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(54) CROSSLAPPER FOR CARD WEBS AND RELATED METHOD FOR CROSSLAPPING

(57) The present invention relates to a crosslapper (100) for a card web (101), comprising:
- a first conveyor belt (110) and a second conveyor belt (120), both arranged in a closed-loop configuration, overlapping each other in at least one conveyor belt portion and adapted to define a conveyance channel (105) for said card web (101), wherein an inlet zone (106) and an outlet zone (107) are defined for said card web (101);
- a collection surface (190) adapted to collect said layered web (101);
a distributor carriage (180) comprising at least one first distributor cylinder (181), whereon said first conveyor belt (110) slides, and at least one second distributor cylinder (182), whereon said second conveyor belt (120) slides, wherein said first distributor cylinder (181) and second distributor cylinder (182) define said outlet zone (107) for said card web (101), said distributor carriage (180) being adapted to move parallel to said collection surface (190), said distributor carriage (180) comprises at least one third distributor cylinder (183), whereon said first conveyor belt (110) is wound, and at least one fourth distributor cylinder (184), whereon said second conveyor belt (120) is wound, wherein said third distributor cylinder (183) and fourth distributor cylinder (184) are adapted to create one or more mobile loops (143) defined in at least one portion of said conveyance channel (105) for said card web (101) in order to accumulate said card web (101) during the motion of the distributor carriage (180).

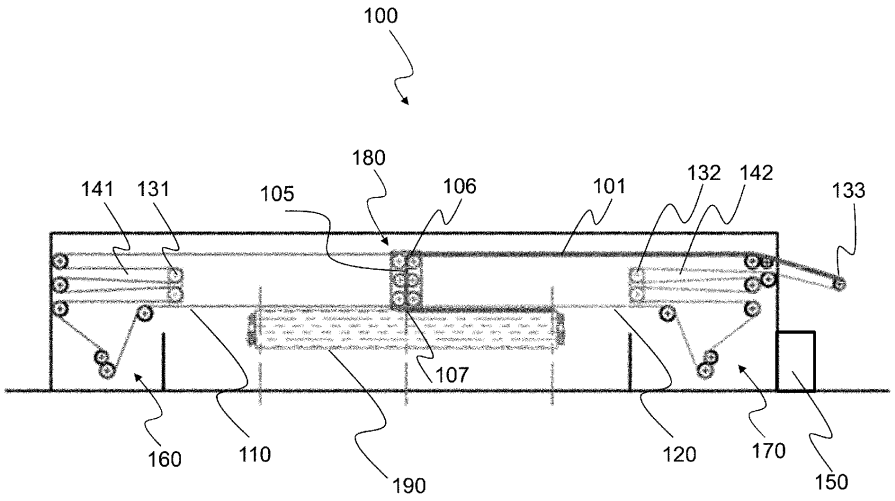

Fig. 1

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Description

[0001] The present invention relates to a machine for crosslapping card webs, also referred to as crosslapper for card webs, in accordance with the preamble of claim 1.

[0002] In particular, disclosed herein are a crosslapper for a card web and a method for crosslapping a card web.

[0003] The crosslapper of the present invention can be used in a textile production line, included at the exit of a carding plant, e.g. a line for processing fibres to be used for manufacturing semifinished products, commonly referred to as non-woven fabrics, or simply as nonwovens, to be subsequently used in many applications.

[0004] Nonwovens are obtained by processing fibres, generally synthetic ones, in carding machines. Carding machines for nonwoven production process the fibres to produce a web formed by the cohesion of the fibres themselves. The strength properties of such a web are insufficient for use in many fields, and therefore thicker webs are produced, having better mechanical strength properties, by coupling multiple webs together by layering. Such coupling by layering is effected directly at the exit of the carding plant by subjecting the web to a crosslapping action that causes the web exiting the carding machine to be overlapped into multiple layers. The crosslapping action is performed by a machine called crosslapper. Current crosslappers, e.g. like the crosslapper described in European patent EP1367166, generally consist of movable carriages whereon two conveyor belts are fixed which, through the reciprocating motion of the movable carriages, cause the web exiting the carding machine to be overlapped into multiple layers. The use of a pair of carriages makes it possible to store the web in the upper carriage (compensator carriage) during the step of reversing the lower carriage (layering or distributor carriage).

[0005] Another example of a crosslapper known in the art is shown in European patent EP1686205, wherein a crosslapper for a card web comprises:

- a first conveyor belt and a second conveyor belt, both arranged in a closed-loop configuration, overlapping each other in at least one conveyor belt portion and adapted to define a conveyance channel for said card web, wherein an inlet zone and an outlet zone are defined for said web card;
- a collection surface adapted to collect said layered web;
- first retriever means comprising at least one first rotary cylinder, whereon said first conveyor belt is wound, said at least one first rotary cylinder being adapted to create one or more mobile loops of said first conveyor belt for tightly moving said first conveyor belt;
- second retriever means comprising at least one second rotary cylinder, whereon said second conveyor belt is wound, said at least one second rotary cylinder being adapted to create one or more mobile loops of said second conveyor belt for tightly moving said second conveyor belt;
- a distributor carriage comprising at least one first distributor cylinder, whereon said first conveyor belt slides, and at least one second distributor cylinder, whereon said second conveyor belt slides, wherein said first distributor cylinder and second distributor cylinder define said outlet zone for said card web, said distributor carriage being adapted to move parallel to said collection surface.

[0006] The crosslappers known in the art suffer from a number of drawbacks, which will be illustrated below.

[0007] A first drawback is related to the asymmetric motion of the conveyor belts. This implies less tension in the web, which, prior to entering the unloading cylinders, is dropped (or abandoned) in a downward section, the angle of which varies according to the crosslapper type and/or configuration.

[0008] Another problem is due to the formation of turbulences in the abandoned web, generated by air mass movements caused by the moving parts of the crosslapper. This results in poor quality of the layered material (called mat), which will typically suffer from bubbling and stretching.

[0009] Another drawback is related to the inertia of the abandoned web, which results in the mat being thicker in particular along the edges, where reversal of the motion of the layering carriage occurs.

[0010] A further drawback comes from the necessity of reducing the speed of the crosslapping operation in order to be able to better control the inertia effects of the abandoned web while reversing the motion of the layering carriage.

[0011] Another problem relates to the need to remove the most dense parts from the mat, and keep only the most homogeneous part of the mat. This necessarily implies the introduction of an additional step, i.e. a trimming step, in the mat production process, downstream of the crosslapping operation. Such step consists of removing the side edges of the mat exiting the crosslapper wherever the density of the mat is different (generally higher) than in the central area of the same. Typically the edges need to be trimmed by a width of approximately 10 to 15 cm per side: this results in a total scrap amount of 20-30 cm, which, considering an average mat width of 400 cm, is 6% on average.

[0012] It is therefore one object of the present invention to solve these and other problems of the prior art, and in particular to provide a crosslapper and a crosslapping method that allow moving the belts transporting the card web in such a way as to effectively keep the web under tension.

[0013] It is a further object of the present invention to provide a crosslapper and a crosslapping method that prevent the effect of turbulences on the card web, thus improving the quality of the manufactured product.

[0014] It is another object of the present invention to

provide a crosslapper and a crosslapping method that allow obtaining a mat having a uniform thickness, particularly at the edges where reversal of the motion of the layering carriage occurs.

[0015] It is a further object of the present invention to provide a crosslapper and a crosslapping method that allow increasing the mat production rate by increasing the speed of the crosslapping process.

[0016] It is a further object of the present invention to provide a crosslapper and a crosslapping method that ensure less mat production scraps, thereby increasing the profitability of the textile production line.

[0017] The invention described herein consists of a crosslapper and a related crosslapping method that comply with two antithetical operating constraints, i.e.: the card web must be fed in at a constant speed, equal to its speed as it exits the carding machine; the material cannot exit at a constant speed, since the layering carriage must necessarily move in a reciprocating manner in order to deposit the various layers.

