris of bags accordingly. Shaking the gripper aside in both perpendicular directions to the rods **160** when it has passed the rotary blades and reaches a predetermined location above the receiver **166** discharges leftover material born by these suspended debris of bags.

[0020] An alternative approach of discharging the left-

over material withheld in the debris of the bags is described with reference to **Fig. 6** in which an isometric view of a section of a for slitting and emptying device in accordance with another preferred embodiment of the present invention is shown. Slitting and emptying device **180** consists of horizontally displaceable rods. Rods **182** are attached to a frame **184,** which is off centered connected to a wheel **186** driven by a motor **188,** by means of a shaft **190.** Another motor **192** drives the rotating blades **194** which are disposed in front of the rods **182.** The rotating wheel **186** moves the rods **182** in a cyclic horizontal translation in directions shown by an arrow indicated by **196.** The rods **182** are leveled above the axis of rotation of the rotary blades at a height, which is selected in a similar manner as, described herein above. Suspended debris of bags, not shown, which are engaged by two adjacent translating rods are tilted in opposing directions. Therefore by vigorously shaking either the gripper, or the rods, the remains of the bags' contents withheld by the debris of bags are discharged.

[0021] A slitting and emptying device of the invention does not necessarily utilize of rotary blades. Blades having any geometrical shape such as swords, or circular blades, are in useful provided that they are disposed in parallel with the rods and are aligned continuous with the rods as is described supra.

Example 1

[0022] Reference is now made to Fig. 7 in which an isometric view of an automatic apparatus for emptying bags in accordance with a preferred embodiment of the present invention is shown. The apparatus includes a deck 190 located at its frontal bottom portion. Deck 190 is adapted to receive a plurality of bags 192 that are preferably organized in several layers disposed over a palette. The bags are delivered and loaded onto the deck typically by a forklift truck, not shown. Deck **190** is optionally provided with a waste container **194** adapted to receive bags debris.

[0023] The apparatus includes a gripping unit **196** movable back and forth along rails **198** from a first side of an upper frame **200** located above the bags to the opposite side. Gripping unit **196** grips bags **192,** lifts them from deck **190,** deliver them to a slitting and emptying device **202** in which they are slitted and emptied. Gripping unit **196** disposes of the empty bags by dropping them into the waste container **194.** Gripping unit **196** operates an actuation means **204** adapted to translate the gripping unit along rails **198.** Extendible arm **206** adjusts the height of the gripper **208** located at the bottom of the gripping unit **196.** As shown in **Fig. 7** the loaded gripping unit **196** is in a halfway position on its way towards the slitting and emptying device **202.**

[0024] After emptying the bags by means of the slitting and emptying device **202,** the gripping unit moves back and parks in a predetermined location above the waste container **194.** Consequently the PGEs are fully retracted and the released bags debris are dropped down. To minimize the volume of the debris, a scheduled additional step in which the heap of debris is compressed, is implemented in the cyclic process. Reference is made to **Fig. 8** showing a side view of the apparatus described hereinabove, at a step in which debris of bags are compressed. Gripping unit **210** reaches a certain location above the opening of container **212** while it is still loaded with full bags **213** on its way towards the slitting and emptying device **214.** Then gripping unit **210** stops, arm **215** extends down into the container **212** and the weight of the current gripped layer of bags compresses the heap of bags debris, not shown, residing in the container. Alternatively the waste container can be placed adjacent to slitting and emptying device **202** at the side opposing bags **192.** In such a case the bags' debris are released off gripper **208** immediately following their being emptied. The bags' debris released at the end of one emptying cycle are further pushed off slitting and emptying device **208** and fall into the waste container during the following emptying cycle. Pushing off is accomplished by means of a grate, not shown, attached to gripper **208** at the side facing slitting and emptying device **208.**

[0025] Legs **217** that are firmly secured to the floor support base construction **216.** However, wheels **218** are provided so as to allow displacing the apparatus from one place to another or for maintenance purposes. Optionally, a funnel **219** is provided beneath receiver **220** through which bags' content is further delivered to a processing machine, a storage tank, or the like.

