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(54) HEDDLE MODULE, DRAWING-IN MACHINE COMPRISING SUCH A HEDDLE MODULE AND METHOD FOR FEEDING HEDDLES

(57) A heddle module (30) for a drawing-in machine comprises a heddles-feeding device (4), a heddles-separating device (8), a heddles-transport device (12) and a heddles-sorting device (10) including at least one sorting conveyor equipped with several heddle-support elements spaced along a sorting path, each heddle-support element being configured to hold one separated heddle and to move it from a feeding position (P1) to at least one sorting transfer position (P2) along the sorting path, and a heddles-transfer device (26) for transferring a separated heddle (60) out of a heddle-support element (122) located at the sorting transfer position (P2) onto the heddles-transport device (12) at the transport transfer position (P3). The heddle module (30) also comprises a heddles-detection device (14) configured to detect at least one parameter different if the heddle is a left heddle or a right heddle, and a controller (16) connected to the heddles-detection device (14) and to the heddles-sorting device (10) and configured to command the heddles-sorting device according to the parameter detected for this heddle by the heddles-detection device (14) and according to a predetermined heddle sequence of heddle types. The heddles-separating device (8) is interposed between the heddles-feeding device (4) and the sorting conveyor (100).

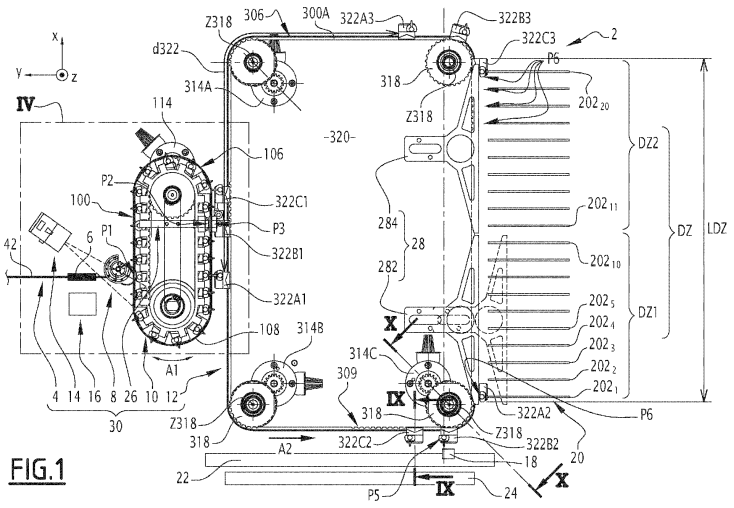

FIG.1

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention concerns a heddle module for a drawing-in machine. The present invention also concerns a drawing-in machine for drawing-in warp threads into heddles of a loom, said drawing-in machine including, amongst others, a heddle module. Finally, the present invention concerns a method for feeding heddles to a heddles-transport device of a heddle module.

[0002] The present invention belongs to the technical field of drawing-in warp threads into heddles of a loom.

BACKGROUNG OF THE INVENTION

[0003] Duplex heddles are sometimes used for heddle frames in order to allow higher densities of warp yarns. Duplex heddles comprise left and right heddles, which include a central eyelet and two upper and lower end loops. Left and right heddles differ by their geometries, mostly in their intermediate region, around their eyelet. For high warp yarn densities, the heddles shall be provided with a regular alternation of left and right heddles on each heddle frame.

[0004] Current drawing-in machines can be equipped with two heddles-feeding device, namely a right heddles-feeding device and a left heddles-feeding device. Each heddles-feeding device includes a stack of right heddles and a stack of left heddles and, according to a heddle sequence, one heddle can be separated from one of the two stacks at a time, e.g. by using a heddles-separating device known from WO00/1 1252A1 or WO99/15723A1.

[0005] Each separated heddle is fed to a transport device, which moves the heddles to a threading position, where a yarn is inserted into the eyelet of each heddle by a threading device, then to one of several discharge positions on respective rods of a heddles-receiving module.

[0006] This operation relies on the fact that left and right heddles are separated and identified prior to being loaded on the transport device. When stacks of duplex heddles are removed from a heddle frame to be re-used for a next drawing-in process, the alternation between left and right heddles might not be fully respected. Thus, an operator shall separate duplex heddles in a stack of left heddles and a stack of right heddles before installing the two different stacks on two feeding devices, for feeding the heddles-separating device.