[0018] The principle of operation of the present invention is based on a symmetric structure in which one carriage slides within two looped conveyor belts, commonly called tables, while ensuring a constant tension of the card web.

[0019] Further advantageous features of the present invention are set out in the appended claims, which are an integral part of the present description.

[0020] The invention will now be described in detail through some non-limiting exemplary embodiments thereof, with particular reference to the annexed drawings, wherein:

- Figure 1 schematically shows a crosslapper according to one embodiment of the present invention;
- Figure 2 schematically shows a detail of the crosslapper of Figure 1;
- Figures 3a, 3b and 3c schematically show three operating configurations of the crosslapper of Figure 1;
- Figure 4 shows an illustrative flow chart of a method for crosslapping a card web associated with the crosslapper of Figure 1;
- Figure 5 schematically shows a crosslapper according to a variant of the embodiment of the crosslapper of Figure 1;
- Figures 6a, 6b and 6c schematically show three operating configurations of the crosslapper variant of Figure 5.

[0021] With reference to Figure 1, there is schematically shown a crosslapper 100 for a card web 101 according to one embodiment of the present invention.

[0022] The crosslapper 100 can be installed downstream of a carding machine in a textile production line.

[0023] The crosslapper 100 may be inserted in new carding lines or, alternatively, with just a few adaptations, in existing carding lines as a replacement for current crosslappers, thus improving the performance of existing plants.

[0024] The carding machine outputs a card web 101, which may be, for example, a non-woven web. The card web 101 exiting the carding machine at a constant speed is fed into the crosslapper 100 by means of, for example, at least one feeding rotary cylinder 133.

[0025] Said crosslapper 100 for a card web 101 comprises a first conveyor belt 110 and a second conveyor belt 120, both arranged in a closed-loop configuration. Said conveyor belts are configured to overlap each other in at least one conveyor belt portion and are adapted to define a conveyance channel 105 for said card web 101. In this manner, an inlet zone 106 and an outlet zone 107 for said web card 101 are defined in the conveyance channel 105. Said first conveyor belt 110 and second conveyor belt 120 are made of substantially inextensible materials, e.g. canvas rubber and/or metal-core rubber, and can be wound, even only partially, on fixed and/or self-moving rotary cylinders (or rollers), which are in turn supported by the structure of the crosslapper 100, e.g. a steel and/or iron metal structure.

[0026] The rotary cylinders make it possible to move said first conveyor belt 110 and second conveyor belt 120 inside the crosslapper 100 and may be free to rotate and/or may be driven by actuator means, e.g. electric motors and/or electrovalves.

[0027] The actuator means are coupled to said rotary cylinders via coupling means, e.g. belts, arms, pistons and/or pulleys.

[0028] The position and trim of one or more rotary cylinders inside the crosslapper 100 can be modified via said actuator means and coupling means, e.g. arms operated by electric motors or pistons controlled by means of electrovalves.

[0029] The crosslapper 100 may further comprise sensor means for detecting the position of its moving parts, or other types of sensor means adapted to monitor production quality and/or quantity, e.g. sensors measuring the speed of the card web 101 and/or of said first conveyor belt 110 and second conveyor belt 120.

[0030] The crosslapper 100 is provided with a control unit 150 adapted to control the actuator means of the crosslapper 100 and adapted to receive data from the sensor means of the crosslapper 100.

[0031] The control unit 150 may comprise a processing module, a memory module, an input/output module, a communication module, an interface module and one or more buses mutually connecting said modules; said control unit 150 may be, for example, a PLC, an axis control system or a computer.

[0032] The memory module may consist of an electronic memory like, for example, a solid-state flash memory, which stores information and instructions implementing the present embodiment of the invention. Such information may concern, for example, the position and the revolution speed of the rotary cylinders. The instructions stored in the memory module will be described in detail later on with reference to the flow chart of Figure 4.

[0033] The processing module is constructed by using electric components such as, for example, microcontrollers or processors with an ARM architecture. The processing module processes the information and the instructions stored in the memory module.

[0034] The input/output module handles, respectively, the input devices, e.g. the sensor means, and the output devices, e.g. the actuator means.

[0035] The interface module allows users and/or service technicians to interface with the crosslapper 100 in order to control its functions and/or verify its operating state.

[0036] The communication module provides communication with a remote management system for managing the crosslapper 100 and/or the textile production plant in which the crosslapper 100 is included. Said communication module may comprise, for example, a Wi-Fi, GSM or ETHERNET module. Therefore, connections to the remote management system are available both in wired and wireless mode.

[0037] In another embodiment of the invention, the crosslapper 100 can interact with the other machines normally included in the textile production cycle via sensor means adapted to detect parameters that, after having been appropriately processed, make it possible to improve the evenness of the product exiting the carding machine and during the next processing steps, e.g. needle looming, quilting, calendering, etc.

[0038] For example, the crosslapper 100, arranged upstream of needle looming machines along the textile production line, may comprise sensor means adapted to measure the thickness, and hence the density, of the final material exiting the needle looms throughout its width; said sensor means may be, for example, optical or X-ray scanners. This will allow the control unit to change, whether on average and/or locally, the density value of the layered material according to the speed of motion of the moving components of the crosslapper 100, such as, for example, the rotary cylinders or the moving carriage 180, which will be described in greater detail below.

[0039] Said crosslapper 100 comprises a collection surface 190 adapted to collect said layered card web 101, a distributor carriage 180, and may comprise first retriever means 160 and second retriever means 170.

[0040] Said first retriever means 160 comprise at least one first rotary cylinder 131, whereon the first conveyor belt 110 is at least partly wound. Said at least one first rotary cylinder 131 is adapted to create one or more mobile loops 141 of the first conveyor belt 110, thus allowing it to be moved under tension. As the first conveyor belt 110 passes on at least one first rotary cylinder 131, one or more mobile loops 141 of the first conveyor belt 110 can be formed within the crosslapper 100. The extension (width) of said loops along a predetermined direction can be determined with respect to at least one fixed or self-moving element comprised in the crosslapper 100, such as, for example, a pin or another rotary cylinder whereon said first conveyor belt 110 is at least partly wound. By moving said at least one first rotary cylinder 131 along said predefined direction, it is possible to vary the width of one or more loops, which are therefore referred to as mobile loops. Thus, the retriever means 160, comprising components like rotary cylinders, pins and the like, permit adjusting the extension of the first conveyor belt 110 inside the crosslapper 100, thereby causing it to be subj ected to an appropriate pull/tension, so that the card web 101 will be appropriately moved under tension to ensure a correct crosslapping process, as described by the present invention. In addition, with reference to the embodiment of the invention of Figure 5, the first rotary cylinder 131 may be operatively connected to a first actuator 171a and to a second actuator 171b adapted to tightly move the first conveyor belt 110 during the motion of the distributor carriage 180. For example, the first actuator 171a may be operatively connected to a first end of the first rotary cylinder 131, while the second actuator 171b may be operatively connected to a second end of the first rotary cylinder 131, so as to move the first rotary cylinder 131 in an independent manner. The first actuator 171a and the second actuator 171b may be electric linear actuators, e.g. controlled by the control unit 150 so as to generate, respectively, a first tension T1 and a second tension T2 of the first conveyor belt 110; in this way, it is possible to obtain a first average force F1 along a sliding direction of the first conveyor belt 110, which can be calculated, for example, as F1=(T1+T2)/2, suitable for keeping the first conveyor belt 110 under tension.

[0041] Moreover, the first actuator 171a and the second actuator 171b may be adapted to move the first conveyor belt 110 along a first direction orthogonal to the sliding direction of the first conveyor belt 110, so as to prevent the first conveyor belt 110 from rubbing against the structure of the crosslapper 100.