[0026] Control unit **222** activates and controls the operation and cooperation of the gripping unit and the slitting unit as well as the operation of the entire system. Controller **222** is preferably provided with a display **224** over which data, messages and instructions to an operator are displayed. Functional keys **226** by which operational data and instructions are inputted by an operator are preferably located on the front panel of the controller **222.** Optional wired or a wireless communication link to a background plant computer system is incorporated in the controller **222.** Instructions and messages are downloaded from the plant computer system through this communication link such as the identities of materials to be discharged by the system, its quantities, locations and destinations. These data and messages are further displayed to the operator. Records such as of time tagged operational data originated by the operator, system statuses and weights of the discharged materials are uploaded through same communication link from controller **222** to the plant computer system.

Example 2

[0027] Reference is made to **Fig. 9** in which a frontal view of a section of an apparatus for emptying bags having a lift for elevating the bags according to another preferred embodiment of the present invention is shown. A lift **230** is installed in a front side of the deck **232** of the

apparatus of the invention. Typically elevating the lift is hydraulically activated. In some embodiments the lift is activated mechanically such as by means of an electric motor. The lift is secured to the floor and or is optionally attached to the base frame **234,** not shown. Palette **236** is placed on top of the lift on which bags **240** are stacked. The lift repeatedly elevates the residual layered bags by a predetermined height during the time in which the gripping unit **242** has left its first position above the layered bags and prior to its returning back to the same location. Therefore the distance in which the gripper has to be lowered towards the current upper layer in order to grip it is significantly shortened which in turn promotes the processing speed of the entire system.

Claims

1. An apparatus for emptying bags comprising a gripping unit in which a gripper is incorporated for gripping bags and carrying bags to and from a slitting and emptying device, the gripper comprising:

- at least two arrays of pointed gripping elements (PGEs) (44, 46, 62,63), wherein each such gripping element having two ends; one end free and tipped, whereas the other end of each PGE is pivoted (50) or connected to axles (65, 65A) or to shafts (78, 80, 82);
- said at least two arrays of PGEs are grouped such that in each array the pointed ends point in the same direction;
- the ends of the GPEs of one array are pivoted, movable between two extreme positions, one extreme position is a fully drawn position while the other extreme position is a fully withdrawn position;
- for gripping, the PGEs of one array of said at least two arrays are withdrawn in a direction, whereas the PGEs of the other array of said at least two arrays are withdrawn in opposing direction, and
- a controller (104) for at least controlling the activation of the gripping unit at least a portion of said PGEs of said two arrays into accessible bags.

2. An apparatus for emptying bags as in claim 1, wherein the spacing between two adjacent PGEs of different arrays is changeable.

3. A gripping unit for emptying bags as in claim 1, further comprising a weighing device for weighing said bags.

4. An apparatus as in claim 1, further comprising an upper frame having a first end and a second end, wherein said gripper is moveable in a path along said upper frame from said first end to said second end

5. An apparatus as in claim 1, wherein said pointed gripping elements are coupled in pairs.

6. An apparatus as in claim 1, wherein said pointed gripping elements are actuated by a pneumatic cylinder (44).

7. A method for gripping bags, said method comprising the steps of

- bringing a plurality of pointed gripping elements (PGE) to the top of at least one bag;
- forcing said plurality of PGEs into the upper bags of said layer by rotating said PGEs;
- pinching said at least one bag by said PGEs, and
- gripping said at least one bag to allow lifting.