[0007] This is time-consuming for the operator and can be source of errors.

SUMMARY OF INVENTION

[0008] The purpose of the prevent invention is to avoid this step of separating the heddles into a stack of left heddles and another stack of right heddles before using the heddles on the drawing-in machine. The purpose of the invention is also to speed up the feeding of heddles to a transport device.

[0009] To this end, the invention concerns a heddle module for a drawing-in machine, said heddle module comprising a heddles-feeding device where heddles are provided in the form of at least one stack, a heddles-separating device configured to separate one heddle from the at least one stack, a heddles-transport device, configured to move heddles according to a predetermined heddle sequence corresponding to a succession of heddle types among left heddle and right heddle, from at least one transport transfer position to a threading position, where a thread is inserted into the transported heddle. According to the invention, the heddle module also comprises a heddles-sorting device including at least one sorting conveyor equipped with several heddle-support elements adjacent to each other along a sorting path, each heddle-support element being configured to hold one separated heddle and to move the separated heddle from at least one feeding position to at least one sorting transfer position along the sorting path. The heddle module also comprises a heddles-transfer device, for transferring a separated heddle out of at least one heddle-support element located at the at least one sorting transfer position onto the heddles-transport device at the at least one transport transfer position, and a heddles-detection device configured to detect at least one parameter of a heddle, before the heddle is transferred by the heddles-transfer device, the parameter being different depending on whether the heddle is a left heddle or a right heddle . The heddle module also comprises a controller connected at least to the heddles-detection device and to the heddles-sorting device and configured to determine the heddle type from the parameter detected for a heddle by the heddles-detection device and to command the heddles-sorting device to move a heddle carried by the sorting conveyor to the sorting transfer position according to the heddle type for this heddle and according to the predetermined heddle sequence. The heddles-separating device is interposed between the heddles-feeding device and the sorting conveyor and configured to bring the separated heddle into engagement with at least one heddle-support element in the at least one feeding position.

[0010] Thanks to the invention, the heddles-sorting device allows feeding the heddles-transport device according to a predetermined heddle sequence, thus respecting the distribution of left and right heddles, from the stack of heddles where the heddles can be right and left heddles in any order. In other words, the heddles-sorting device, the heddles-transfer

device, the heddles-detection device and the controller allow the heddle module of the invention to correctly position and alternate the left and right heddles in a drawing-in machine according to a drawing-in draft, without having an operator to sort the heddles into two different stacks of left heddles and right heddles.

[0011] For the present invention, a drawing-in draft corresponds to how successive warp threads are to be drawn through the heddles of heddle frames of a loom, in order to produce a fabric with a desired pattern on the loom. A drawing-in draft is, for instance, prepared for all fancy patterns woven on a loom. It can include how warp threads are to be drawn through the dropwires of a loom. The warp threads can come from a warp beam or from a bobbin.

[0012] For the present invention, a heddle sequence is a succession of heddle types among left heddle and right heddle. This heddle sequence can be a regular or irregular alternance of left and right heddles. The heddle sequence can be determined from a drawing-in draft or can be a preset heddle sequence.

[0013] Duplex heddles are heddles for heddle frames and can have any type of end loop and of eyelet.

[0014] According to advantageous but non-compulsory aspects of the invention, such a heddle module might incorporate one or several of the following features:

