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(54) **Feeding system for feeding cardboard sheets to a module processing said cardboard sheets and method thereof**

(57) The invention relates to a feeding system (100, 900) for feeding cardboard sheets (106) to a module that processes them, comprising: at least one storage unit (101, 901, 901') for storing cardboard sheets in a vertical position, at least one unitary feeder (102, 902) for unit-by-unit supplying the cardboard sheets to a module that processes them; a belt conveyor (103, 903) for transporting the cardboard sheets, which comprises a conveyor belt (104) defining a closed-loop path and a plurality of picking units (105) configured to pick a cardboard sheet from a storage unit and hold it vertically, the picking units being affixed to the conveyor belt at different positions along said closed-loop path, so that the picking units move integrally with the conveyor belt; and a control unit operatively connected to the belt conveyor and to the at least one unitary feeder, configured to a) selectively enable a given picking unit to pick a cardboard sheet from a storage unit and b) selectively enable a given unitary feeder to fetch a cardboard sheet being carried by a picking unit. The invention also relates to a method for feeding cardboard sheets to a module that processes them.

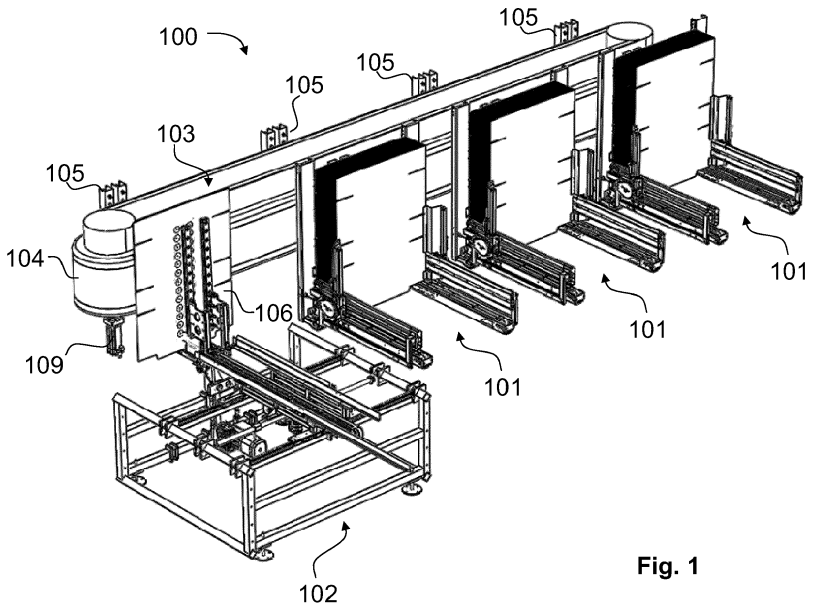

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a feeding system for feeding cardboard sheets, such as for example die-cut cardboard sheets, to a module processing said cardboard sheets, such as for instance a box forming module or another module that uses cardboard sheets. The invention also relates to a method for feeding cardboard sheets to a module processing them. In particular, the feeding system of the invention, and the associated method, make it possible to supply cardboard sheets to the module processing them with high throughput but without requiring the cardboard sheets being transported at high speed.

BACKGROUND OF THE INVENTION

[0002] Storage units for storing cardboard sheets are widely used in a multitude of machines that process, manipulate and/or transform this type of cardboard sheets, such as for instance box forming machines.

[0003] Usually these machines comprise a storage unit that cooperates with a unitary feeder that picks the cardboard sheets from the storage unit and supplies them unit by unit to a module that will process said cardboard sheets, for instance, to form a cardboard box.

[0004] It is known to use storage units for storing cardboard sheets in a horizontal position. In such storage units, also referred to as horizontal storage units, the cardboard sheets are arranged one on top of another, with their flat surfaces being horizontal with respect to the floor surface, forming a pile or stack.

[0005] In some of such horizontal storage units, the cardboard sheets are dispensed from the bottom of the stack, either individually or in groups of a few.

[0006] However, as the number of stacked cardboard sheets increases, so does the total weight of the stack, rendering the operation of dispensing the cardboard sheets to a unitary feeder that picks them difficult. Therefore, the storage capacity of these horizontal storage units is fairly limited, which means that an operator needs to replenish the storage unit with cardboard sheets more often. Moreover, the arrangement of the cardboard sheets in a stack makes it necessary for the operator to climb to a higher position to add more cardboard sheets to the top of the stack, which further complicates the replenishment of the storage unit.

[0007] Alternatively, some horizontal storage units allow the cardboard sheets stored therewithin be dispensed from the top of the stack.

[0008] Nevertheless, this also presents a number of drawbacks. For example, as the cardboard sheets are dispensed, the height of the stack decreases. The storage unit and/or the unitary feeder that picks the cardboard sheets need to account for this variation, so that the cardboard sheets can be dispensed properly to the unitary feeder. Furthermore, since the cardboard sheets are picked up from the top of the stack, it is not possible to replenish the storage unit while it is dispensing cardboard sheets. This means increased down times of the machine to which the cardboard sheets are to be fed.

[0009] A further known alternative consists of a storage unit for storing cardboard sheets in a semi-horizontal position (also referred to as semi-horizontal storage units) in which the cardboard sheets are arranged forming a pile that is tilted about 45° with respect to the floor surface and can be dispensed from the bottom of the pile.

[0010] However, such semi-horizontal storage units present the same drawbacks as those already discussed above.

[0011] There are also in the prior art storage units for storing cardboard sheets in a vertical position (also referred to as vertical storage units). In such vertical storage units the cardboard sheets are arranged one behind another, with their flat surfaces vertical with respect to the floor surface, forming a row.

[0012] These vertical storage units have a loading side, typically in the rear, from which the cardboard sheets can be loaded into the storage unit, and a dispensing side, typically in the front, from which the cardboard sheets can be dispensed.

[0013] This solution presents a number of advantages over the horizontal and semi-horizontal storage units. In particular, the arrangement of the cardboard sheets as a row, rather than as a stack, makes the dispensing simpler and independent from the total number of cardboard sheets stored. Thus, the storage capacity is no longer limited by the weight and can be larger than in the horizontal or semi-horizontal storage units, which means that these vertical storage units have to be replenished less often.

[0014] Moreover, the replenishing of the storage unit is simpler and can be done while the storage unit is dispensing cardboard sheets. In this case, the operator only needs to add more cardboard sheets into the storage unit from its loading side, and no longer needs to climb to a higher position as it happens for the horizontal and semi-horizontal storage units.

[0015] There also exist machines that are capable of processing cardboard sheets of different formats (i.e., different size and/or form factor). Such machines typically comprise a plurality of storage units, each being used for storing cardboard sheets of a different format, and require a feeding system for selectively feeding the cardboard sheets from any of the storage units to the module that processes said cardboard sheets.

[0016] A known example of a feeding system for a machine having multiformat processing capabilities comprises a plurality of semi-horizontal storage units arranged in a row above a guiderail on which a carriage can travel back and forth. An end of the guiderail is operatively coupled to a unitary feeder for unit-by-unit supplying the cardboard sheets to a module that processes them. The carriage is adapted for receiving a cardboard

sheet dispensed from the bottom side of one of the storage units and carrying it to the unitary feeder.

[0017] This feeding system presents, however, a number of drawbacks. First of all, after receiving a cardboard sheet from one of the storage units, the carriage needs to travel to the end of the guiderail to discharge said cardboard sheet and travel back empty to the portion of the guiderail on which the storage units are located, before it can receive another cardboard sheet and repeat the cycle. This cyclic behavior inherently leads to a low rate at which cardboard sheets can be delivered to the unitary feeder. Thus, the feeding system exhibits a low throughput.

[0018] This problem becomes even worse as the number of storage units comprised in the feeding system increases, because the guiderail has to be longer and the travelling times of the carriage to go back and forth between the storage units and the unitary feeder increases. Therefore, the scalability of this known solution is very poor.

[0019] Some attempts to Increase the throughput of this prior-art feeding system involve increasing the speed at which the carriage travels on the guiderail. However, this option also presents some disadvantages. For example, as the inertia of the carriage increases, the requirements for the electromechanical systems that have to accelerate, slow down and reverse the direction of movement of the carriage become more challenging. In addition, the aerodynamics of the cardboard sheet being transported by the carriage get more complex at higher speeds, as the wind resistance tends to pull the cardboard sheet upwards (i.e., away from the carriage), with an increasing risk of the cardboard sheet becoming dislodged. When such thing occurs, an operator has to stop the operation of the feeding system and proceed to manually remove any cardboard sheet jammed inside the feeding system.

[0020] It is therefore an object of the present invention to provide a feeding system for feeding cardboard sheets to a module processing said cardboard sheets capable of achieving a high throughput but without requiring the cardboard sheets being transported at high speed.

[0021] It is another object of the present invention to provide a feeding system whose throughput is independent from the number of storage units comprised in it, so that it has good scalability, and which is more flexible to handle cardboard sheets of different formats.

[0022] It is yet another object of the present invention to provide a feeding system that is more robust to failures; makes servicing in case of failure easier; and requires less maintenance.

[0023] A further object of the present invention is to provide a method for feeding cardboard sheets to a module processing said cardboard sheets, that solves the drawbacks described above.

SUMMARY OF THE INVENTION

[0024] The objects of the present invention are solved with the feeding system of claim 1 and the method for feeding cardboard sheets to a module that processes them of claim 15. Other favorable embodiments of the invention are defined in the dependent claims.

[0025] The present invention relates to a feeding system for feeding cardboard sheets to a module processing said cardboard sheets, such as a box forming module, that comprises at least one storage unit for storing cardboard sheets in a vertical position, the/each storage unit having a loading side from which the cardboard sheets can be loaded into said storage unit, and a dispensing side from which the cardboard sheets can be dispensed; and at least one unitary feeder for unit-by-unit supplying the cardboard sheets to a module processing said cardboard sheets.