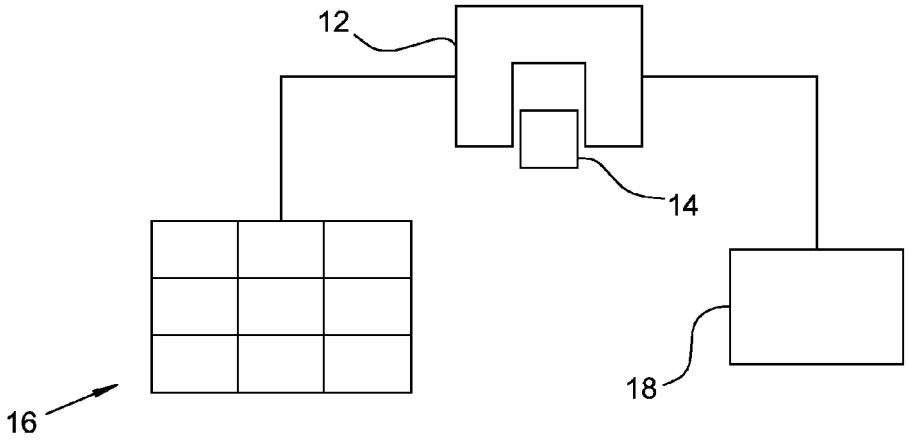

Fig. 1

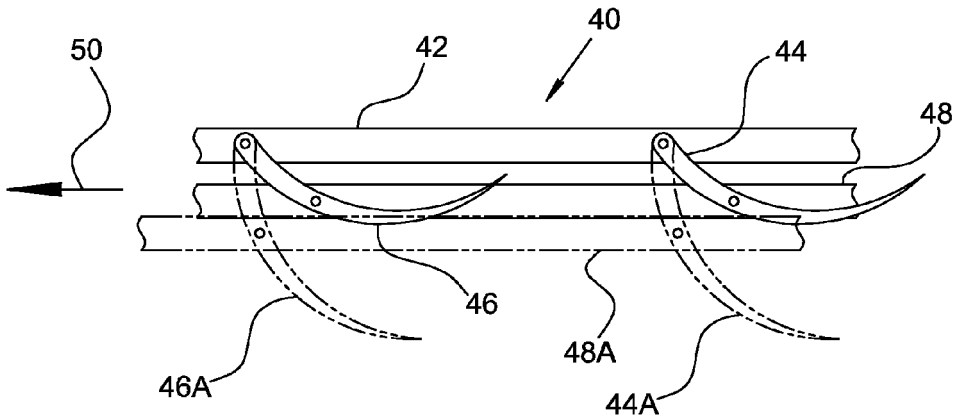

Fig. 2A

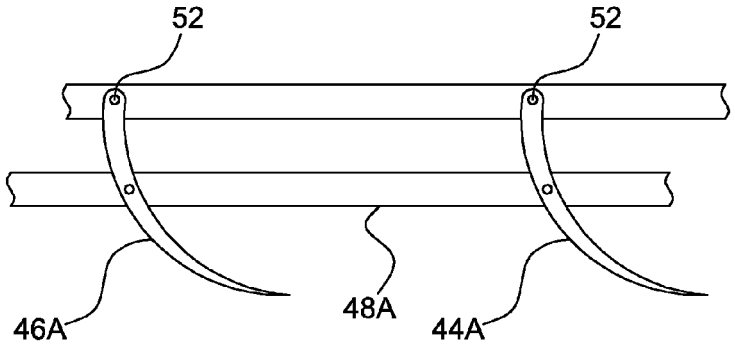