[0042] For example, the first conveyor belt 110 can be moved along the first orthogonal direction, which may be coplanar with the first conveyor belt 110 itself, under a first differential force D1 that can be added to the first average force F1. Such first differential force D1 is generated by a difference between the first tension T1 caused by the first actuator 171a and the second tension T2 caused by the second actuator 171b, i.e. D1=T1-T2, and allows centering the first conveyor belt 110 on the first rotary cylinder 131 while preventing the first conveyor belt 110 from getting damaged by rubbing against the structure of the crosslapper 100, e.g. two or more sidewalls of the crosslapper 100.

[0043] In this manner, advantageously, the crosslapper 100 according to the present invention allows centering the first conveyor belt 110 without requiring the use of pneumatic centering units like those that are present on prior-art crosslappers.

[0044] Said second retriever means 170 comprise at least one second rotary cylinder 132 whereon said second conveyor belt 120 is wound, said at least one second rotary cylinder 132 being adapted to create one or more

mobile loops 142 of said second conveyor belt 120 for tightly moving said second conveyor belt 120. As previously specified, as the second conveyor belt 120 passes on at least one second rotary cylinder 132, one or more mobile loops 142 of the second conveyor belt 120 can be formed within the crosslapper 100. The extension (width) of said loops along a predetermined direction can be determined with respect to at least one fixed or self-moving element comprised in the crosslapper 100, such as, for example, a pin or another rotary cylinder whereon said second conveyor belt 120 is at least partly wound. By moving said at least one second rotary cylinder 132 along said predefined direction, it is possible to vary the width of one or more loops, which are therefore referred to as mobile loops. Thus, the retriever means 170, comprising components like rotary cylinders, pins and the like, permit adjusting the extension of the second conveyor belt 120 inside the crosslapper 100, thereby causing it to be subjected to an appropriate pull/tension, so that the card web 101 will be appropriately moved under tension to ensure a correct crosslapping process, as described by the present invention. The number of mobile loops of said first conveyor belt 110 and said second conveyor belt 120 and their respective widths contribute to determining the correct feeding of the card web 101 in the conveyance channel 105.

[0045] In addition, still with reference to the embodiment of the invention shown in Figure 5, the second rotary cylinder 132 may be operatively connected to a third actuator 172a and to a fourth actuator 172b adapted to tightly move the second conveyor belt 120 during the motion of the distributor carriage 180.

[0046] For example, the third actuator 172a may be operatively connected to a first end of the second rotary cylinder 132, while the fourth actuator 172b may be operatively connected to a second end of the second rotary cylinder 132, so as to move the second rotary cylinder 132 in an independent manner. The third actuator 172a and the fourth actuator 172b may be electric linear actuators, e.g. controlled by the control unit 150 so as to generate, respectively, a third tension T3 and a fourth tension T4 of the second conveyor belt 120; in this way, it is possible to obtain a second average force F2 along a sliding direction of the second conveyor belt 120, which can be calculated, for example, as F2=(T3+T4)/2, suitable for keeping the second conveyor belt 120 under tension.

[0047] Moreover, the third actuator 172a and the fourth actuator 172b may be adapted to move the second conveyor belt 120 along a second direction orthogonal to the sliding direction of the second conveyor belt 120, so as to prevent the second conveyor belt 120 from rubbing against the structure of the crosslapper 100.

[0048] For example, the second conveyor belt 120 can be moved along the second orthogonal direction, which may be coplanar with the second conveyor belt 120 itself, under a second differential force D2 that can be added to the second average force F2. Such second differential force D2 is generated by a difference between the third tension T3 caused by the third actuator 172a and the fourth tension T4 caused by the fourth actuator 172b, i.e. D2=T3-T4, and allows centering the second conveyor belt 120 on the second rotary cylinder 132 while preventing the second conveyor belt 120 from getting damaged by rubbing against the structure of the crosslapper 100, e.g. two or more sidewalls of the crosslapper 100.

[0049] In this manner, advantageously, the crosslapper 100 according to the present invention allows centering the second conveyor belt 120 without requiring the use of pneumatic centering units like those that are present on prior-art crosslappers.

[0050] Figure 2 schematically shows a detail of the crosslapper 100 of Figure 1, i.e. the distributor carriage 180, according to the present embodiment of the invention. Said distributor carriage 180 comprises at least one first distributor cylinder 181, whereon said first conveyor belt 110 slides, and at least one second distributor cylinder 182, whereon said second conveyor belt 120 slides.

[0051] Said first distributor cylinder 181 and second distributor cylinder 182 define said outlet zone 107 for the card web 101.

[0052] The distributor carriage 180 is adapted to move parallel to the collection surface 190 for depositing thereon the card web 101 in successive layers to form the mat. According to the present embodiment of the invention, the card web 101 is fed into the crosslapper 100, e.g. by means of at least one inlet rotary cylinder 133 (shown in Figure 1) and is then transported, e.g. by means of the second conveyor belt 120, towards the distributor carriage 180. At this point, the card web 101 enters the conveyance channel 105 through the inlet zone 106 and exits the distributor carriage 180 through the outlet zone 107. As it moves parallel to the collection surface 190 in a reciprocating manner along a direction parallel to the collection surface 190, the distributor carriage 180 deposits the card web 101 in successive layers onto said collection surface 190 to form the mat.

[0053] Said distributor carriage 180 comprises at least one third distributor cylinder 183, whereon said first conveyor belt 110 is wound, and at least one fourth distributor cylinder 184, whereon said second conveyor belt 120 is wound. Said third distributor cylinder 183 and fourth distributor cylinder 184 are adapted to create one or more mobile loops 143 defined in at least one portion of said conveyance channel 105 for the card web 101, positioned between said inlet zone 106 and outlet zone 107 by the distributor carriage 180. This technical measure advantageously makes it possible to accumulate the card web 101 during the motion of the distributor carriage 180.

[0054] With reference to Figures 3a, 3b and 3c, there is schematically shown the principle of operation of the crosslapper 100 according to the embodiment of the invention of Figure 1, in three operating configurations thereof, respectively. The principle of operation of the present invention is based on a symmetric structure of the crosslapper 100 (i.e. a so-called "accordion" structure), wherein the distributor carriage 180 slides through

said first conveyor belt 110 and second conveyor belt 120, commonly referred to as tables.

[0055] The two tables always have a specular behaviour: when the first table becomes longer, the second table becomes shorter, and vice versa. The lengthening and shortening of the tables is made possible by the synchronous motion of one or more mobile loops, which follow the development of both tables, which are substantially inextensible, while ensuring a constant tension of the same.

[0056] The reciprocating motion of said third distributor cylinder 183 and fourth distributor cylinder 184 advantageously ensures an adequate accumulation of the card web 101 by means of one or more mobile loops 143 generated during the motion (acceleration/deceleration) of the distributor carriage 180. This results in the card web 101 being subjected to appropriate pull/tension for a proper crosslapping process, without the web being abandoned inside the distributor carriage 180.

[0057] Figures 3a and 3c respectively show a first and a third operating configuration of the crosslapper 100 according to the present embodiment of the invention, wherein said at least one first rotary cylinder 131 is moved in such a way as to increase the width of the mobile loops 141 of said first conveyor belt 110 when said at least one second rotary cylinder 132 is moved in such a way as to decrease the width of the mobile loops 142 of said second conveyor belt 120, and vice versa (Figure 3c).

[0058] In said first operating configuration of the crosslapper 100, the third distributor cylinder 183 and the fourth distributor cylinder 184 are moved in such a way as to substantially increase the width of said mobile loops 143 defined in at least one portion of said conveyance channel 105 when said distributor carriage 180 is decelerating.

[0059] In said third operating configuration of the crosslapper 100, the third distributor cylinder 183 and the fourth distributor cylinder 184 are moved in such a way as to substantially decrease the width of said mobile loops 143 defined in at least one portion of said conveyance channel 105 when said distributor carriage 180 is accelerating.