[0026] The feeding system is characterized in that it further comprises:

- a belt conveyor for transporting the cardboard sheets dispensed by the at least one storage unit to the at least one unitary feeder, the belt conveyor comprising a conveyor belt that defines a closed-loop path and a plurality of picking units; wherein each picking unit of said plurality is configured to pick a cardboard sheet from a storage unit of the at least one storage unit and hold it vertically while being transported from said storage unit to a unitary feeder of the at least one unitary feeder; wherein each picking unit of the plurality of picking units is affixed to the conveyor belt at a different position along said closed-loop path, so that when movement is imparted to the conveyor belt the plurality of picking units move integrally with the conveyor belt; and
- a control unit operatively connected to the belt conveyor and to the at least one unitary feeder, the control unit being configured to:

    a) selectively enable a given picking unit of said plurality to pick a cardboard sheet from a storage unit of the at least one storage unit when said picking unit is at a position of the closed-loop path that faces the dispensing side of said storage unit; and

    b) selectively enable a given unitary feeder of the at least one unitary feeder to fetch a cardboard sheet being carried by a picking unit of said plurality when said picking unit is at a position of the close-loop path that faces said unitary feeder.

[0027] The use of a belt conveyor having a plurality of picking units makes it possible for the feeding system of the present invention to transport simultaneously several cardboard sheets from one or more storage units to one or more unitary feeders. Since the picking units are af-

fixed to the conveyor belt and move integrally with it, each picking unit can transport a cardboard sheet without interfering with the others. Thus, conversely to the prior-art solution based on a guiderail and a carriage travelling back and forth, in which only one cardboard sheet could be transported at a time, the feeding system of the invention allows carrying many cardboard sheets at the same time, which can be of different sizes and/or shapes.

[0028] For a given speed at which the conveyor belt is driven, the larger the number of picking units provided in the belt conveyor, the higher the throughput of the feeding system. Alternatively, for a given target throughput, the larger the number of picking units in the belt conveyor, the lower the required speed to attain said target throughput. Thus, the feeding system of the invention makes it possible to achieve a high throughput without requiring the cardboard sheets being transported at high speed.

[0029] In addition, transporting the cardboard sheets at relatively low speeds reduces the risk of failures, such as for instance the cardboard sheets becoming dislodged due to wind resistance. It also reduces the tear and wear of the mechanical and/or electromechanical parts of the system, softening the requirements for these parts and/or extending their lifetime.

[0030] Furthermore, the throughput of the feeding system of the invention is fairly independent from the number of storage units that it comprises, because it is mainly related to the number of picking units in the belt conveyor and the speed at which the conveyor belt moves. Consequently, the feeding system of the invention exhibits a good scalability with the number of storage units.

[0031] The use of vertical storage units, combined with the fact that the picking units can hold the cardboard sheets vertically while being transported, results in a feeding system that is more compact, while at the same time being of easy access to an operator that needs to do repairing, maintenance work, or just some cleaning. In addition, loading cardboard sheets into the storage units can be done from the loading side of the storage units without interfering with the functioning of the feeding system.

[0032] Additionally, having a control unit to selectively determine from which storage unit each cardboard sheet is to be picked, and to which unitary feeder is to be delivered, makes the feeding system of the invention very versatile and capable of handling cardboard sheets of different formats.

[0033] In some examples of the present invention, the cardboard sheets are die cut, while in some other examples they are not.

[0034] Preferably, the at least one storage unit is adapted to store cardboard sheets of different formats.

[0035] In the context of this application, a cardboard sheet is in a vertical position, or is arranged vertically, if the flat surface of said cardboard sheet is substantially perpendicular to the floor surface (i.e., the normal to the flat surface of the cardboard sheet is substantially perpendicular to the direction of the Earth's gravity). Similarly, a cardboard sheet is in a horizontal position, or is arranged horizontally, if the flat surface of said cardboard sheet is substantially parallel to the floor surface (i.e., the normal to the flat surface of the cardboard sheet is substantially parallel to the direction of the Earth's gravity).

[0036] Furthermore, also in the context of this application, two surfaces or two directions are considered to be substantially perpendicular if the angle defined therebetween is between 75° and 105°. Similarly, two surfaces or two directions are considered to be substantially parallel if the angle defined therebetween is smaller than 15°.

[0037] Preferably, a picking unit is considered to be at a position of the closed-loop path that faces the dispensing side of a storage unit, when said picking unit is located between the conveyor belt and said storage unit and the orthogonal projection of said picking unit on the plane defined by the flat surface of a cardboard sheet kept on the dispensing side of said storage unit overlaps, at least in part, said flat surface.

[0038] Also preferably, a picking unit is considered to be at a position of the close-loop path that faces a unitary feeder, when said picking unit is located between the conveyor belt and said unitary feeder and the orthogonal projection of said unitary feeder on the plane defined by the flat surface of a cardboard sheet being carried by said picking unit overlaps, at least in part, said flat surface.

[0039] Preferably, the control unit is operatively connected to the plurality of picking units of the belt conveyor.

[0040] In some embodiments, the feeding system further comprises a motor operatively coupled to the belt conveyor for imparting a stepped motion to the conveyor belt, so that at each step the conveyor belt advances or recedes by a predetermined amount. However, in other embodiments the feeding system comprises a motor operatively coupled to the belt conveyor capable of, alternatively or additionally, imparting a continuous motion, to the conveyor belt.

[0041] Having a motor (such as, for instance, a stepper motor or a servomotor) that imparts a stepped motion to the belt conveyor is advantageous because it allows the control unit to know very precisely the distance by which the conveyor belt (and the picking units affixed to it) have been displaced along the closed-loop path.

[0042] In such embodiments, the spacing between any pair of consecutive picking units of the plurality of picking units along the closed-loop path of the conveyor belt preferably corresponds to an integer number of steps.

[0043] This simplifies the control of the picking units, because all the picking units comprised in the belt conveyor stop at a same discrete set of positions as the picking units are moved along the closed-loop path of the conveyor belt. In other words, after a given picking unit leaves a position of the close-loop path, the next picking unit will land at that same position after the conveyor belt has been moved a predetermined number of steps.

[0044] In some cases, said integer number of steps may be different for at least some pairs of consecutive

picking units. In some other cases, it may be a same integer number, such as 1, 2, 3, 5, or 10, for any pair of consecutive picking units. Preferably, a step corresponds to the distance between the at least one storage unit and the at least one unitary feeder, or between two consecutive storage units in case that there is more than one storage unit.

[0045] Additionally in such embodiments, the/each storage unit and the/each unitary feeder are optionally arranged relative to the belt conveyor at a position along the closed-loop path of the conveyor belt at which at least one of the picking units stops after the conveyor belt is advanced or receded by a predetermined number of steps.

[0046] If the storage unit or units and the unitary feeder or feeders are advantageously at positions along the close-loop path that are in common with those at which the picking units stop, the transfer of cardboard sheets between the at least one storage unit and the picking units, and between the picking units and the at least one unitary feeder, is simpler. Therefore, this feature further simplifies the control of the feeding system during operation.

[0047] In some embodiments of the present invention, the belt conveyor comprises two rollers mechanically coupled to the conveyor belt, the rollers being located within the closed-loop path defined by the conveyor belt at opposite ends of said path. Additionally, the two rollers are arranged vertically so that a portion of the surface of the conveyor belt faces the at least one storage unit and/or the at least one unitary feeder.

[0048] Arranging the belt conveyor sideways, with its end rollers in a vertical position, is advantageous to make the feeding system more compact, as the belt conveyor can be disposed closer to the at least one storage unit and the at least one unitary feeder. Moreover, it also simplifies the mechanical design of the picking units because the cardboard sheets are transported substantially parallel to the surface of the conveyor belt.

[0049] In some preferred embodiments, each picking unit comprises a member adapted to be protruded away from the conveyor belt and retracted towards the conveyor belt, said member comprising one or more suction cups.

[0050] More preferably, the belt conveyor comprises at least one actuator (such as for instance pneumatic and/or electrical actuator) for protruding and/or retracting the member of the picking units.

[0051] In some cases each picking unit comprises one of such actuators operatively connected to the member of said picking unit. In other cases, the at least one actuator is mounted on a frame of the belt conveyor at a fix position along the closed-loop path of the conveyor belt, and is adapted to clutch with the member of the picking units when they reach said position. In the latter cases, the conveyor belt preferably comprises as many actuators as there are storage units in the feeding system.

[0052] In some embodiments, the/each unitary feeder comprises means for unit-by-unit supplying cardboard sheets and a transfer arm configured to fetch a cardboard sheet being carried by a picking unit of said plurality when said picking unit is at a position of the close-loop path that faces said unitary feeder and transfer said cardboard sheet to said unit-by-unit supplying means.

[0053] The transfer arm may optionally comprise an articulated arm with a member comprising one or more suction cups provided at an end of the articulated arm and actuating means. More preferably, the actuating means comprise a motor and a crank and connecting rod mechanism to mechanically couple the motor to the articulated arm.

[0054] In one of such embodiments, the number of suction cups on the member of said articulated arm is the same as the number of suction cups on the member of any one of the picking units, and the spatial distribution of the suction cups on the member of said articulated arm is a mirror image of the spatial distribution of the suction cups on the member of any one of the picking units. If the suction cups on the member of the articulated arm of the unitary feeder are in correspondence with those on the member of the picking units, the articulated arm can pull the cardboard sheet from the picking unit more easily and requiring a force that is smaller in magnitude.

[0055] In some further embodiments, the/each storage unit advantageously comprises guiding and biasing means for guiding the cardboard sheets stored within and biasing them towards the dispensing side of the storage unit.

[0056] In certain embodiments, the at least one storage unit and the at least one unitary feeder are arranged facing the conveyor belt forming a row on a same side of the belt conveyor. Such an arrangement provides an easier and more unobstructed access to the belt conveyor, and may be preferred to facilitate its reparation and other maintenance work.

[0057] As an alternative, the at least one storage unit and the at least one unitary feeder may be arranged on different sides, preferably opposite sides, of the belt conveyor. Such an arrangement leads to a feeding system having a more compact footprint, and may be preferred when the feeding system has to be installed in a small-sized area of a plant or factory.

[0058] In these embodiments, the feeding system may preferably comprise two or more (such as, for instance, three, four, six, eight, or ten) storage units.