- The sorting path is a closed sorting path, whereas the heddle-support elements that are adjacent to each other along the closed sorting path are regularly distributed along the closed sorting path and whereas, when a first heddle-support element is at the feeding position, a second heddle-support element is at the sorting transfer position and at least one heddle-support element is located between the first and second heddle-support elements, on both sides of the first heddle-support element along the closed sorting path.
- Each sorting conveyor includes at least one endless member movably arranged around a frame of the heddles-sorting device and on which the several adjacent heddle-support elements are secured, and at least one drive of the sorting conveyor drives a driving wheel in engagement with the endless member for moving the heddle-support elements of the respective endless member along the sorting path.
- When it is arranged around the frame of the heddles-sorting device, the endless member has an elongated shape with two opposite long straight sides and with its longest dimension perpendicular to a longitudinal axis of the heddles-feeding device and the at least one feeding position and the at least one sorting transfer position are respectively arranged on the two opposite long straight sides of the endless member.
- The endless member is a belt and each heddle-support element includes a recess where an external protrusion of the belt is received and is secured to the belt by a screw screwed in the external protrusion.
- Each heddle-support element has upper and lower guiding members configured to cooperate with guiding rails of the frame of the heddles-sorting device, the rails extending parallel to at least a portion of the sorting path.
- The controller includes a memory for storing value of the parameter detected by the heddle-detection device or a heddle type information derived from this parameter for each heddle carried by the sorting conveyor in relation to the at least one heddle-support element supporting this heddle.
- The heddles-transfer device includes at least one motorized pusher housed in the frame of the heddles-sorting device and configured to push a heddle out of the at least one heddle-support element located at the at least one sorting transfer position into the at least one transport transfer position.
- The heddles-detection device includes a camera oriented to aim at a zone around an eyelet of the heddle when the heddle is in a detection position.
- Each heddle-support element is equipped with a first nail; the heddles-transport device includes at least one transport conveyor equipped with several heddle-holding elements spaced along a transport path; each heddle-holding element is equipped with a second nail and a first nail of a heddle-support element located at the sorting transfer position and a second nail of a heddle-holding element located at the transport transfer position are aligned along a direction parallel to the longitudinal axis of a heddle, the first nail and the second nail being adapted to penetrate into the same end loop of the heddle when the heddle is transferred by the heddles-transfer device from the sorting transfer position to the transport transfer position.
- The sorting conveyor includes an upper sorting conveyor portion and a lower sorting conveyor portion; the upper sorting conveyor portion is arranged on an upper frame of the heddles-sorting device and equipped with several heddle-support elements, each adapted to interact with an upper end loop of a heddle; the lower sorting conveyor portion is arranged on a lower frame of the heddles-sorting device and equipped with several heddle-support members, each adapted to interact with a lower end loop of a heddle; a heddle-support element of the upper sorting conveyor portion and a heddle-support element of the lower sorting conveyor portion form a pair of heddle-support elements cooperating with the same heddle; the heddles-sorting device comprises several pairs of heddle-support elements that are spaced and movable along the sorting path and an upper drive of the upper sorting conveyor portion and a lower drive of the lower sorting conveyor portion are synchronized by the controller.

[0015] According to a second aspect, the invention concerns a drawing-in machine for drawing-in warp threads into harness components for a loom. This drawing-in machine comprises a heddle module as mentioned here above, a thread-

insertion device for inserting a warp thread through a heddle located at the threading position and a heddles-receiving module comprising several adjacent heddle-support rods. The heddles-transport device of the heddle module is configured to move heddles according to the predetermined heddle sequence from the at least one transport transfer position to one of several discharge positions, where each transported heddle can be transferred out of the heddles-transport device onto the heddles-receiving module, each heddle-support rod facing one of several discharge positions. The number of heddle-support elements that can hold different heddles on the heddles-sorting device is strictly larger than the number of discharge positions.

[0016] According to a third aspect, the invention concerns a method for feeding heddles to a heddles-transport device of a heddle module of a drawing-in machine, according to a heddle sequence corresponding to a succession of heddle types among left and right heddles and prior to inserting a thread in this heddle. Said method is implemented with a heddles-sorting device equipped with several heddle-support elements spaced along a sorting path of the heddles-sorting device and co-moved along the sorting path and with a heddles-feeding device in which heddles are provided in the form of at least one stack of left and right heddles. Each heddle-support element is configured to hold one heddle. The heddles-sorting device is configured to move several heddles at the same time along the sorting path; both left and right heddles can be transferred between the sorting transfer position and the transport transfer position. The method includes at least the following steps consisting in:

a) moving the heddle-support elements of the sorting device along the sorting path up to placing a free heddle-support element at a feeding position;
b) separating a heddle from the at least one stack;
c) detecting a parameter representative of the geometry of the heddle, the parameter differing depending on whether the heddle is a left heddle or a right heddle;
d) feeding the free heddle-support element located at the feeding position with a heddle, at the feeding position;
e) moving the heddle-support elements of the heddles-sorting device along the sorting path in order to place, in the sorting transfer position, a heddle-support element holding a heddle whose detected parameter corresponds to a predetermined value, the predetermined value depending on the heddle sequence; and
f) moving the heddle out of the heddle-support element located at the sorting transfer position onto a heddle-holding element of the heddles-transport device located at a transport transfer position.