[0060] Figure 3b shows a second operating configuration of the crosslapper 100 according to the present embodiment of the invention, wherein said third distributor cylinder 183 and fourth distributor cylinder 184 are moved in such a way as to substantially nullify the width of said mobile loops 143 defined in at least one portion of said conveyance channel 105 when said distributor carriage 180 is moving at a substantially constant speed.

[0061] With reference to the embodiment shown in Figure 5, the crosslapper 100 may additionally comprise a third conveyor belt 130, arranged in a closed-loop configuration, adapted to slide on a driving rotary cylinder 134 operatively connected to a fifth actuator 173, e.g. an electromechanical servomotor. Such driving rotary cylinder 134 can receive the card web 101 fed into the crosslapper 110. The third conveyor belt 130 may be made of substantially inextensible materials, e.g. canvas rubber and/or metal-core rubber, and may be wound, at least partly, on at least one fixed and/or self-moving rotary cylinder or roller 137 that may be supported by the structure of the crosslapper 100. Moreover, the third conveyor belt 130 is adapted to slide on at least a fifth distributor cylinder 185 and a sixth distributor cylinder 186 comprised in the distributor carriage 180, so as to convey the card web 101 towards the inlet zone 106. The third conveyor belt 130 overlaps in at least one further portion 108 the second conveyor belt 120 so as to define a confinement zone for said card web 101 upstream of the distributor carriage 180, wherein the third conveyor belt 130 is adapted to be moved by said fifth actuator 173 in accordance with the motion of the distributor carriage 180. Advantageously, this makes it possible to create a confinement zone between the third conveyor belt 130 and the second conveyor belt 120, where the card web 101 is at least partly confined, which varies in accordance with the motion of the distributor carriage 180 effected, for example, by a fifth actuator 174. Advantageously, from such confinement zone the card web 101 is evenly conveyed towards the inlet zone 106, thus minimizing the adverse effects of any aerodynamic turbulences on the card web 101.

[0062] With reference to Figures 6a, 6b and 6c, there is schematically shown the principle of operation of the crosslapper 100 according to the embodiment of the invention of Figure 5, in three operating configurations thereof, respectively. As described with reference to Figures 3a, 3b and 3c, the principle of operation of the present invention is based on a symmetric structure of the crosslapper 100 (i.e. a so-called "accordion" structure), wherein the distributor carriage 180 slides through said first conveyor belt 110, second conveyor belt 120 and third conveyor belt 130, commonly referred to as tables. The first conveyor belt 110 and the second conveyor belt 120 always have a specular behaviour: when the first table becomes longer, the second table becomes shorter, and vice versa, while the third conveyor belt 130 substantially follows the second conveyor belt 120. The lengthening and shortening of the tables is made possible by the synchronous motion of one or more mobile loops, which follow the development of both tables, which are substantially inextensible, while ensuring a constant tension of the same.

[0063] With reference to Figure 4, the following will describe an exemplary method for crosslapping a card web, coming from a feeding assembly, in the crosslapper 100 according to the embodiment of the invention shown in Figure 1, wherein said crosslapper 100 comprises a movement phase, in which said distributor carriage 180 is moved parallel to said collection surface 190.

[0064] Said movement phase is controlled by the control unit 150 in such a way that, during said movement phase, said first conveyor belt 110 and second conveyor belt 120 are tightly moved by at least one third distributor cylinder 183, whereon said first conveyor belt 110 is wound, and by at least one fourth distributor cylinder 184,

whereon said second conveyor belt 120 is wound, wherein said third distributor cylinder 183 and fourth distributor cylinder 184 create one or more mobile loops 143 defined in at least one portion of said conveyance channel 105 for said card web 101.

[0065] The third distributor cylinder 183 and the fourth distributor cylinder 184 are comprised in the distributor carriage 180. During said movement phase, the width of the mobile loops 143 defined in at least one portion of the conveyance channel 105 is changed in such a way as to accumulate the card web 101 during the motion of the distributor carriage 180. During said movement phase, when the width of the mobile loops 141 of the first conveyor belt 110 increases, the width of the mobile loops 142 of the second conveyor belt 120 decreases, and vice versa.

[0066] At step 400, the crosslapper is initialized with no material, by positioning the distributor carriage 180 in proximity to the centerline of the machine and the other actuators in a consequent position, defined as a function of calculated laws of motion ("electronic cams").

[0067] At step 410, the crosslapper is started, accelerating up to its normal speed (corresponding to the speed out of the upstream carding machine). In this phase, the machine is already completely synchronous: the control unit 150 moves all machine actuators according to calculated laws of motion ("electronic cams"). The distributor carriage 180 is moved by using a pseudo-trapezoid speed profile, which alternates constant-speed phases, deceleration phases and acceleration phases, while the other actuators are synchronized accordingly to perform the above-described movement phases.

[0068] At step 420, the crosslapper 100 is completely synchronous and runs at a speed similar to the speed out of the carding machine. At this point, the web is loaded and the production process begins.

[0069] At step 430, the crosslapper 100 is fully operational, and is ready to receive any changes to its operating parameters, e.g. the output layer width or the number of overlapped layers.

[0070] At step 440, the control unit 150 verifies whether the crosslapping operation should continue or not based on a predefined criterion, e.g. the processing time and/or in response to a command generated, for example, upon an emergency signal issued while the crosslapper 100 is in operation. If so, the control unit will execute step 410, otherwise it will execute step 450.

[0071] At step 450, the control unit 150 executes all the operations necessary for the crosslapper 100 to complete the crosslapping operation. During this step, the control unit may signal the idle state of the crosslapper 100, e.g. by means of luminous indicators such as LED indicators, and/or audible signals, e.g. buzzers or loudspeakers.

[0072] As regards the embodiment shown in Figures 5 to 6C, during the movement phase of the above-described method the first actuator 171a and the second actuator 171b operatively connected to the first rotary cylinder 131 cause the first conveyor belt 110 to move under tension during the motion of the distributor carriage 180, and move the first conveyor belt 110 along the first direction orthogonal to the sliding direction of the first conveyor belt 110 so as to prevent the first conveyor belt 110 from rubbing against the structure of the crosslapper 100.

[0073] In addition, during the movement phase of the above-described method the third actuator 172a and the fourth actuator 172b operatively connected to the second rotary cylinder 132 cause the second conveyor belt 120 to move under tension during the motion of the distributor carriage 180, and move the second conveyor belt 120 along the second direction orthogonal to the sliding direction of the second conveyor belt 120 so as to prevent the second conveyor belt 120 from rubbing against the structure of the crosslapper 100.

[0074] In addition, the third conveyor belt 130, arranged in a closed-loop configuration, slides on a driving rotary cylinder 134 operatively connected to the fifth actuator 173. The third conveyor belt 130 overlaps in at least one further portion 108 said second conveyor belt 120 so as to define a confinement zone for the card web 101 upstream of the distributor carriage 180, wherein the third conveyor belt 130 is moved by the fifth actuator 173 in accordance with the motion of the distributor carriage 180.

[0075] The advantages of the present invention are apparent from the above description.

[0076] The crosslapper and the crosslapping method of the present invention advantageously permit crosslapping a card web while keeping the web tighter, by symmetrically and synchronously moving the tables that transport the web.

[0077] The crosslapper and the crosslapping method of the present invention advantageously improve the quality of the manufactured product by reducing the effect of turbulences on the card web during the process.

[0078] Another advantage of the present invention lies in the fact that a mat is obtained which has a uniform thickness, due to the reduction of the turbulences to which the card web is subjected during the process.

[0079] The crosslapper and the crosslapping method of the present invention advantageously allow increasing the mat production speed, in that the crosslapping process can effectively control the card web so as to reduce any imperfections in the mat caused by the inertia of the card web.