[0059] Optionally, a first storage unit and a second storage unit of said two or more storage units are configured to store cardboard sheets of, respectively, a first format and a second format, said second format being different from said first format.

[0060] Having a plurality of storage units enhances the flexibility of the feeding system to support multiformat capabilities. Cardboard sheets of different formats and/or having different ornamental motifs can be stored in different storage units and be dispensed to the same belt

conveyor that will transport them to the at least one unitary feeder for being processed.

[0061] In those embodiments in which the feeding system comprises two or more storage units arranged forming a row together with the at least one unitary feeder, the at least one unitary feeder is preferably at an intermediate position in said row, so that there is at least one storage unit at either one of the two lateral sides of the at least one unitary feeder.

[0062] Alternatively, the at least one unitary feeder may be at an end of said row, with all the storage units being on a same lateral side of the at least one unitary feeder.

[0063] The lateral sides of a unitary feeder preferably refer to those sides that connect a front side, from which the unitary feeder receives cardboard sheets transported by the picking units, with a rear side, from which the unitary feeder supplies cardboard sheets on a unit-by-unit basis to a module processing them.

[0064] In some embodiments, the feeding system may advantageously comprise two, three or more unitary feeders. Different unitary feeders may be adapted to handle cardboard sheets of different format and/or may be operatively coupled to different types of modules processing said cardboard sheets, such as for instance a printing and/or engraving module, a box forming module, a box closing module, or a box covering module.

[0065] The invention also relates to a multiformat box forming machine that comprises a mutiformat box forming module and a feeding system in accordance to the present invention, wherein the at least one unitary feeder of the feeding system is operatively coupled to the multiformat box forming module.

[0066] Additionally, the present invention relates to a method for feeding cardboard sheets to a module processing said cardboard sheets, such as a box forming module, that comprises the steps of:

a) providing at least one storage unit for storing cardboard sheets in a vertical position;
b) loading cardboard sheets into the at least one storage unit from a loading side of said at least one said storage unit;
c) providing at least one unitary feeder for unit-by-unit supplying the cardboard sheets to a module processing said cardboard sheets;
d) providing a belt conveyor for transporting the cardboard sheets from the at least one storage unit to the at least one unitary feeder, wherein the belt conveyor comprises a conveyor belt that defines a closed-loop path and a plurality of picking units, each picking unit of said plurality being affixed to the conveyor belt at a different position along said closed-loop path and being configured to hold a cardboard sheet vertically while being transported;
e) imparting movement to the conveyor belt, so that the plurality of picking units move integrally with it;
f) selectively enabling a given picking unit of said plurality to pick a cardboard sheet from a storage unit of the at least one storage unit when said picking unit is at a position of the closed-loop path that faces a dispensing side of said storage unit; and
g) selectively enabling a given unitary feeder of the at least one unitary feeder to fetch a cardboard sheet being carried by a picking unit of said plurality when said picking unit is at a position of the close-loop path that faces said unitary feeder.

[0067] In this application, the term conveyor belt refers to a continuous band that defines a closedloop path, to which movement can be imparted, and that is suitable for mounting the picking units. In that sense, this term also encompasses, among others, a continuous track, an articulated band made of modular plates, or a chain formed by a plurality of links.

BRIEF DESCRIPTION OF THE FIGURES

[0068] In the following some preferred embodiments of the invention will be described with reference to the enclosed figures. They are provided only for illustration purposes without however limiting the scope of the invention.

Figure 1 shows a perspective view of a feeding system according to a first embodiment of the present invention.

Figure 2 is another perspective view of the embodiment of Figure 1 showing the belt conveyor on the front.

Figure 3 shows a top plan view of the embodiment of Figure 1.

Figure 4 shows a detailed view of two of the picking units comprised in the belt conveyor of the feeding system according to the first embodiment.

Figure 5 is a detailed view of the unitary feeder of the feeding system according to the first embodiment.

Figure 6 shows a detailed rear view of one of the storage units of the feeding system according to the first embodiment.

Figures 7A and 7B correspond to two different instants of a sequence showing how a picking unit of the belt conveyor picks a cardboard sheet from one of the storage units of the feeding system according to the first embodiment.

Figure 8 corresponds to an instant of the sequence in which the transfer arm of the unitary feeder fetches a cardboard sheet being transported by a picking unit comprised in the belt conveyor of the feeding

system according to the first embodiment.

Figure 9 shows a top plan view of a feeding system according to a second embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0069] Figures 1-3 illustrate an exemplary feeding system according to a first embodiment of the present invention. Figures 1 and 2 provide two perspective views of the feeding system from opposite sides of the belt conveyor, while Figure 3 presents a top plan view of the feeding system in which the arrangement of the elements of the feeding system relative to each other can be better observed.

[0070] In particular, it is depicted in the figures a feeding system 100 for feeding cardboard sheets 106 to a module that processes said cardboard sheets (not shown in the figures). The feeding system 100 comprises three storage units 101 for storing cardboard sheets 106 in a vertical position, and a unitary feeder 102 for unit-by-unit supplying the cardboard sheets 106 to the module that will process them, such as for instance a multiformat box forming module.

[0071] The feeding system 100 further comprises a belt conveyor 103 for transporting the cardboard sheets 106 dispensed by the storage units 101 to the unitary feeder 102. The belt conveyor 103 comprises a conveyor belt 104 that defines a closed-loop path and a plurality of picking units 105.

[0072] Each storage unit 101 has a loading side 107, from which the cardboard sheets 106 can be loaded into it, and a dispensing side 108, from which the cardboard sheets 106 can be dispensed. As it can be best seen in Figure 3, the loading side 107 is the side of the storage unit 101 that is farther from the belt conveyor 103, while the dispensing side 108 is the side that is closer to the belt conveyor 103.

[0073] Each picking unit 105 is configured to pick a cardboard sheet 106 from any of the three storage units 101 and hold it vertically while being transported from said storage unit to the unitary feeder 102. Although in this particular example the belt conveyor 103 comprises eight picking units 105, in other examples it might comprise more or fewer than eight. Moreover, each picking unit 105 is affixed to the conveyor belt 104 at a different position along said closed-loop path. In this manner, when movement is imparted to the conveyor belt 104 the plurality of picking units 105 move integrally with the conveyor belt 104.

[0074] In addition, the feeding system 100 also comprises a control unit (not depicted in Figures 1-3) that is operatively connected to the belt conveyor 103, in particular to the picking units 105, and to the unitary feeder 102. The control unit is configured to:

a) selectively enable a given picking unit 105 to pick a cardboard sheet 106 from a storage unit 101 when said picking unit 105 is at a position of the closed-loop path that faces the dispensing side 108 of said storage unit 101; and

b) selectively enable the unitary feeder 102 to fetch a cardboard sheet 106 being carried by a picking unit 105 when said picking unit 105 is at a position of the close-loop path that faces the unitary feeder 102.

[0075] In Figure 3 it can be seen that a picking unit 105, namely the one carrying a cardboard sheet 106 on the right-hand side of the figure, is at a position of the close-loop path that faces the unitary feeder 102. Indeed, said picking unit is located between the conveyor belt 104 and the unitary feeder 102, and the orthogonal projection of the unitary feeder 102 on the plane defined by the flat surface of a cardboard sheet 106 being carried by said picking unit 105 overlaps said flat surface.

[0076] In the same manner, there are three picking units 105, namely the three to the left of the picking unit carrying a cardboard sheet 106 in Figure 3, that are at three positions of the closed-loop path that face the dispensing sides 108 of the storage units 101. Certainly, said picking units are located between the conveyor belt 104 and the storage units 101, and the orthogonal projection of said picking units 105 on the plane defined by the flat surface of a cardboard sheet 106 kept on the dispensing side 108 of said storage units 101 overlaps said flat surface.

[0077] In this example, the storage units 101 and the unitary feeder 102 are arranged facing the conveyor belt 104 forming a row on a same side of the belt conveyor 103. However, in other examples they could have been arranged on different sides of the belt conveyor 103.

[0078] As it can be observed in Figured 1, the feeding system 100 comprises a motor 109, in particular a stepper motor or a servomotor, operatively coupled to the belt conveyor 103 for imparting a stepped motion to the conveyor belt 104. The motor 109 causes, at each step, the conveyor belt 104 to advance or recede by a predetermined amount.

[0079] In this example, the spacing d between any pair of consecutive picking units 105 along the closed-loop path of the conveyor belt 104 has been selected to be an integer number of steps. Furthermore, as the eight picking units 105 are uniformly distributed along the closed-loop path of the conveyor belt 104, the spacing d between any pair of consecutive picking units 105 is constant.

[0080] Therefore, after stepping forward the conveyor belt 104 a number of steps corresponding to the spacing d, the distribution of the picking units 105 relative to a frame 110 of the belt conveyor 103 appears to be the same. In other words, the belt conveyor features a periodic behavior with a period equal to the spacing d.

[0081] Furthermore, as depicted in Figure 3, the storage units 101 and the unitary feeder 102 are arranged

relative to the belt conveyor 103 so that they are substantially centered at different positions along the closed-loop path of the conveyor belt 104 at which the picking units 105 stop. In fact, starting from the configuration shown in Figure 3, every time that the conveyor belt 104 is advanced or receded by a number of steps corresponding to the spacing d, there is a picking unit 105 that stops at a position that faces each of the three storage units 101 and the unitary feeder 102.

[0082] The belt conveyor 103 comprises two rollers 111 mechanically coupled to the conveyor belt 104 and located within the closed-loop path defined by the conveyor belt 104 at opposite ends of said path. In the feeding system 100, the belt conveyor 103 is disposed sideways (i.e., with the two rollers 111 being arranged vertically) so that a portion of the surface of the conveyor belt 104 faces the storage units 101 and the unitary feeder 102.

[0083] Referring now to Figure 4, it is there represented a detailed view of two of the picking units 105 comprised in the belt conveyor 104 of the feeding system 100. Each picking unit 105 comprises a member 401 adapted to be protruded away from the conveyor belt 104 and retracted towards the conveyor belt 104. In the example illustrated in the figure, said member 401 takes the form of a vertically-oriented H-shaped plate comprising a plurality of suction cups 402 arranged in two parallel columns corresponding to the vertical portions of the H-shaped plate. Apart from the H-shaped plate shown in Figure 4, the member 401 may also take other forms.