[0017] Advantageously, the method includes at least the following steps consisting in

g) memorizing for each heddle-support element of the heddles-sorting device if a heddle is held or if the heddle-support element is free; and
h) if a heddle is held by a heddle-support element, memorizing, for this heddle-support element, the parameter detected at step c) for this heddle or another parameter representative of the left or right type of this heddle.

[0018] According to optional features, the sorting path is a closed sorting path and/or, during steps a) and e), a movement of the heddle-support elements is possible in both directions along the closed sorting path.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The invention will be better understood, based on the following description, which is given in correspondence with the appended figures and as an illustrative example, without restricting the object of the invention. In the annexed figures:

- Figure 1 is a partial top view of a drawing-in machine according to the invention, this machine incorporating a heddle module according to the invention;
- Figure 2 is a partial isometric view of the drawing-in machine of the invention;
- Figure 3 is a partial front view of the drawing-in machine of the invention, it shows the plane I-I along which figure 1 is taken ;
- Figure 4 is an enlarged view of detail IV on figure 1 ;
- Figure 5 is a partial enlarged sectional view along line V-V on figure 4, at the level of an upper conveyor section ;
- Figure 6 is an isometric detail view of the drawing-in machine at two transfer positions;
- Figure 7 is an isometric detail view of the drawing-in machine, with a heddle at a detection position;
- Figure 8 is a perspective view of an endless belt used in a transport device of the drawing-in machine of the invention;
- Figure 9 is a partial enlarged sectional view along line IX-IX on figure 1;
- Figure 10 is a partial enlarged sectional view along line X-X on figure 1;
- Figure 11 is a partial top view, similar to figure 1, for a heddle module and a drawing-in machine according to a second embodiment of the invention; and

- Figure 12 is a partial front view of the drawing-in machine of figure 11.

DETAILLED DESCRIPTION OF SOME EMBODIMENTS

[0020] The drawing-in machine 2 schematically represented on figure 1 comprises a heddles-feeding device 4, which includes a stack 6 of duplex heddles 60. The duplex heddles can be of two types, namely left heddles 60L or right heddles 60R.

[0021] A heddle is an example of a harness component usable on a loom.

[0022] The drawing-in machine 2 also includes a heddles-separating device 8, a heddles-sorting device 10, a heddles-transport device 12, a heddles-detection device 14, a controller 16, a thread-insertion device 18, a heddles-receiving module 20, a dropwire module 22, a warp-clamping frame 24 for clamping warp yarns of a non-represented warp beam, a heddles-transfer device 26 and a heddles-discharging device 28.

[0023] The thread-insertion device 18 may be common to heddles and dropwires.

[0024] The heddles-feeding device 4, the heddles-separating device 8, the heddles-sorting device 10, the heddles-transport device 12, the heddles-detection device 14, the controller 16 and the heddles-transfer device 26 belong to a heddle module 30, which is part of the drawing-in machine 2.

[0025] X, Y, Z denote an orthogonal marker of a non-represented frame of the drawing-in machine 2 with reference axes X and Y horizontal and reference axis Z vertical and oriented to the top.

[0026] The heddles-feeding device 4 comprises a single magazine made of two guide rails 42, vertically aligned, which support a single stack 6 of duplex heddles 60. The heddles 60 are supported by their respective end loops 62 and the rails 42 are fixed with regard to a non-represented frame of the drawing-in machine 2. The rails 42 can be inclined relative to a horizontal plane, as considered in WO00/68479A1, or parallel to such a horizontal plane, as considered in WO99/15723A1. In the example of the figures, the guide rails 42 extend parallel to the reference axis Y. In other words, the reference axis Y is a longitudinal axis of the heddles-feeding device 4 and, within the stack 6, the heddles 60 are adjacent to each other along the longitudinal axis Y.

[0027] A60 denotes a longitudinal axis of a heddle 60. This axis A60 extends between the end loops 62 of each heddle 60 and is parallel to their longest dimension. This longitudinal axis A60 is parallel to the reference axis Z when the corresponding heddle is mounted on the heddles-feeding device 4, on the heddles-sorting device 10 and on the heddles-transport device 12.

[0028] In the stack 6, heddles 60 can be of two types, namely left heddle 60L or right heddle 60R. Left heddle 60L and right heddle 60R differ at least in the position, in a direction perpendicular to axis A60, of their intermediate region and of their eyelet 64, with regard to the end loops 62.