[0080] A further advantage of the crosslapper and crosslapping method of the present invention lies in the fact that mat production scraps are reduced, since the mat exiting the crosslapper requires less trimming of its edges.

[0081] Of course, without prejudice to the principle of the present invention, the forms of embodiment and the implementation details may be extensively varied from those described and illustrated herein merely by way of non-limiting example, without however departing from

the protection scope of the present invention as set out in the appended claims.

Claims

1. Crosslapper (100) for a card web (101), comprising:

   - a first conveyor belt (110) and a second conveyor belt (120), both arranged in a closed-loop configuration, overlapping each other in at least one conveyor belt portion and adapted to define a conveyance channel (105) for said card web (101), wherein an inlet zone (106) and an outlet zone (107) are defined for said card web (101);
   - a collection surface (190) adapted to collect said layered web (101);
   - a distributor carriage (180) comprising at least one first distributor cylinder (181), whereon said first conveyor belt (110) slides, and at least one second distributor cylinder (182), whereon said second conveyor belt (120) slides, wherein said first distributor cylinder (181) and second distributor cylinder (182) define said outlet zone (107) for said card web (101), said distributor carriage (180) being adapted to move parallel to said collection surface (190),

   said crosslapper (100) being **characterized in that** said distributor carriage (180) comprises at least one third distributor cylinder (183), whereon said first conveyor belt (110) is wound, and at least one fourth distributor cylinder (184), whereon said second conveyor belt (120) is wound, wherein said third distributor cylinder (183) and fourth distributor cylinder (184) are adapted to create one or more mobile loops (143) in at least one portion of said conveyance channel (105) for said card web (101) in order to accumulate said card web (101) during the motion of the distributor carriage (180).

2. Crosslapper (100) according to claim 1, wherein said third distributor cylinder (183) and fourth distributor cylinder (184) are moved in such a way as to substantially increase the width of said mobile loops (143) defined in at least one portion of said conveyance channel (105) when said distributor carriage (180) decelerates.

3. Crosslapper (100) according to claims 1 or 2, wherein said third distributor cylinder (183) and fourth distributor cylinder (184) are moved in such a way as to substantially decrease the width of said mobile loops (143) defined in at least one portion of said conveyance channel (105) when said distributor carriage (180) accelerates.

4. Crosslapper (100) according to one or more of claims 1 to 3, wherein said third distributor cylinder (183) and fourth distributor cylinder (184) are moved in such a way as to substantially nullify the width of said mobile loops (143) defined in at least one portion of said conveyance channel (105) when said distributor carriage (180) is moving at a substantially constant speed.

5. Crosslapper (100) according to one or more of claims 1 to 4, comprising:

   - first retriever means (160) comprising at least one first rotary cylinder (131), whereon said first conveyor belt (110) is wound, said at least one first rotary cylinder (131) being adapted to create one or more mobile loops (141) of said first conveyor belt (110) for tightly moving said first conveyor belt (110);
   - second retriever means (170) comprising at least one second rotary cylinder (132), whereon said second conveyor belt (120) is wound, said at least one second rotary cylinder (132) being adapted to create one or more mobile loops (142) of said second conveyor belt (120) for tightly moving said second conveyor belt (120).

6. Crosslapper (100) according to claim 5, wherein said at least one first rotary cylinder (131) is moved in such a way as to increase the width of the mobile loops (141) of said first conveyor belt (110) when said at least one second rotary cylinder (132) is moved in such a way as to decrease the width of the mobile loops (142) of said second conveyor belt (120), and vice versa.

7. Crosslapper (100) according to claim 5 or 6, wherein said first rotary cylinder (131) is operatively connected to a first actuator (171a) and a second actuator (171b) adapted to tightly drive the first conveyor belt (110) during the motion of the distributor carriage (180) and adapted to move the first conveyor belt (110) along a first direction orthogonal to a sliding direction of the first conveyor belt (110), so as to prevent the first conveyor belt (110) from rubbing against a structure of the crosslapper (100), and wherein said second rotary cylinder (132) is operatively connected to a third actuator (172a) and a fourth actuator (172b) adapted to tightly drive the second conveyor belt (120) during the motion of the distributor carriage (180) and adapted to move the second conveyor belt (120) along a second direction orthogonal to a sliding direction of the second conveyor belt (120), so as to prevent the second conveyor belt (120) from rubbing against a structure of the crosslapper (100).

8. Crosslapper (100) according to one or more of claims 1 to 7, comprising a third conveyor belt (130) ar-

ranged in a closed-loop configuration, adapted to slide on a driving rotary cylinder (134) operatively connected to a fifth actuator (173), said third conveyor belt (130) overlapping in at least one further portion (108) said second conveyor belt (120) so as to define a confinement zone for said card web (101) upstream of said distributor carriage (180), wherein said third conveyor belt (130) is adapted to be moved by said fifth actuator (173) in accordance with the motion of the distributor carriage (180).

9. Method for crosslapping a card web (101) coming from a feeding unit in a crosslapper (100), said crosslapper (100) comprising:

- a first conveyor belt (110) and a second conveyor belt (120), both arranged in a closed-loop configuration, overlapping each other in at least one conveyor belt portion and adapted to define a conveyance channel (105) for said card web (101), wherein an inlet zone (106) and an outlet zone (107) are defined for said card web (101);
- a collection surface (190) adapted to collect said layered web (101);
- a distributor carriage (180) comprising at least one first distributor cylinder (181), whereon said first conveyor belt (110) slides, and at least one second distributor cylinder (182), whereon said second conveyor belt (120) slides, wherein said first distributor cylinder (181) and second distributor cylinder (182) define said outlet zone (107) for said card web (101),

said method comprising:

- a movement phase, wherein said distributor carriage (180) is moved parallel to said collection surface (190),

said method being **characterized in that** during said movement phase said first conveyor belt (110) and second conveyor belt (120) are tightly moved by at least one third distributor cylinder (183), whereon said first conveyor belt (110) is wound, and by at least one fourth distributor cylinder (184), whereon said second conveyor belt (120) is wound, wherein said third distributor cylinder (183) and fourth distributor cylinder (184) create one or more mobile loops (143) defined in at least one portion of said conveyance channel (105) for said card web (101) in order to accumulate said card web (101) during the motion of the distributor carriage (180), said third distributor cylinder (183) and fourth distributor cylinder (184) being comprised in said distributor carriage (180).

10. Method according to claim 9, wherein during said movement phase the width of said mobile loops (143) defined in at least one portion of said conveyance channel (105) is increased when said distributor carriage (180) is decelerates.

11. Method according to claim 9 or 10, wherein during said movement phase the width of said mobile loops (143) defined in at least one portion of said conveyance channel (105) is decreased when said distributor carriage (180) is accelerates.

12. Method according to one or more of claims 9 to 11, wherein during said movement phase the width of said mobile loops (143) defined in at least one portion of said conveyance channel (105) is substantially null when said distributor carriage (180) is moving at a substantially constant speed.

13. Method according to one or more of claims 9 to 12, wherein said crosslapper (100) comprises:

- first retriever means (160) comprising at least one first rotary cylinder (131), whereon said first conveyor belt (110) is wound, said at least one first rotary cylinder (131) being adapted to create one or more mobile loops (141) of said first conveyor belt (110) for tightly moving said first conveyor belt (110);
- second retriever means (170) comprising at least one second rotary cylinder (132), whereon said second conveyor belt (120) is wound, said at least one second rotary cylinder (132) being adapted to create one or more mobile loops (142) of said second conveyor belt (120) for tightly moving said second conveyor belt (120),

and wherein during said movement phase, when the width of the mobile loops (141) of said first conveyor belt (110) increases, the width of the mobile loops (142) of said second conveyor belt (120) decreases, and vice versa.