Fig. 2B

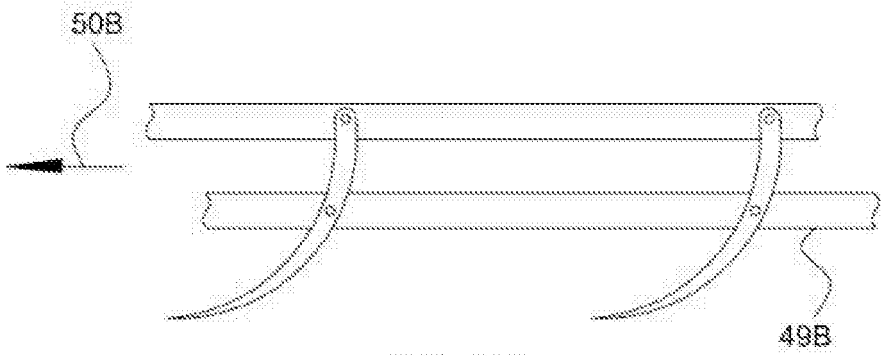

Fig. 2C

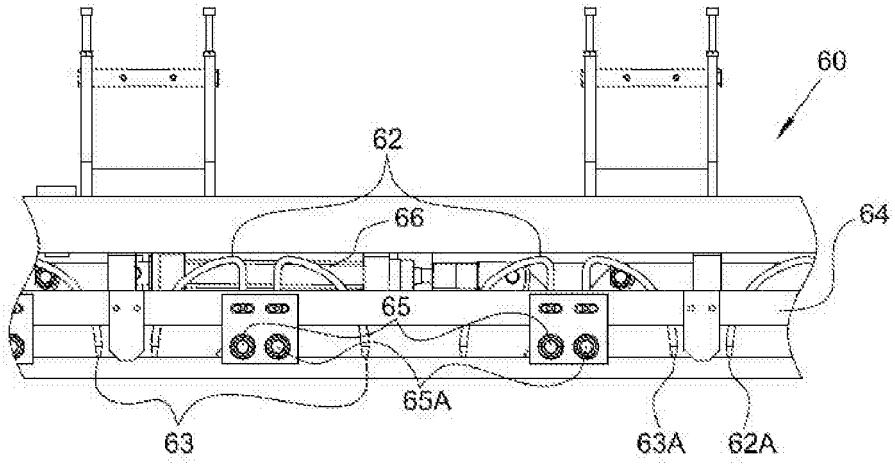

Fig. 3A

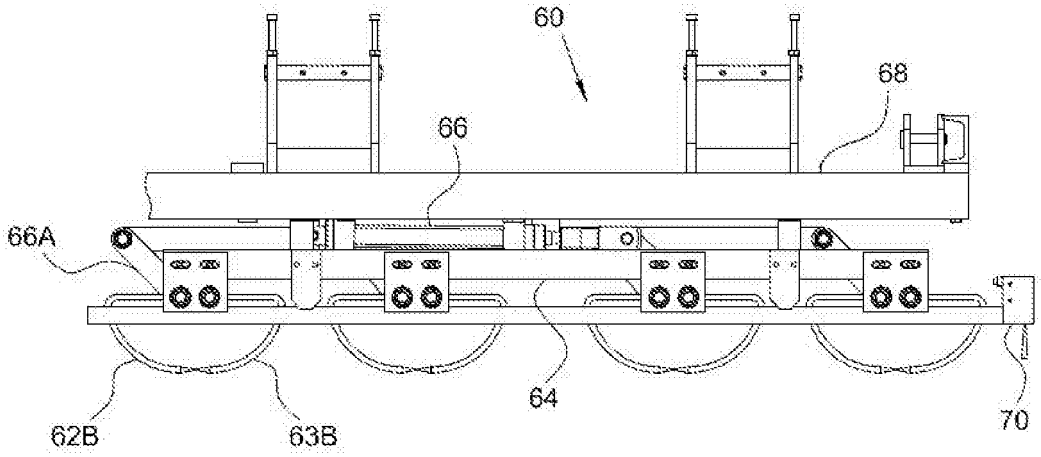