[0084] The belt conveyor 103 also comprises some actuators for protruding and retracting the member 401 of the picking units 105. In the example in Figure 4, the picking unit 105 is operatively connected to a pneumatic and/or electrical actuator 403.

[0085] When a picking unit 105 is at a position of the closed-loop path that faces the dispensing side 108 of a given storage unit 101, the control unit may activate the actuator 403 to fully protrude the member 401 of the picking unit 105 towards the storage unit 101. The pressure exerted by the member 401 on the cardboard sheet 106 kept on the dispensing side 108 of the storage unit 101 causes the suction cups 402 to adhere to it. In this way, when the actuator 403 is subsequently activated to recede the member 401 towards the conveyor belt 103, the member 401 drags the cardboard sheet 106 from the storage unit 101.

[0086] This sequence is represented in Figures 7A and 7B. In particular, Figure 7A corresponds to an instant in which the member 401 has already picked the cardboard sheet 106 and is being receded towards the conveyor belt 104, while Figure 7B correspond to the instant when the member 401 has already been fully receded and the belt conveyor 103 is ready to transport the cardboard sheet 106.

[0087] A detailed view of the unitary feeder 102 of the feeding system 100 is provided in Figure 5. The unitary feeder 102 has a front side 501, from which it receives cardboard sheets 106 transported by the picking units 105, and a rear side 502, from which it supplies the cardboard sheets 106 on a unit-by-unit basis to a module processing them. The unitary feeder 102 also comprises two lateral sides 503, 504 that connect the front side 501 with the rear side 502.

[0088] The unitary feeder 102 comprises means 505 for unit-by-unit supplying cardboard sheets 106 and a transfer arm 506 configured to fetch a cardboard sheet 106 being carried by a picking unit 105 when it is at a position of the close-loop path that faces the unitary feeder 102 and transfer the cardboard sheet 106 to the unit-by-unit supplying means 505.

[0089] In the example of Figure 5, the transfer arm 506 includes an articulated arm 507, with a member 508 that comprises a plurality of suction cups 509 arranged in two columns, said member 508 being provided at an end of the articulated arm 507. The transfer arm 506 further includes actuating means 510 based on a motor 511 and a crank-and-connecting-rod mechanism 512 to mechanically couple the motor 511 to the articulated arm 507. The actuating means 510 rotate the cardboard sheet 106 from a vertical position to a horizontal position before being transferred to the unit-by-unit supplying means 505.

[0090] When a picking unit 105 carrying a cardboard sheet 106 is at a position of the close-loop path that faces the unitary feeder 102, the control unit may enable the actuating means 510 of the transfer arm 506 to fetch the cardboard sheet 106. In that case, the articulated arm 507 of said transfer arm 506 is projected towards the picking unit 105, so that the pressure exerted by the member 508 on the cardboard sheet 106 causes the suction cups 509 to adhere to it. Afterwards, the actuating means 510 are subsequently activated to retract the articulated arm 507, removing the cardboard sheet 106 from the picking unit 105, and rotating the cardboard sheet 106 to a horizontal position (as illustrated in Figure 8).

[0091] Figure 6 presents a detailed rear view (i.e., from the loading side 107) of one of the storage units 101 of the feeding system 100. The storage unit 101 comprises means 601 for guiding the cardboard sheets 106 stored within from the loading side 107 to the dispensing side 108 of the storage unit 101, and means 602 for biasing them towards said dispensing side 108. The storage unit 101 is adapted to store cardboard sheets 106 of different formats.

[0092] In the example of Figures 1-3, the storage units 101 and the unitary feeder 102 are arranged forming a row, in which the unitary feeder 102 is at an end of said row, so that all the storage units 101 are on a same lateral side of the unitary feeder 102.

[0093] As an alternative, Figure 9 provides another example of a feeding system according to a second embodiment of the present invention. Again, the feeding system 900 comprises three storage units 901, 901' and a unitary feeder 902, all arranged forming a row on a same side of a belt conveyor 903. Conversely to the previous example, now the unitary feeder 902 is at an intermediate

position in said row, so that two storage units 901 are on the lateral side 904 of the unitary feeder 902 while a third storage unit 901' is on the opposite lateral side 905 of the unitary feeder 902. Thus, there is at least one storage unit at either one of the two lateral sides of the unitary feeder 902.

[0094] Although Figures 1-3 and 9 show feeding systems that have been described as having, three storage units and a single unitary feeder, other examples of feeding systems according to the present invention may comprise more or fewer storage units and/or more than one unitary feeder.

[0095] Finally, a multiformat box forming machine capable of handling cardboard sheets of several different formats can be readily obtained by operatively coupling a mutiformat box forming module to the unitary feeder of the feeding systems according to the first or second exemplary embodiments discussed above in connection with Figures 1-3 and 9.

[0096] While the invention has been described with respect to some specific examples, including presently preferred modes of carrying out the invention, those skilled in the art will appreciate that there are numerous variations and permutations of the above described feeding system and associated method, including substitution of specific elements by others technically equivalent, without departing from the scope of the invention as set forth in the appended claims.

Claims

1. A feeding system (100, 900) for feeding cardboard sheets (106) to a module processing said cardboard sheets, such as a box forming module, comprising:

- at least one storage unit (101, 901, 901') for storing cardboard sheets (106) in a vertical position, the/each storage unit (101, 901, 901') having a loading side (107) from which the cardboard sheets can be loaded into said storage unit, and a dispensing side (108) from which the cardboard sheets can be dispensed; and
- at least one unitary feeder (102, 902) for unit-by-unit supplying the cardboard sheets (106) to a module processing said cardboard sheets;

characterized in that the feeding system further comprises:

- a belt conveyor (103, 903) for transporting the cardboard sheets (106) dispensed by the at least one storage unit (101, 901, 901') to the at least one unitary feeder (102, 902), the belt conveyor (103, 903) comprising a conveyor belt (104) that defines a closed-loop path and a plurality of picking units (105),
wherein each picking unit (105) of said plurality is configured to pick a cardboard sheet (106) from a storage unit (101, 901, 901') of the at least one storage unit and hold it vertically while being transported from said storage unit to a unitary feeder of the at least one unitary feeder (102, 902);
wherein each picking unit (105) of the plurality of picking units is affixed to the conveyor belt (104) at a different position along said closed-loop path, so that when movement is imparted to the conveyor belt (104) the plurality of picking units (105) move integrally with the conveyor belt (104); and
- a control unit operatively connected to the belt conveyor (103, 903) and to the at least one unitary feeder (102, 902), the control unit being configured to:

a) selectively enable a given picking unit (105) of said plurality to pick a cardboard sheet (106) from a storage unit (101, 901, 901') of the at least one storage unit when said picking unit is at a position of the closed-loop path that faces the dispensing side (108) of said storage unit (101, 901, 901'); and
b) selectively enable a given unitary feeder (102, 902) of the at least one unitary feeder to fetch a cardboard sheet (106) being carried by a picking unit (105) of said plurality when said picking unit (105) is at a position of the close-loop path that faces said unitary feeder (102, 902).

2. The feeding system according to claim 1, further comprising a motor (109) operatively coupled to the belt conveyor (103, 903) for imparting a stepped motion to the conveyor belt (104), so that at each step the conveyor belt (104) advances or recedes by a predetermined amount.

3. The feeding system according to claim 2, wherein the spacing (d) between any pair of consecutive picking units (105) of the plurality of picking units along the closed-loop path of the conveyor belt (104) corresponds to an integer number of steps.

4. The feeding system according to claim 2 or 3, wherein the/each storage unit (101, 901, 901') and the/each unitary feeder (102, 902) are arranged relative to the belt conveyor (103, 903) at a position along the closed-loop path of the conveyor belt (104) at which at least one of the picking units (105) stops after the conveyor belt (104) is advanced or receded by a predetermined number of steps.

5. The feeding system according to any of claims 1 to 4, wherein the belt conveyor (103, 903) comprises

two rollers (111) mechanically coupled to the conveyor belt (104), the rollers (111) being located within the closed-loop path defined by the conveyor belt (104) at opposite ends of said path, and wherein the two rollers (111) are arranged vertically so that a portion of the surface of the conveyor belt (104) faces the at least one storage unit (101, 901, 901') and/or the at least one unitary feeder (102, 902).

6. The feeding system according to any of claims 1 to 5, wherein each picking unit (105) comprises a member (401) adapted to be protruded away from the conveyor belt (104) and retracted towards the conveyor belt (104), said member (401) comprising one or more suction cups (402).

7. The feeding system according to any of claims 1 to 6, wherein the/each unitary feeder (102, 902) comprises means (505) for unit-by-unit supplying cardboard sheets (106) and a transfer arm (506) configured to fetch a cardboard sheet (106) being carried by a picking unit (105) of said plurality when said picking unit is at a position of the close-loop path that faces said unitary feeder (102, 902) and transfer said cardboard sheet (106) to said unit-by-unit supplying means (505).

8. The feeding system according to claim 7, wherein the transfer arm (506) comprises:

- an articulated arm (507) with a member (508) comprising one or more suction cups provided at an end of the articulated arm (507); and
- actuating means (510), wherein the actuating means preferably comprise a motor (511) and a crank and connecting rod mechanism (512) to mechanically couple the motor (511) to the articulated arm (507).

9. The feeding system according to any of the preceding claims, wherein the/each storage unit (101, 901, 901') comprises guiding and biasing means (601, 602) for guiding the cardboard sheets (106) stored within and biasing them towards the dispensing side (108) of the storage unit.

10. The feeding system according to any of the preceding claims, wherein the at least one storage unit (101, 901, 901') and the at least one unitary feeder (102, 902) are arranged facing the conveyor belt (104) forming a row on a same side of the belt conveyor (103, 903).

11. The feeding system according to claim 10, wherein the feeding system (100, 900) comprises two or more storage units (101, 901, 901').

12. The feeding system according to claim 11, wherein the at least one unitary feeder (902) is at an intermediate position in said row, so that there is at least one storage unit (901, 901') at either one of the two lateral sides (904, 905) of the at least one unitary feeder.