14. Method according to claim 13, wherein said crosslapper (100) comprises a first actuator (171a) and a second actuator (171b) operatively connected to said first rotary cylinder (131), which tightly drive the first conveyor belt (110) during the motion of the distributor carriage (180) and move the first conveyor belt (110) along a first direction orthogonal to a sliding direction of the first conveyor belt (110), so as to prevent the first conveyor belt (110) from rubbing against the structure of the crosslapper (100), and wherein said crosslapper (100) comprises a third actuator (172a) and a fourth actuator (172b) operatively connected to said second rotary cylinder (132), which tightly drive the second conveyor belt (120) during the motion of the distributor carriage (180) and move the second conveyor belt (120) along a second direction orthogonal to a sliding direction of the second conveyor belt (120), so as to prevent the

second conveyor belt (120) from rubbing against the structure of the crosslapper (100).

15. Method according to one or more of claims 9 to 14, wherein said crosslapper (100) comprises a third conveyor belt (130) arranged in a closed-loop configuration, which slides on a driving rotary cylinder (134) operatively connected to a fifth actuator (173), said third conveyor belt (130) overlapping in at least one further portion (108) said second conveyor belt (120) so as to define a confinement zone for said card web (101) upstream of said distributor carriage (180), wherein said third conveyor belt (130) is moved by said fifth actuator (173) in accordance with the motion of the distributor carriage (180).

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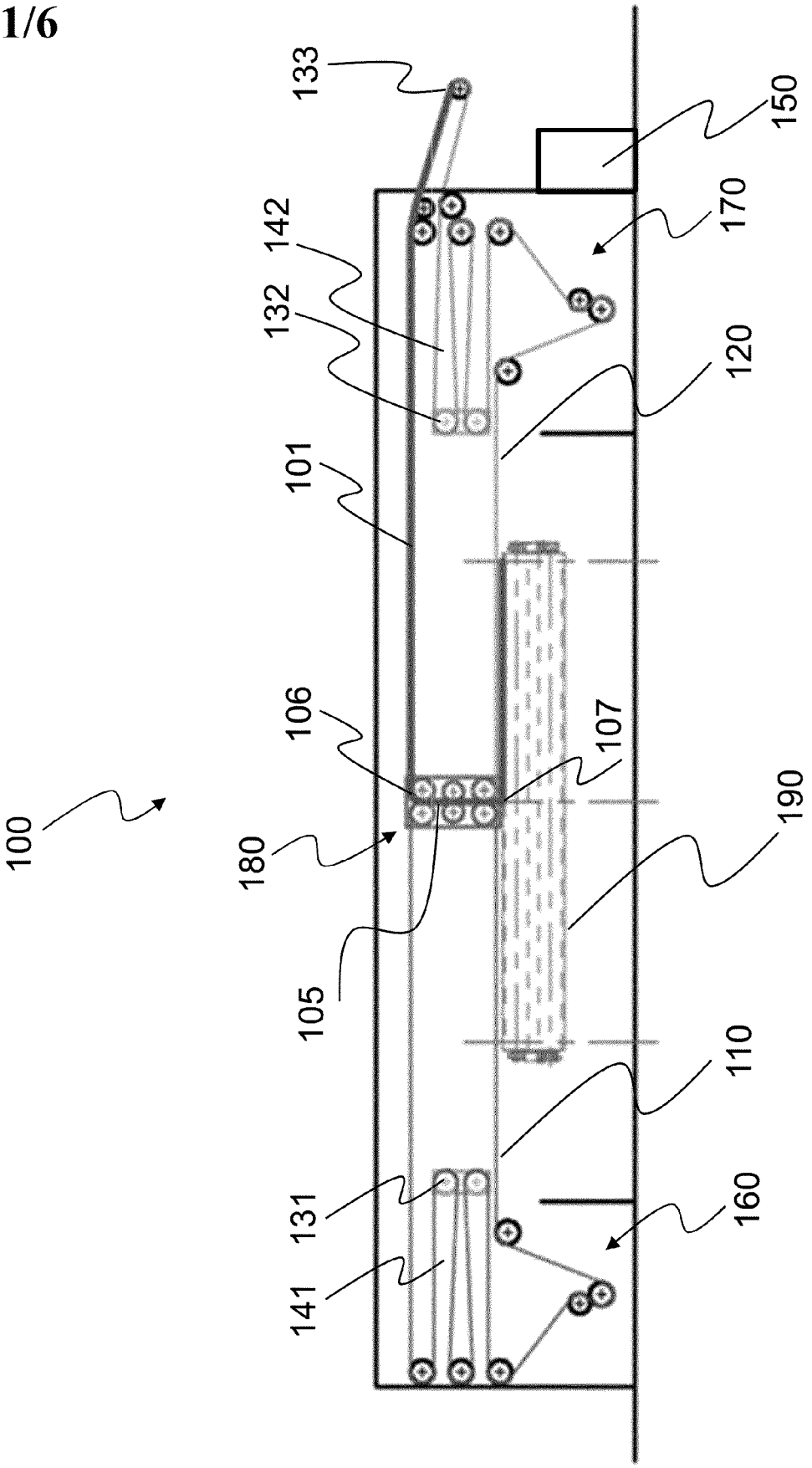
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Fig. 1