[0029] In practice, the heddle stack 6 can be directly extracted from a heddle frame that has been previously used on a loom. Such a stack 6 includes right and left heddles 60L, 60R but their alternation might be altered by heddles added on the frame during its previous period of use on a loom. Thanks to the heddles-sorting device the distribution of heddles 60 in the stack 6 does not have to be precisely known nor controlled in advance

[0030] The heddles-separating device 8 is configured to separate heddle 60 one by one from the stack 6 of heddles 60 borne by the magazine formed by the two guide rails 42 and to transfer each separated heddle one after the other onto the heddles-sorting device 10 at a feeding position P1. On the figures, the heddles-separating device 8 is partially shown. The heddles-separating device 8 can be built as disclosed in WO00/68479A1 or WO99/15723A1 whose contents are included in this description by reference. Alternatively, other types of heddles-separating devices can be used in the heddle module 30.

[0031] The sorting device 10 comprises a sorting conveyor 100 made of an upper sorting conveyor portion 102 and a lower sorting conveyor portion 104 which extend parallel to each other, one above the other.

[0032] Each sorting conveyor portion 102 or 104 includes an endless belt 108, which forms an endless member defining a closed sorting path 106 when it is mounted on a frame 120 of the sorting device 10.

[0033] Each endless belt 108 is equipped with several heddle-support elements 122. By convention, a heddle-support element 122 secured to the endless belt 108 of the upper sorting conveyor portion 102 is an upper heddle-support element and a heddle-support element 122 secured to the endless belt 108 of the lower sorting conveyor portion 102 is a lower heddle-support element. An upper heddle-support element 122 interacts with an upper end loop 62 of a heddle 60 mounted on the sorting device 10, whereas a lower heddle-support element 122 interacts with the lower end loop 62 of the same heddle 60. On each endless belt 108, the heddle-support elements 122 are adjacent to each other along the sorting path 106. In other words, each heddle-support element 122 of each endless belt 108 is shifted along the sorting path 106 with regard to the other heddle-support elements 122 of the same endless belt 108. Each heddle-support element 122 is configured to hold one heddle 60 and the heddle-support elements 122 co-move with the endless belt 108 along the sorting path 106. Alternatively, a steel band or a chain can be used as an endless member, instead of a polymer belt. The endless member can take different shapes when not mounted on the frame.

[0034] The closed sorting path 106 has an elongated or oblong shape with its longest dimension parallel to the reference

axis X and perpendicular to the main direction of the guide rails 42. Each endless belt 108 has an elongated or oblong shape that corresponds to the shape of the closed sorting path 106.

[0035] Two servomotors 112, 114 are respectively engaged with gears 116 and drive toothed wheels 118 in meshing engagement with the inner surface of each belt 108. Advantageously, the inner surface of each belt 108 is provided with teeth 109, in order to cooperate with teeth provided on the radial external surface of the respective wheels 118. Each wheel 118 rotates around a rotation axis X118, which is parallel to the reference axis Z.

[0036] The two servomotors 112 and 114 form drives for the sorting conveyor 100, more precisely for the respective endless belts 108 of its upper and lower sorting conveyor portions 102 and 104. The servomotor 112 forms an upper drive for the upper conveyor portion 102 and the servomotor 114 forms a lower drive for the lower conveyor portion 104.

[0037] As shown by double arrow A1, the two servomotors 112 and 114 can drive the endless belts 108, and thus the heddle-support element 122, in two opposite directions along the closed sorting path 106.

[0038] The upper and lower servomotors 112 and 114 are electrically synchronized by the controller 16, preferably with no direct mechanical link between them. Preferably upper and lower sorting conveyor portions 102 and 104 follow the same movement when they are driven by upper and lower servomotors 112 and 114.

[0039] The heddles-sorting device 10 includes the frame 120, which supports the two sorting conveyor portions 102 and 104, in particular the servomotors 112 and 114, the gears 116 and the wheels 118. The endless belts 108 are arranged around this frame 120 and the closed sorting path 106 is defined around this frame.

[0040] As visible on figures 2 and 3, the two servomotors 112 and 114 can be respectively located above and under the upper and lower conveyor portions 102 and 104. It should be noted here that figure 1 is a top view of the drawing-in machine 2, seen from a middle plane I-I, located between the upper conveyor portion 102 and the lower conveyor portion 104, as shown on figure 3.

[0041] The frame 120 is rigidly secured to the non-represented frame of the drawing-in machine 2.