13. The feeding system according to claim 11 or 12, wherein a first storage unit and a second storage unit of said two or more storage units are configured to store cardboard sheets of, respectively, a first format and a second format, said second format being different from said first format.

14. Multiformat box forming machine, comprising:

- a mutiformat box forming module; and
- a feeding system (100, 900) according to any of the preceding claims, wherein the at least one unitary feeder (102, 902) is operatively coupled to the multiformat box forming module.

15. A method for feeding cardboard sheets (106) to a module processing said cardboard sheets, such as a box forming module, comprising the steps of:

a) providing at least one storage unit (101, 901, 901') for storing cardboard sheets (106) in a vertical position;
b) loading cardboard sheets (106) into the at least one storage unit (101, 901, 901') from a loading side (107) of said at least one said storage unit;
c) providing at least one unitary feeder (102, 902) for unit-by-unit supplying the cardboard sheets (106) to a module processing said cardboard sheets;
characterized in that the method further comprises the steps of:
d) providing a belt conveyor (103, 903) for transporting the cardboard sheets (106) from the at least one storage unit (101, 901, 901') to the at least one unitary feeder (102, 902), wherein the belt conveyor (103, 903) comprises a conveyor belt (104) that defines a closed-loop path and a plurality of picking units (105), each picking unit (105) of said plurality being affixed to the conveyor belt (104) at a different position along said closed-loop path and being configured to hold a cardboard sheet (106) vertically while being transported;
e) imparting movement to the conveyor belt (104), so that the plurality of picking units (105) move integrally with it;
f) selectively enabling a given picking unit (105) of said plurality to pick a cardboard sheet (106) from a storage unit (101, 901, 901') of the at least one storage unit when said picking unit is at a position of the closed-loop path that faces

a dispensing side (108) of said storage unit (101, 901, 901'); and

g) selectively enabling a given unitary feeder (102, 902) of the at least one unitary feeder to fetch a cardboard sheet (106) being carried by a picking unit (105) of said plurality when said picking unit (105) is at a position of the close-loop path that faces said unitary feeder (102, 902).