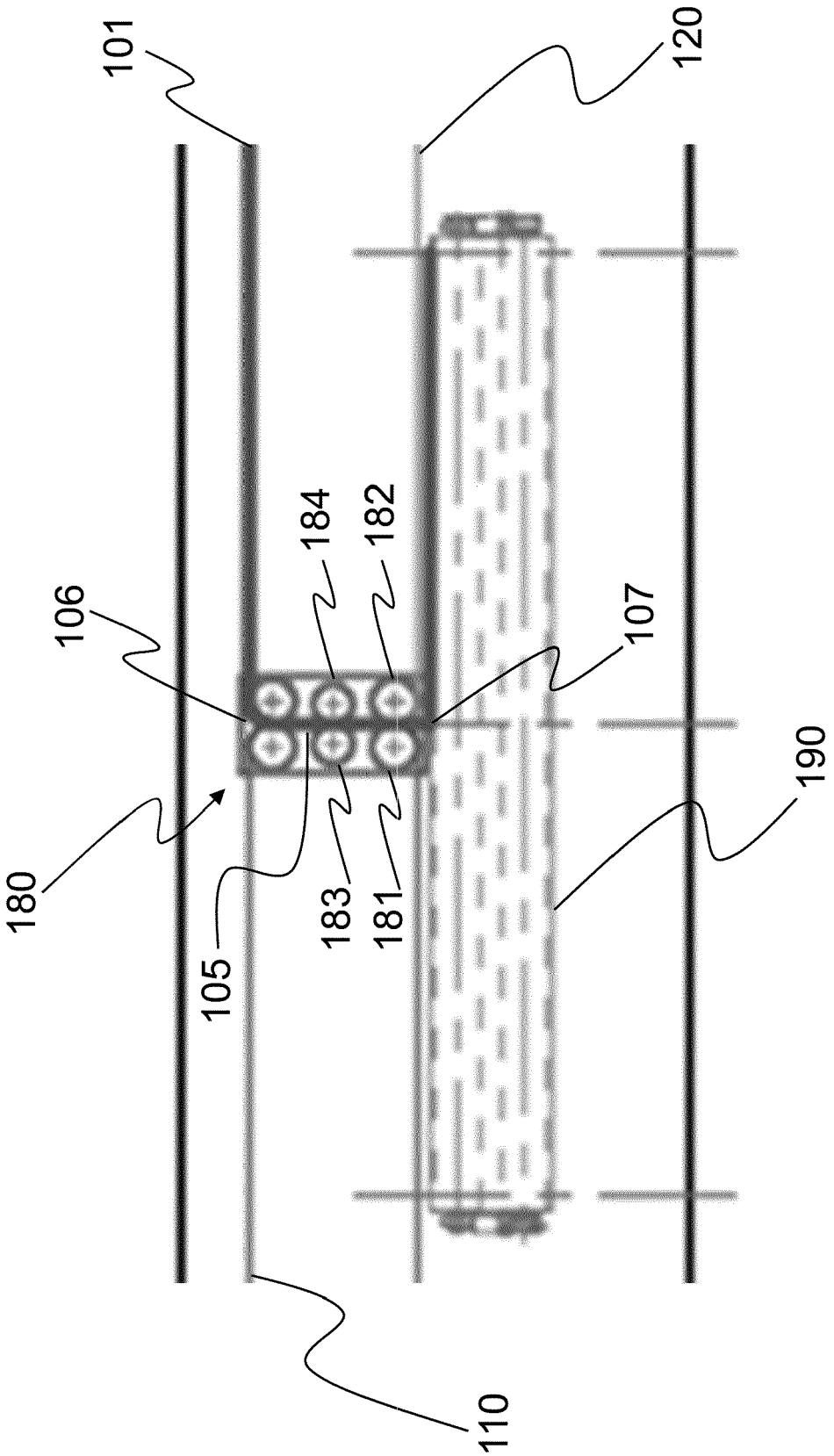
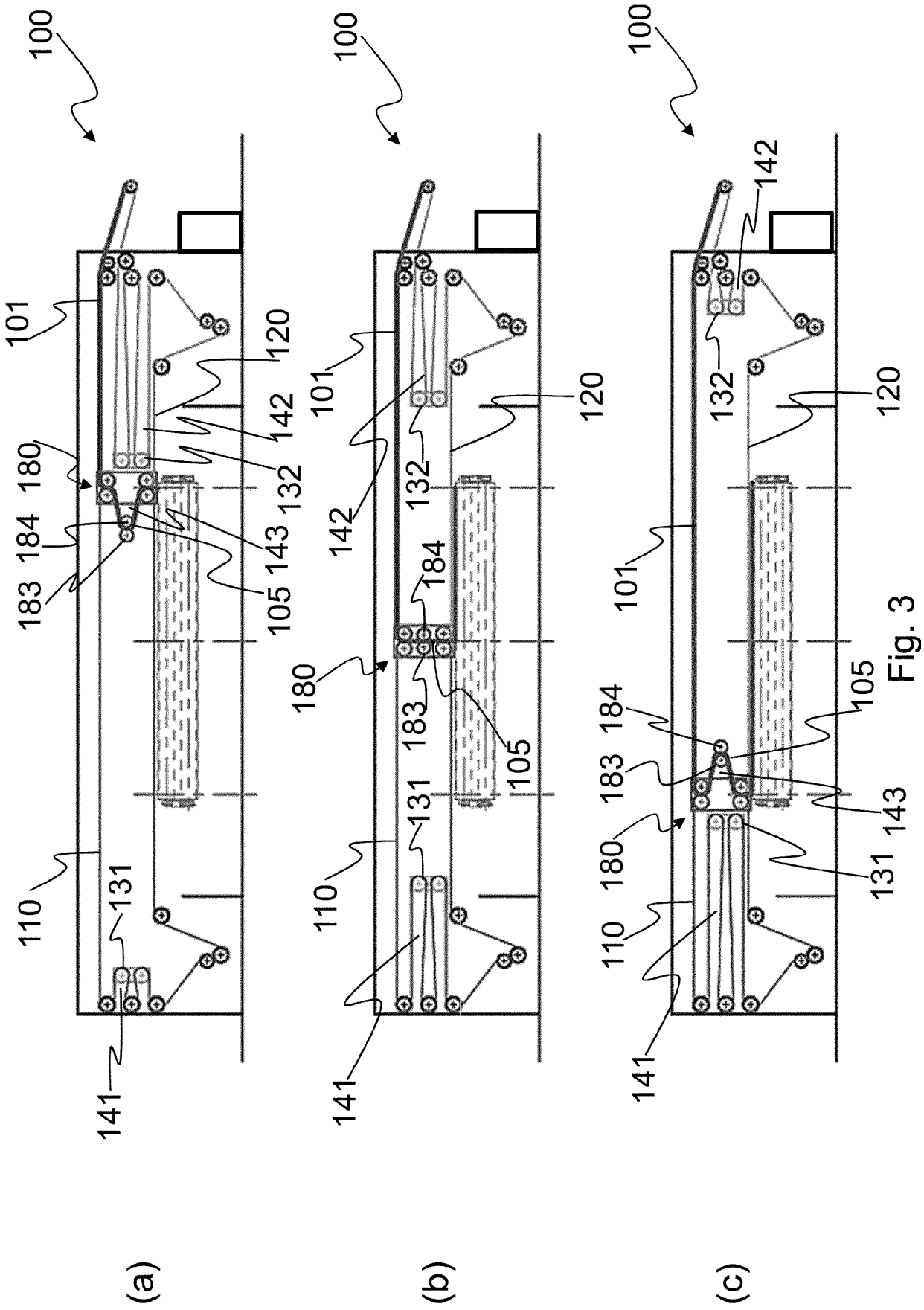


Fig. 2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(c)