[0042] Advantageously, the upper and lower heddle-support elements 122 are identical, except for their orientation along the reference axis Z.

[0043] The heddles-receiving module 20 includes twenty pairs of support rods 202 arranged parallel to each other and adjacent to each other along a direction parallel to the reference axis X, on a side of the heddles-transport device 12 opposite to the heddles-sorting device 10. These twenty pairs of support rods 202 correspond to twenty discharge positions of the heddles-transport device 12. These pairs of support rods are individually referenced 202_k, with k an integer between 1 and 20.

[0044] Advantageously, the number of heddle-support elements 122 mounted on each endless belt 108 is strictly larger than the number of discharge positions of the heddles-transport device, i.e. the number of pairs of support rods 202 that can be installed in the receiving module 20 of the drawing-in machine 2. In other words, the number of heddle-support elements 122 of the sorting conveyor 100 that can hold different heddles, which is the maximal heddle capacity of the sorting conveyor 100, is strictly larger than the number of discharge positions. In the present example, since there are twenty pairs of support rods 202_1 to 202_{20}, the number of heddle-support elements 122 on each endless belt 108 is larger than or equal to twenty-one, in practice equal to twenty-four as shown, for example, on figure 4.

[0045] Alternatively, a different number of heddle-support elements 122 can be secured to each endless belt 108, this number being strictly larger than the number of discharge positions. Advantageously, the number of heddle-support elements 122 mounted on each endless belt 108 is at least five.

[0046] The heddle-support elements 122 are regularly distributed on the external peripheral surface 108A of each endless belt 108. The two endless belts, that is the endless belt 108 of the upper conveyor portion 102 and the endless belt 108 of the lower conveyor portion 104, are equipped with the same number of heddle-support elements 122. The upper heddle-support elements 122 and the lower heddle-support elements 122 form pairs of heddle-support elements 122. More precisely, two vertically aligned support elements 122, i.e. two heddle-support elements aligned to hold a heddle 60 with its axis A60 parallel to the reference axis Z, form a pair of heddle-support elements configured for holding a heddle 60.

[0047] Each heddle-support elements 122 is secured to the external peripheral surface 108A of one of the belts 108 by a screw 124. This is visible in particular on figure 5, which is a partial cut view taken along a plane radial to the rotation axis X118 of a wheel 118, at the level of the upper conveyor section 102. On figure 4, the line V-V shows the trace of this plane at the level of the lower conveyor section 104.

[0048] Each heddle-support element 122 includes a polymer body 126 fixed to the endless belt 108 by the screw 124 and provided with two guiding parts 128 and 130 that can cooperate with two guiding rails 120A and 120B which belong to the frame 120. The two guiding parts 128 and 130 can be respectively engaged within two guiding slots 132 and 134 formed by the two guiding rails 120A and 120B.

[0049] Alternatively, the body 126 of a heddle-support element 122 can be made of another material, e.g. metal.

[0050] The longest dimension of the closed sorting paths 106 is parallel to the reference axis X and the guiding rails 120A and 120B are parallel to this axis.

[0051] Advantageously, the two rails 120A and 120B, thus the two guiding slots 132 and 134, extend parallel to straight portions of the closed sorting path 106, in particular to two long straight sides of the belt 108 .

[0052] For the sake of clarity, only one rail 120A is represented on figure 2, the other one being omitted in order to show the upper guiding parts 128 of some heddle-support elements 122.

[0053] Advantageously, the external peripheral surface 108A of the endless belts 108 include regularly distributed external protrusions, each equipped with a threaded hole 108B adapted to receive one screw 124 and each body 126 has a recess 126A configured to receive one such external protrusion. In practice, the number of protrusions provided on the external surface 108A of each endless sorting belt 108 equals the number of heddle-support elements 122 mounted on this endless belt.

[0054] Each body 126 is provided with three superimposed bores 126B adjacent to one another along the reference axis Z. Only the intermediate bore 126B accommodates a screw 124 when the corresponding heddle-support element 122 is secured to an endless belt 108.

[0055] Each heddle-support element 122 also includes a pin 136, mounted on the body 126 and equipped with a nail 138 configured for penetrating in an end loop 62 of a heddle 60. The pin 136 of a heddle-support element 122 is slidable, with respect to the body of this heddle-support element 122, along an axis, which is vertical when the heddle-support element 122 is mounted in the heddles-sorting device 10.