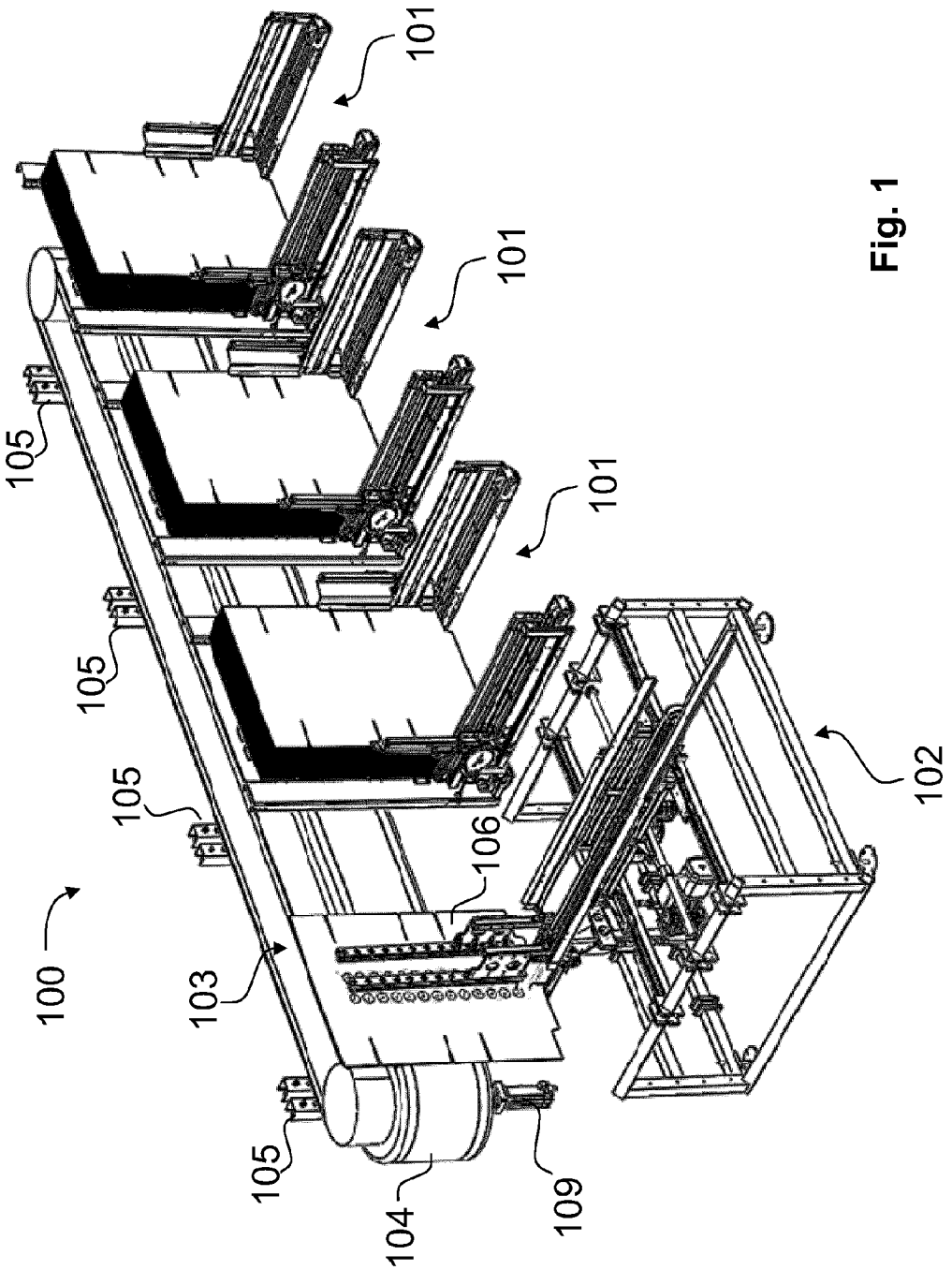

Fig. 1

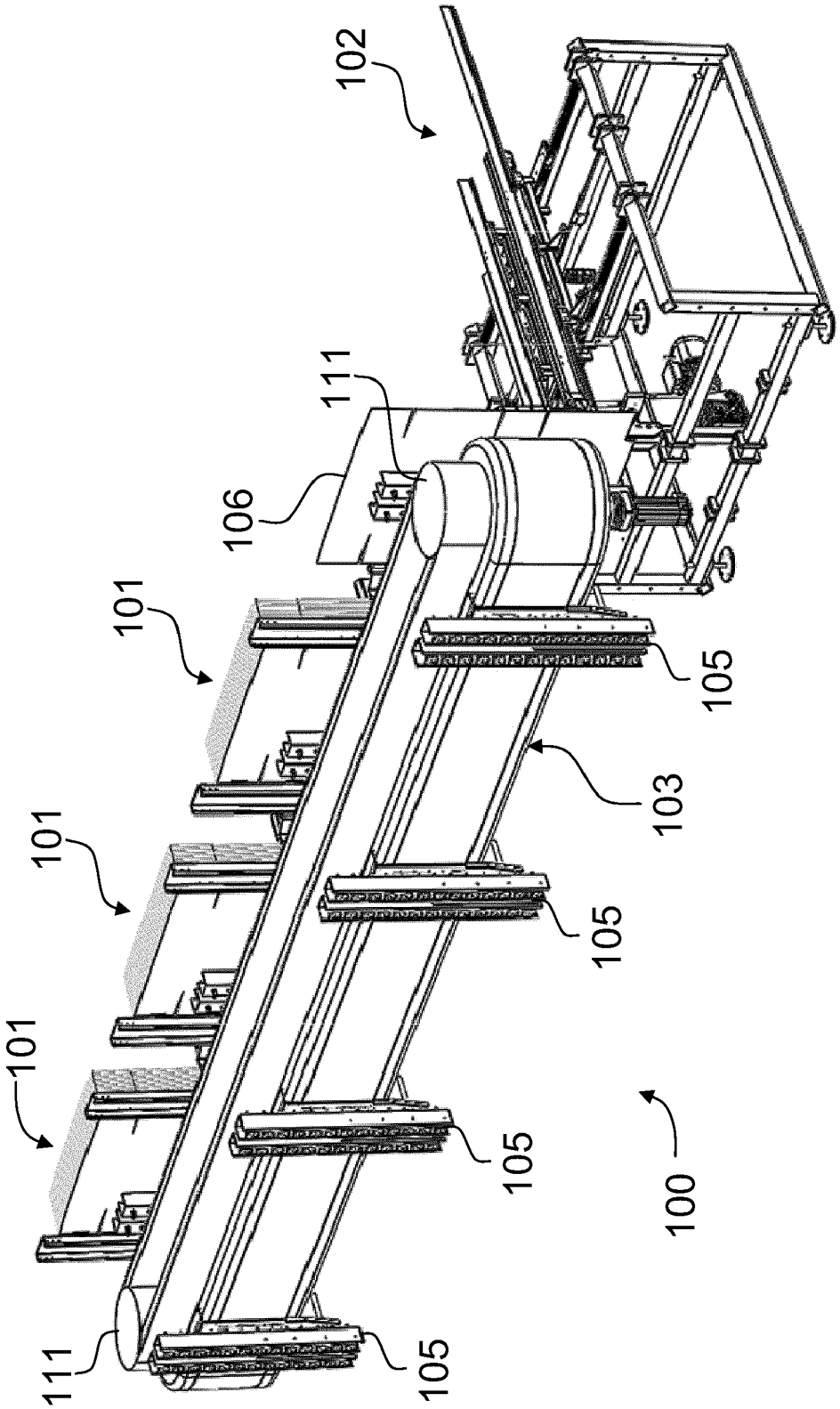

Fig. 2

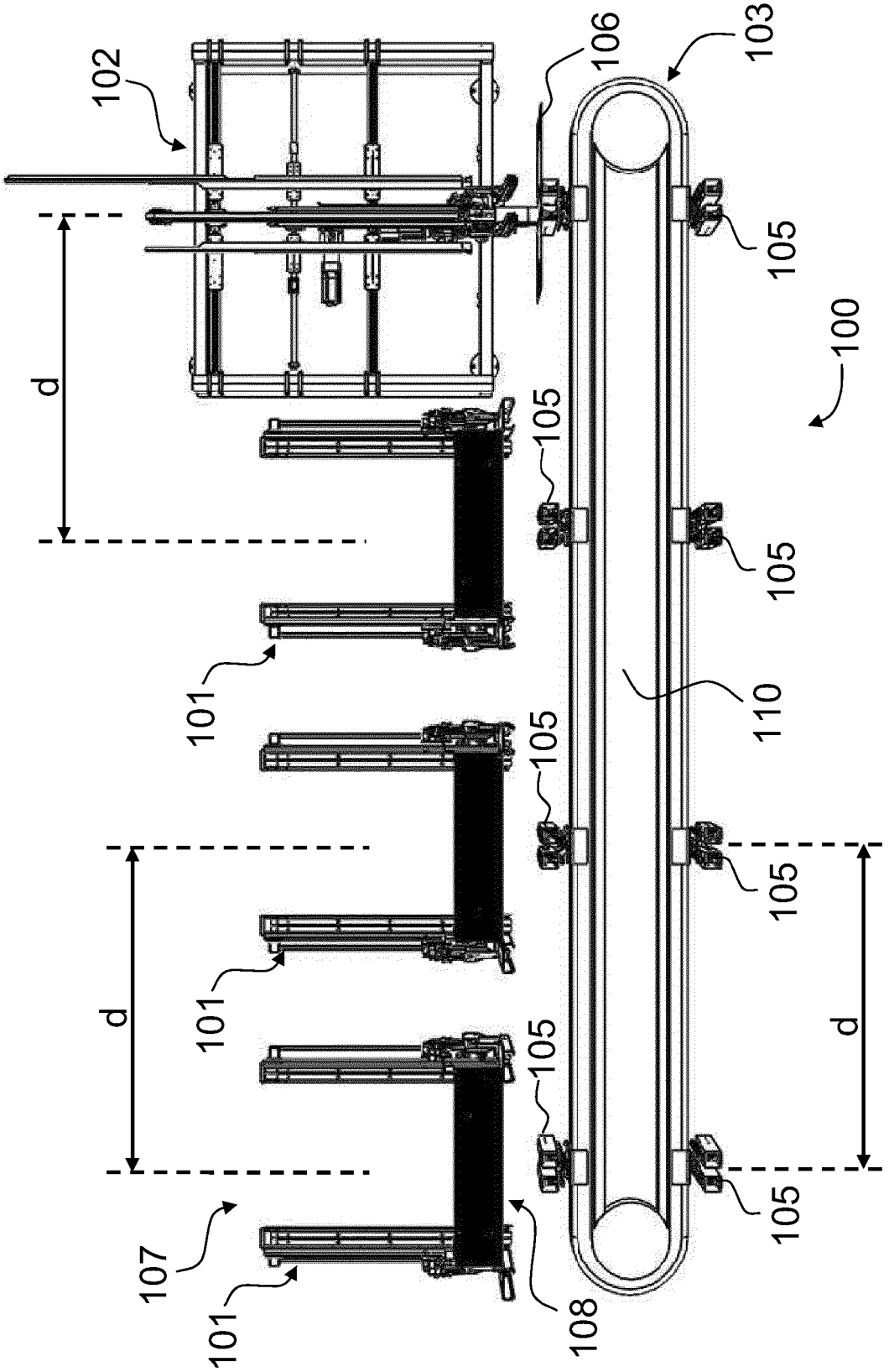
102
106
103
105
100
d
105
105
101
110
105
105
d
101
105
d
107
101
108