Fig. 3B

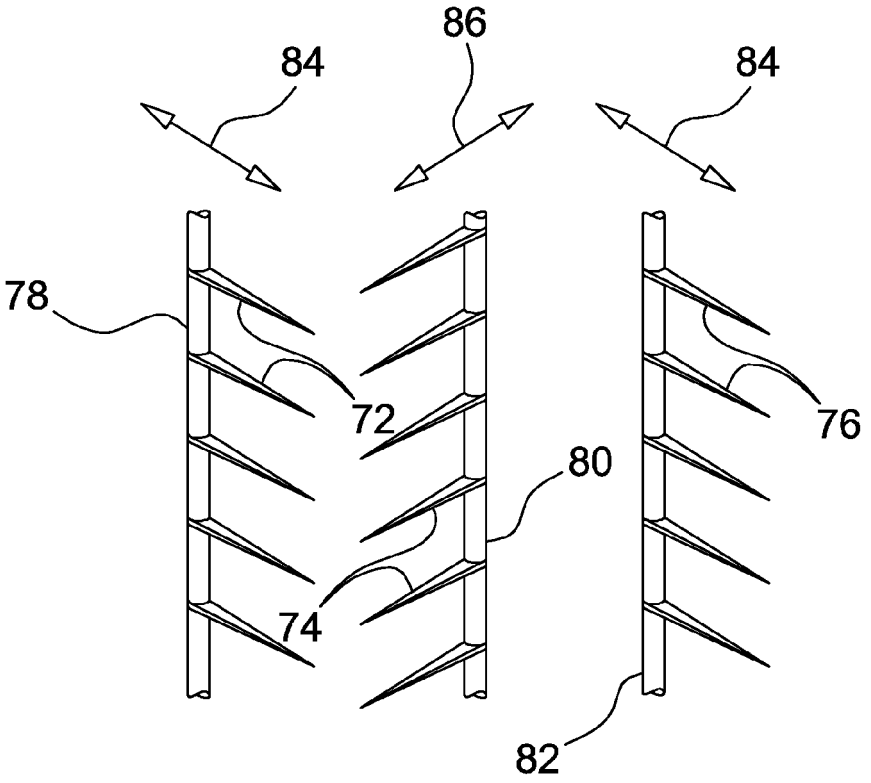

Fig. 3C

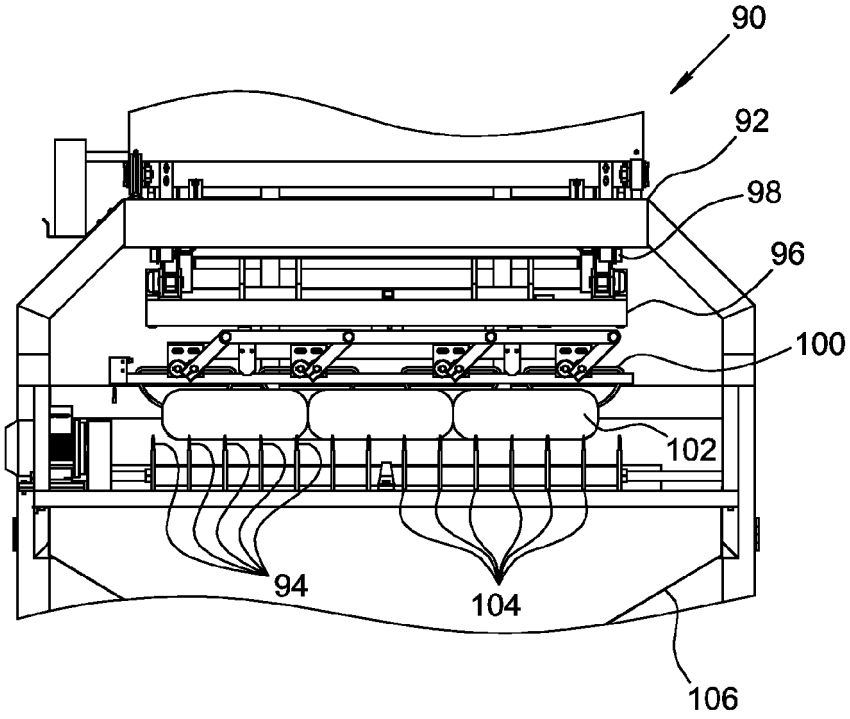

Fig. 4