Fig. 3

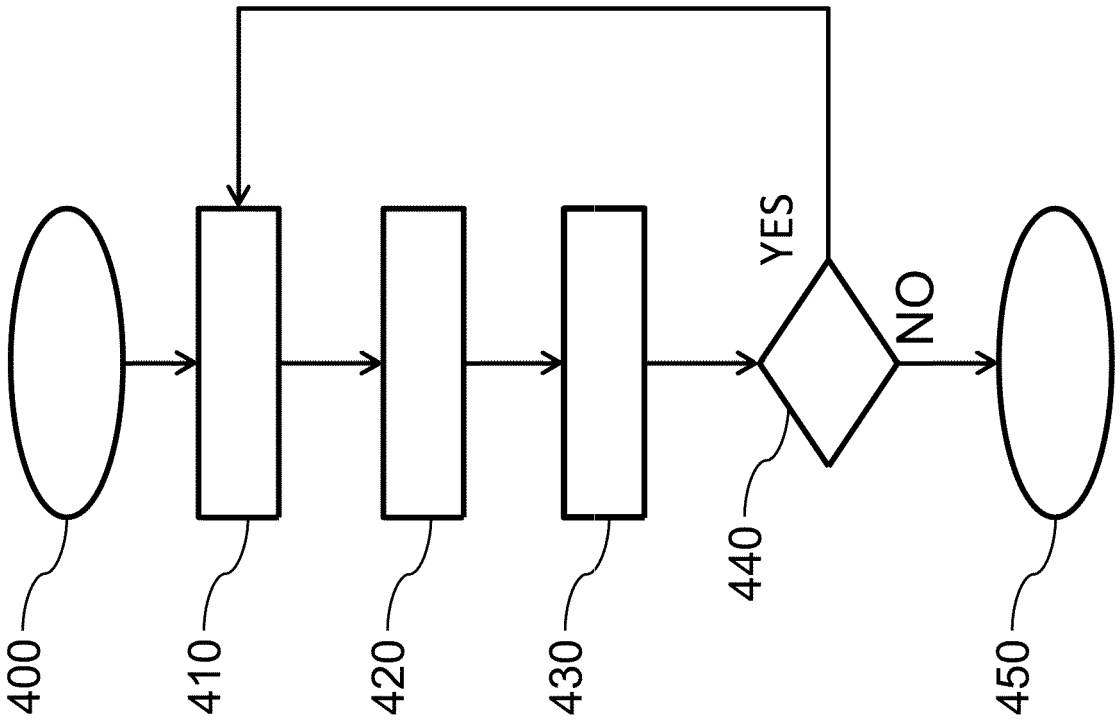
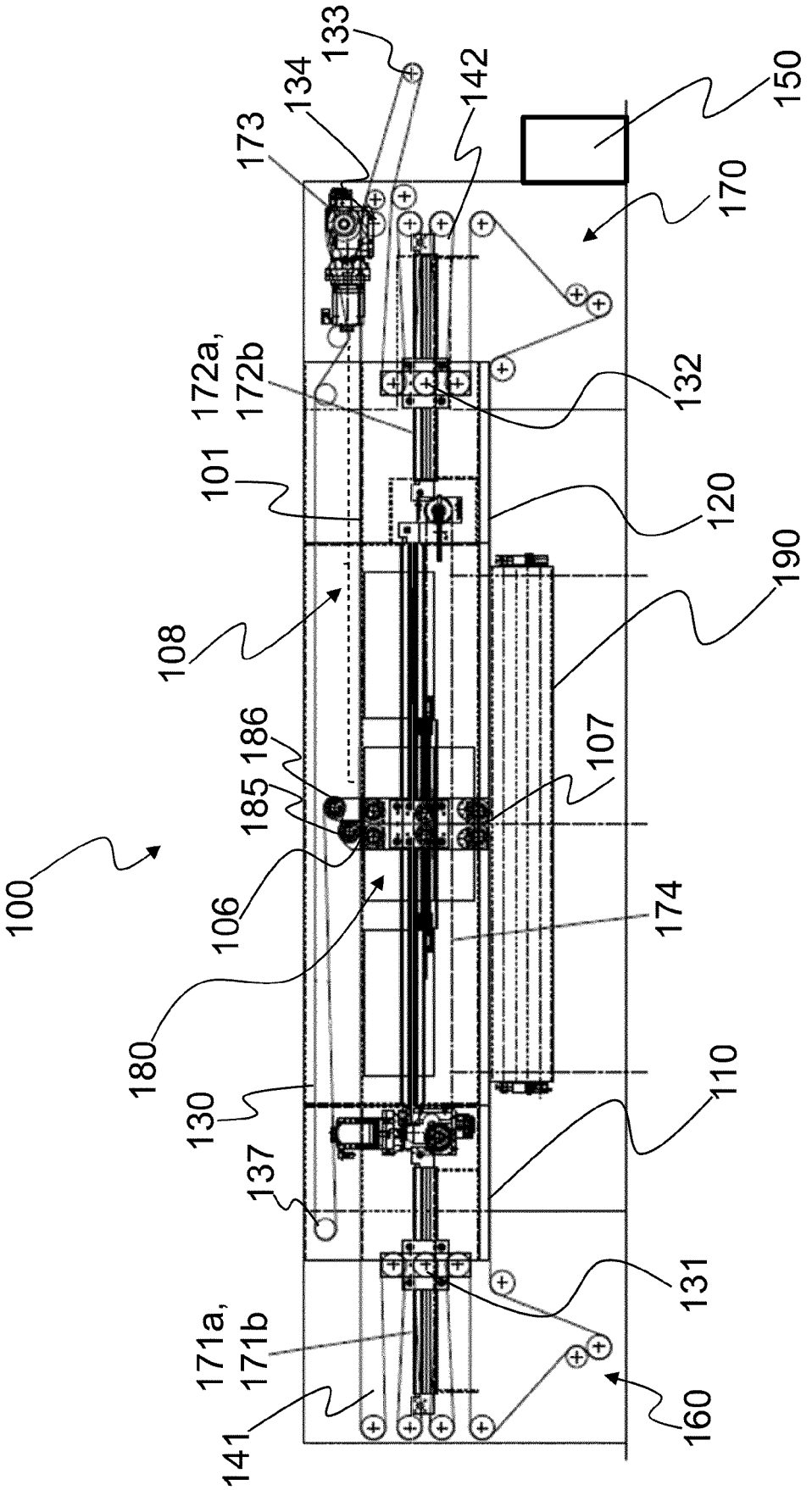


Fig. 4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172b
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171a,
171b
160
141

Fig. 5

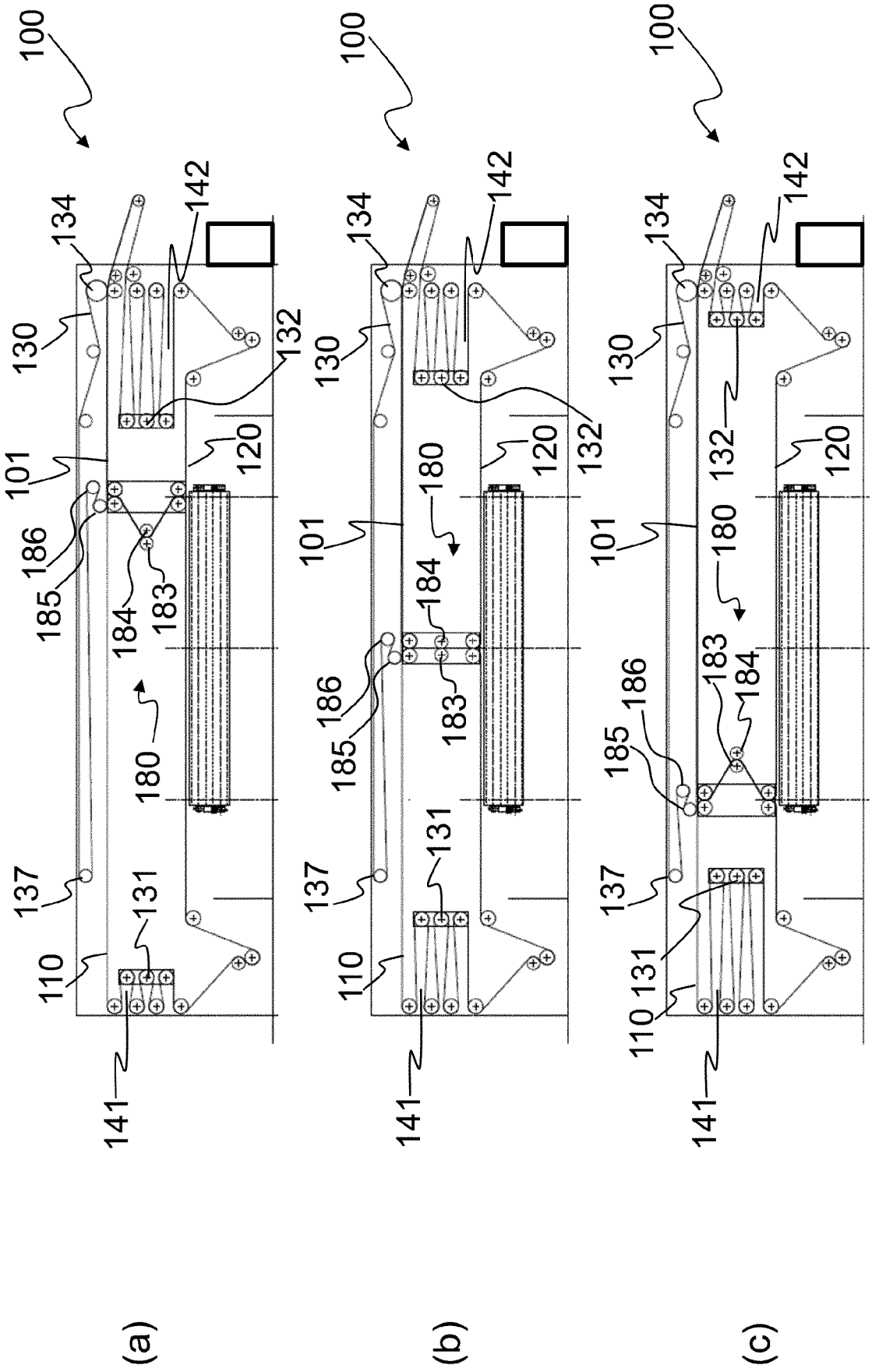
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Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 21 20 7234

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D01G
D04H

1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	20 January 2022	Todarello, Giovanni

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20-01-2022

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