Fig. 3

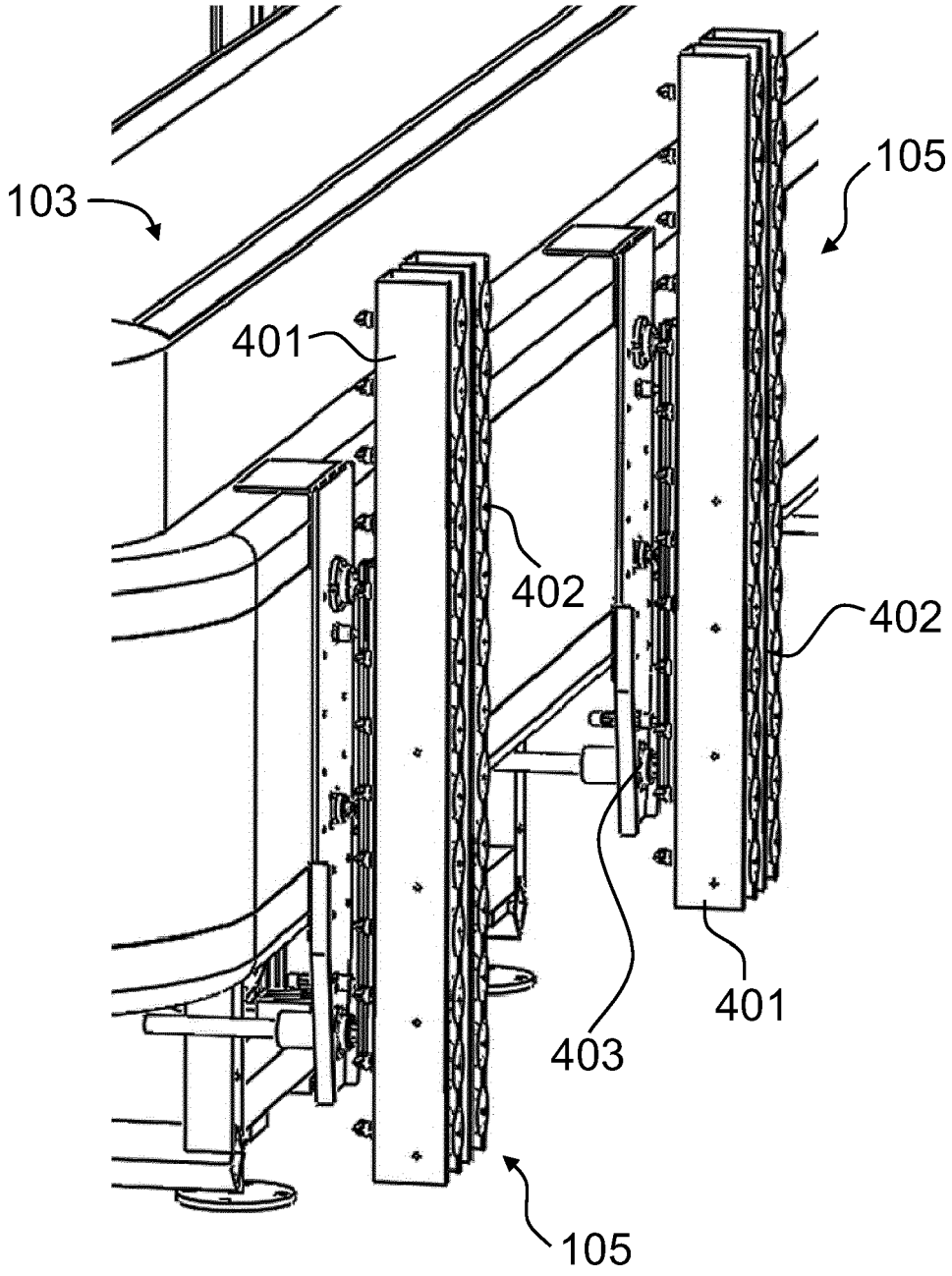

Fig. 4

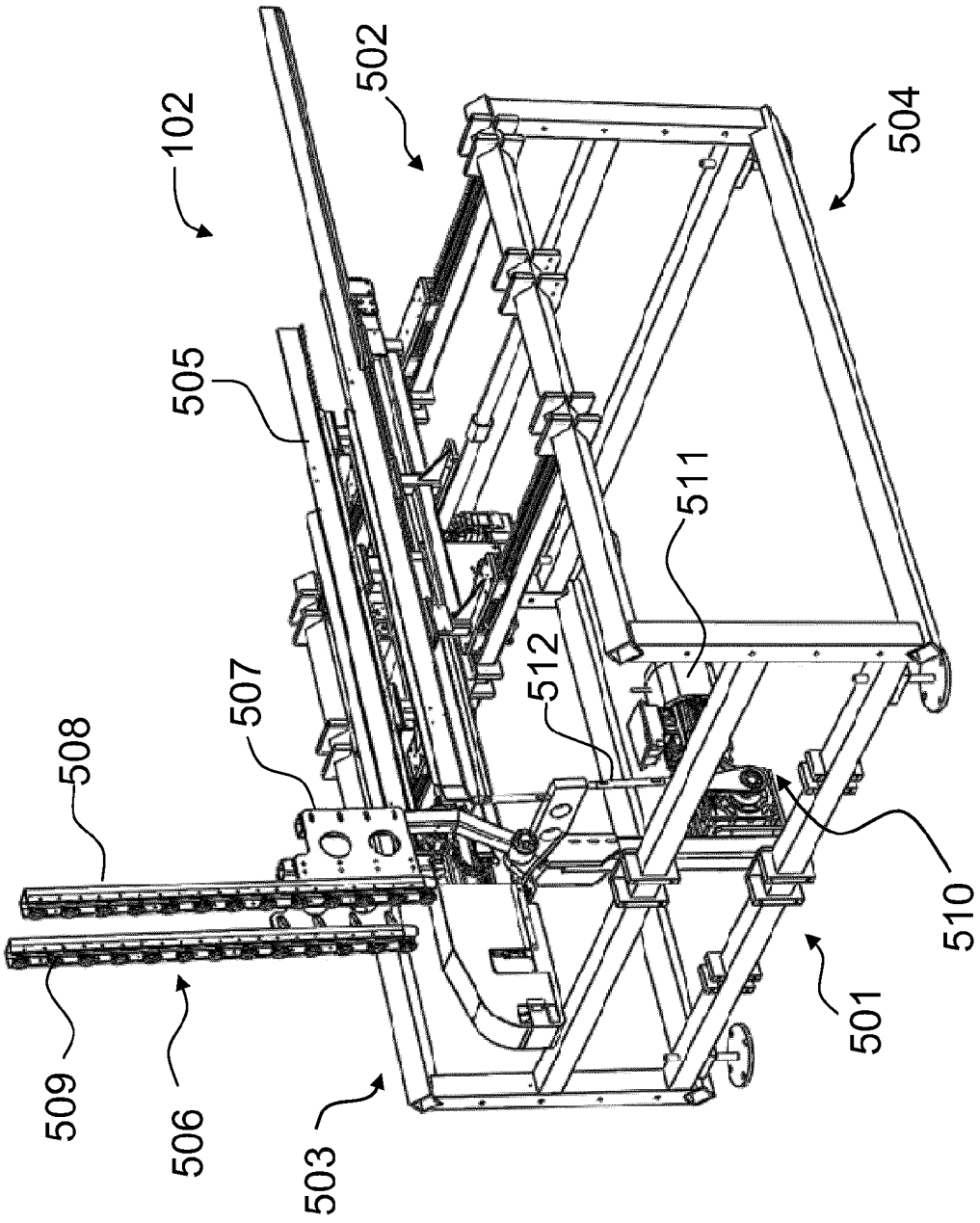

Fig. 5

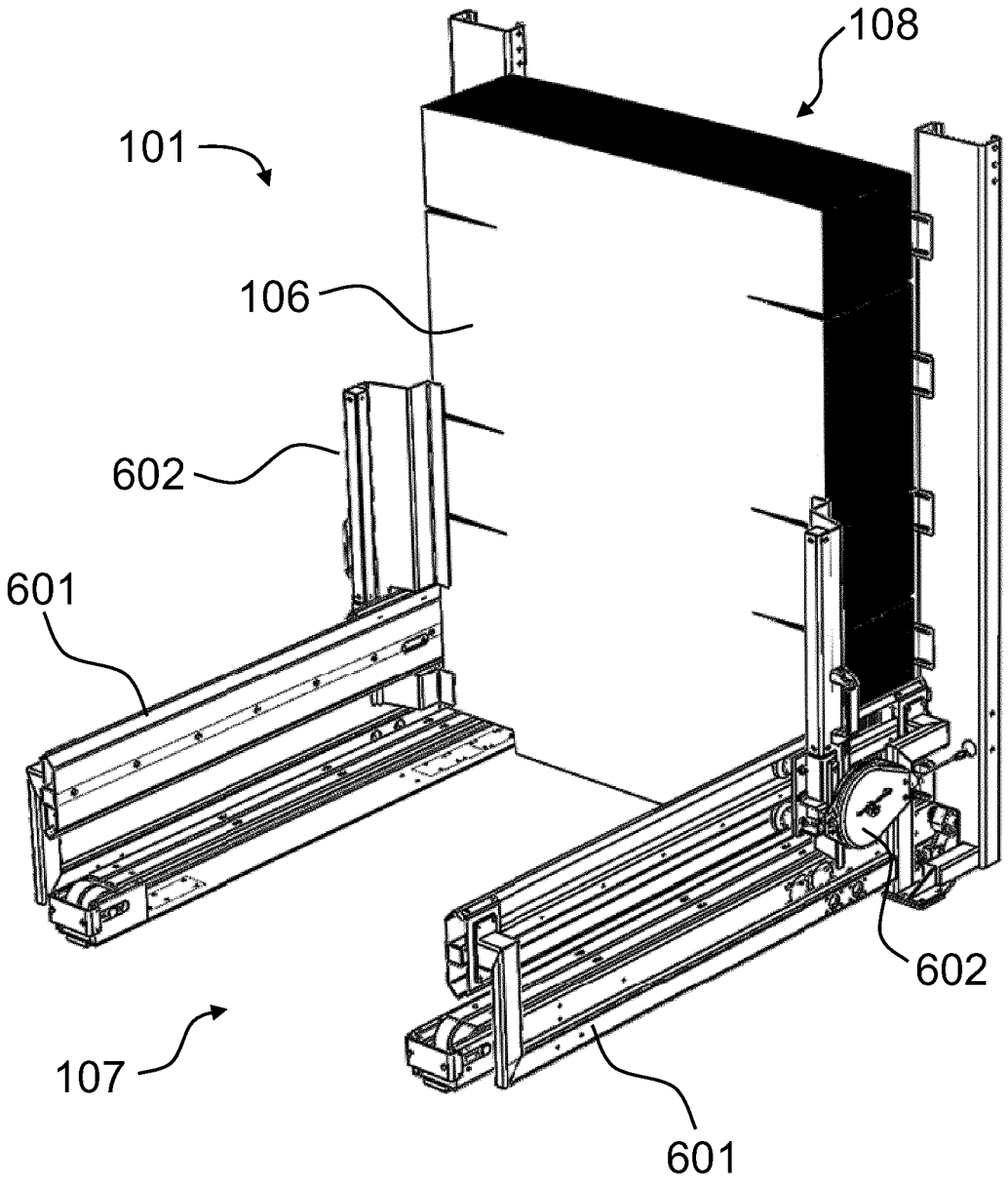

Fig. 6

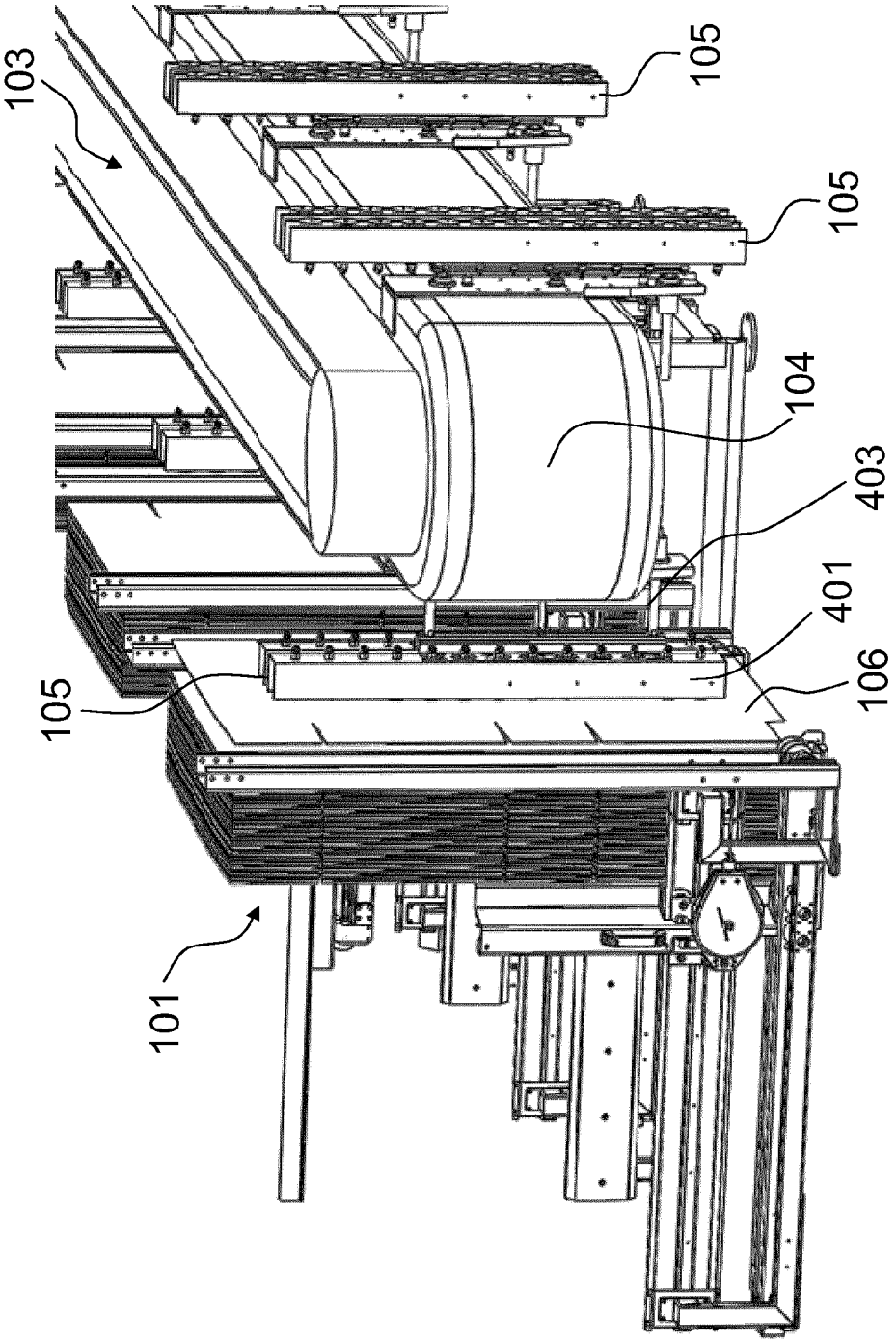

Fig. 7A

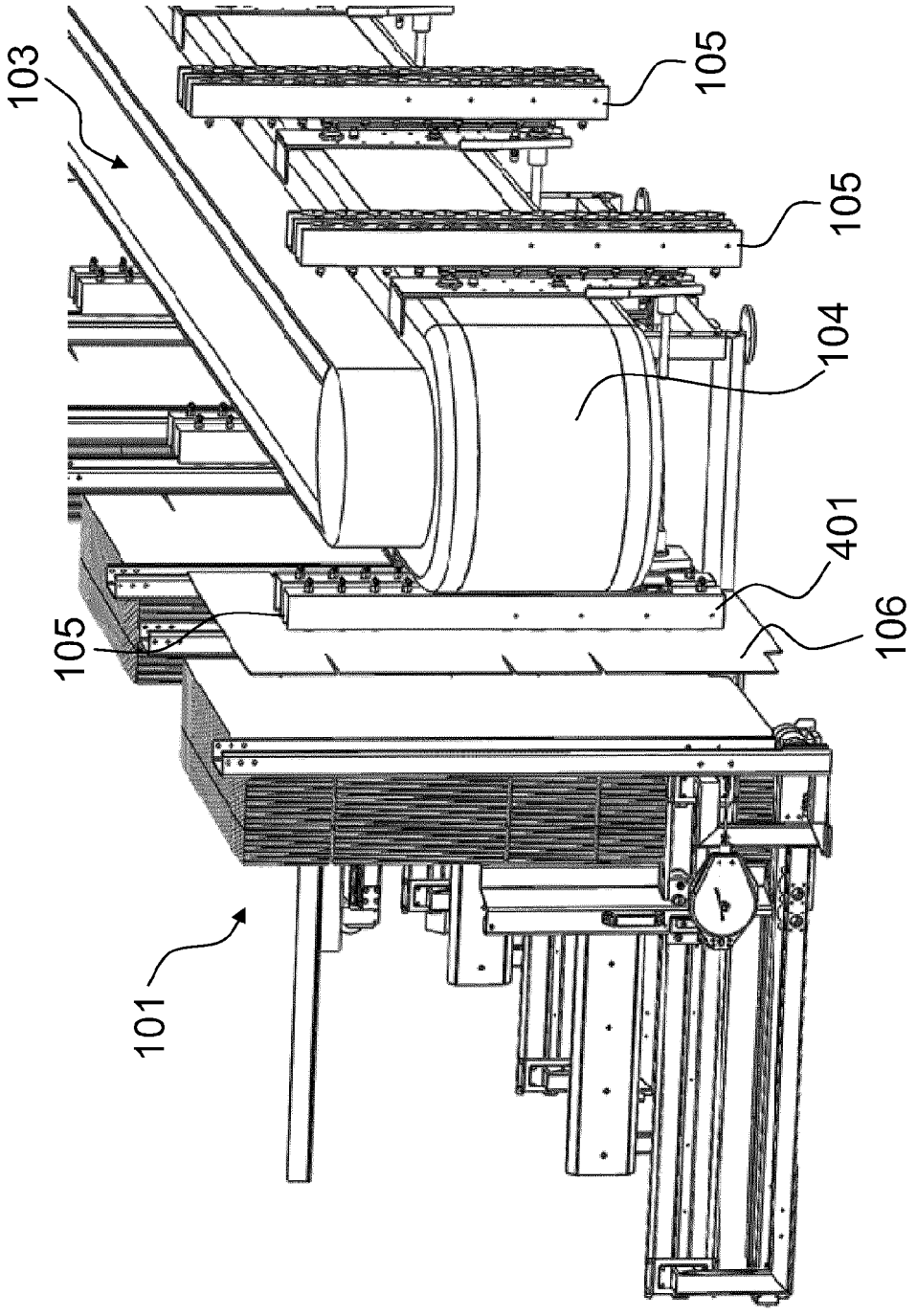

Fig. 7B

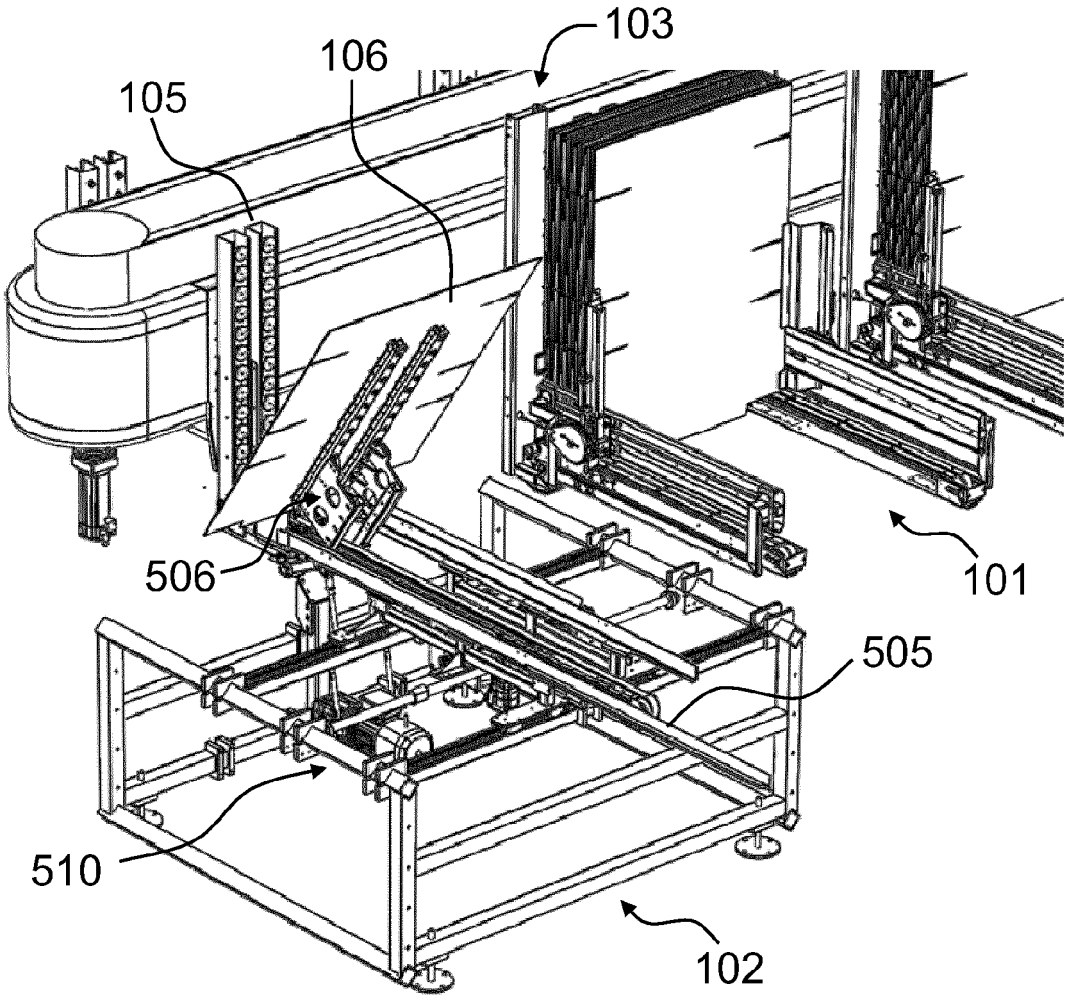

Fig. 8

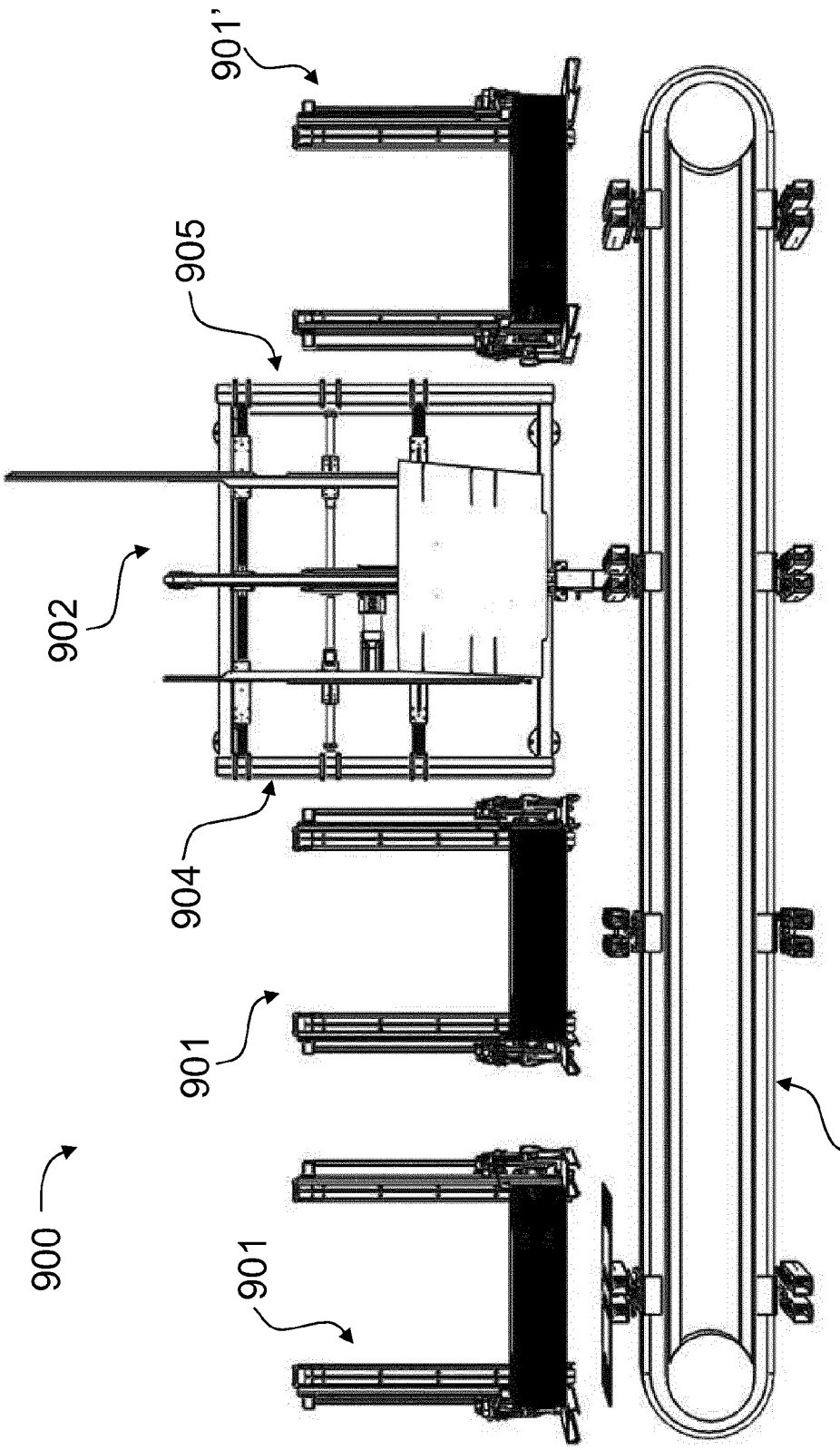

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 14 17 5407

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B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11 December 2014	Athanasiadis, A

CATEGORY OF CITED DOCUMENTS

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11-12-2014

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