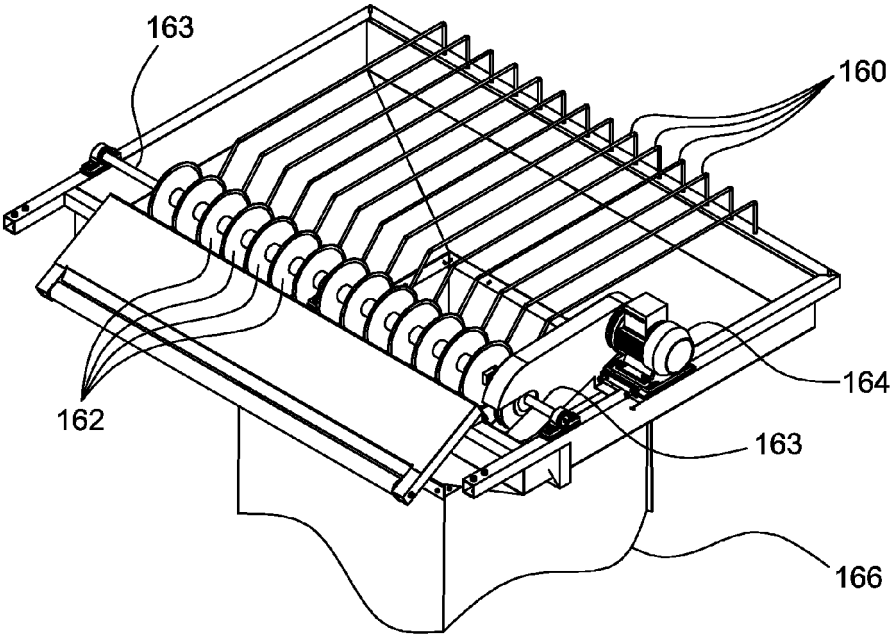

Fig. 5

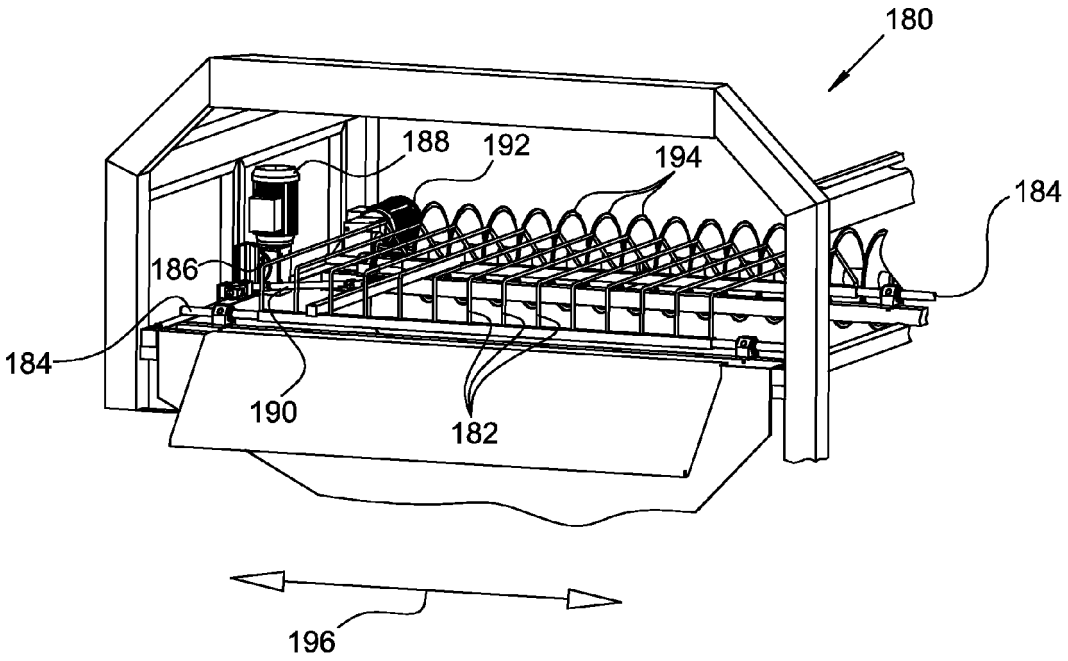

Fig. 6

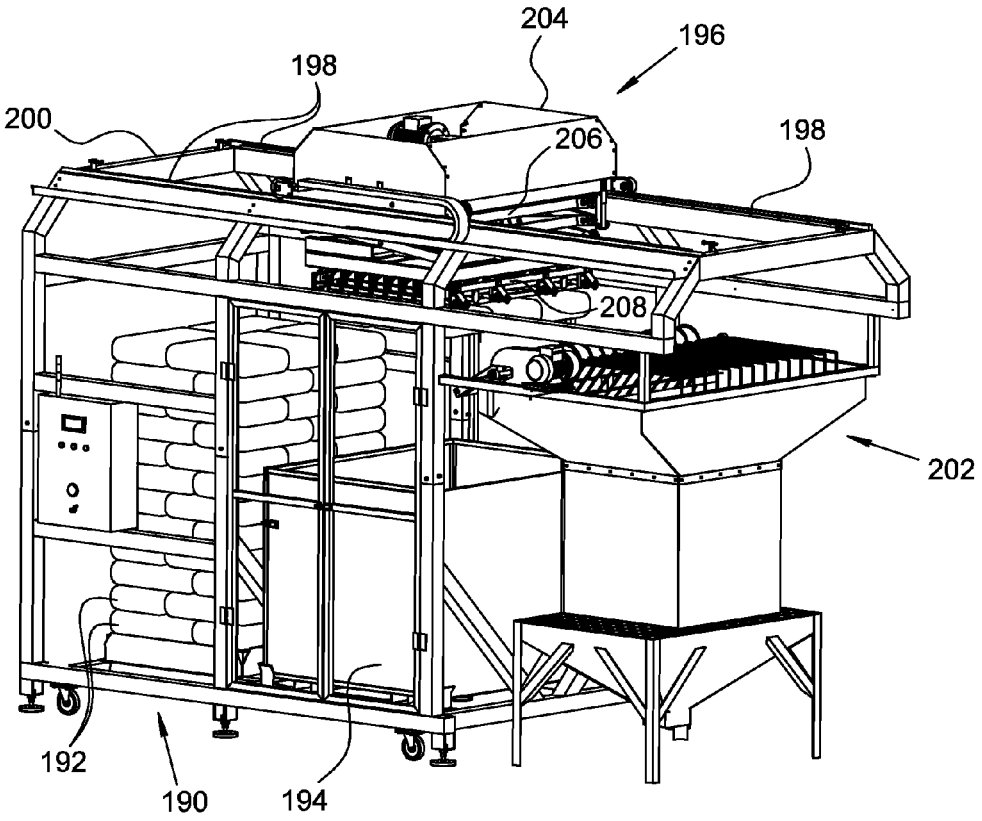
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Fig. 7

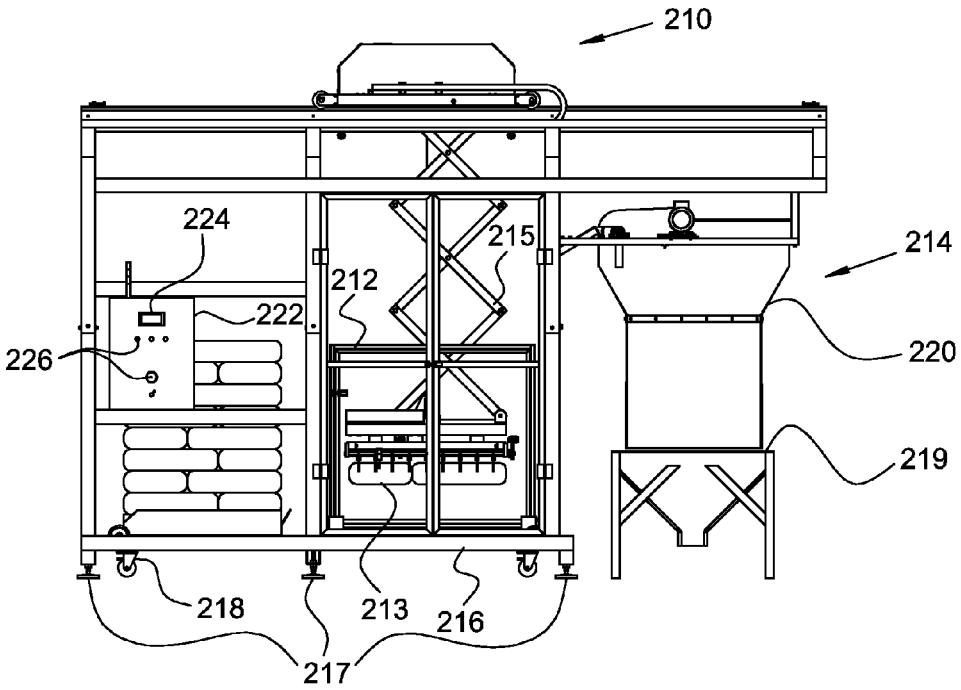
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Fig. 8

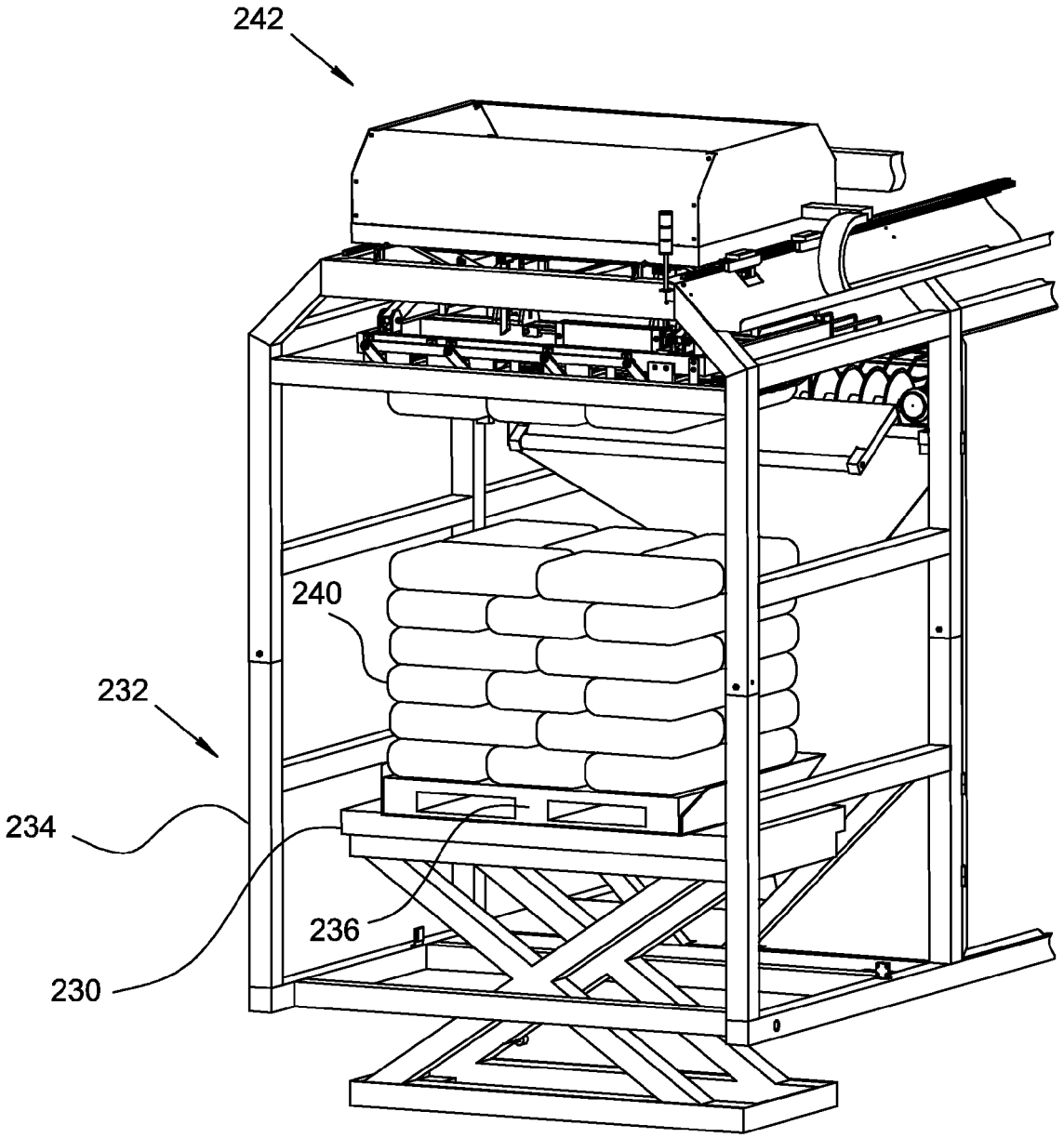

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 13 15 8860

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	19 April 2013	Wartenhorst, Frank

CATEGORY OF CITED DOCUMENTS

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