[0056] Each pin 136 of an upper heddle-support element 122 is loaded upwardly, with respect to its body 126, by a spring 140. Conversely, each pin 136 of a lower heddle-support element 122 is loaded downwardly, with respect to its body 126, by a spring 140. Thus, the pins 136 of the heddle-support elements 122 of one of the upper and lower conveyor portions 102 and 104 are loaded by the springs 140 in a direction away from the other conveyor portion 104 or 102. As a result, the pins 136 of the two heddle-support elements 122 of a pair of heddle-support elements are loaded by their respective springs 140 in opposite directions, away from each other.

[0057] The heddles-sorting device 10 also defines a sorting transfer position P2. When a heddle is in this sorting transfer position P2, it can be moved by the heddles-transfer device 26 into a transport transfer position P3 defined by the heddles-transport device 12.

[0058] The heddles-transfer device 26 includes a pusher 262 housed in the frame 120 of the heddles-sorting device 10 and movable relative to this frame 120 and to the conveyor portions 102 and 104 in a direction parallel to the reference axis Y, between a retracted position represented on figures 1 and 4 and in solid lines on figure 6, on the one hand, and an extended position represented in dotted lines on figure 6, on the other hand. The heddles-transfer device 26 also includes a non-represented drive configured to move the pusher 262 between its retracted and extended positions, and vice-versa.

[0059] In the retracted position of the pusher 262, a heddle 60 is in the sorting transfer position P2, whereas the same heddle has been moved into the transport transfer position P3 when the pusher 262 is in its extended position.

[0060] In practice, the heddles-transfer device 26 can incorporate two pushers 262, one next to each conveyor portions 102 and 104. An upper pusher 262 can be located just below the pin 136 of the upper heddle-support elements 122 and a lower pusher 262 can be located just above the pin 136 of the lower heddle-support elements 122.

[0061] In its retracted position, each pusher 262 does not interfere with the heddles 60 borne by the heddles-sorting device 10 and moving along the closed sorting path 106. In its extended position, each pusher 262 crosses the closed sorting path 106 and pushes the heddle 60 hold by the adjacent pair of heddle-support elements 122 out of the sorting transfer position P2 and towards the transport transfer position P3.

[0062] The feeding position P1 and the sorting transfer position P2 are regularly spaced along the closed sorting path 106. In other words, the distance between the feeding position P1 and the sorting transfer position P2 is the same in both directions A1 along the sorting path 106.

[0063] The heddle-support elements 122, that are adjacent to each other along the closed sorting path 106, are regularly distributed along the closed sorting path 106, in a way which takes into count the repartition of the two positions P1 and P2. More precisely, when a first heddle-support element 122 is at the feeding position P1, a second heddle-support element 122 is at the sorting transfer position P2, and at least one heddle-support element 122 is located between the first and second heddle-support elements, on both sides of the heddle-support element 122 along the closed sorting path 106.

[0064] Advantageously, and as shown on the figures, the two positions P1 and P2 are located on opposite long straight sides of the oblong sorting belt 108 and the distance between the feeding position P1 and the sorting transfer position P2 along the closed sorting path 106 is the same in both directions.

[0065] Preferably, the number of heddle-support elements 122 between the two positions P1 and P2 and along the closed sorting path 106 is the same in both directions.

[0066] In the example of the figures, this number is 10. In a variant, this number can be different. It is preferably chosen larger than or equal to 1.

[0067] Release means 162 are provided at the feeding position P1. When actuated by a dedicated non-represented drive, these release means 162 push the pins 136 of the two heddle-support elements 122 of a pair of heddle-support elements present at the feeding position P1 towards each other, against the action of their respective return springs 140, in two opposite directions parallel to the reference axis Z. In other words, the pin 136 of one upper heddle-support element 122 is pushed downwardly, whereas the pin 136 of the lower heddle-support element 122 of the same pair is pushed upwardly by the release means 162.

[0068] This results in moving the nails 138 of these two heddle-support elements 122 towards each other, which allows each of these nails to engage within a respective end loop 62 of the separated heddle presented by the heddles-separating device 8.

[0069] When the release means 162 are no more actuated or when the heddle-support elements 122 of the pair of heddle-support elements leave the feeding position P1, the pins 136 of the two heddle-support elements of the pair of heddle-support elements 122 present in the feeding position P1 are pushed back by their respective springs 140 into their return positions, which hooks the two nails 138 of the two heddle-support elements 122 present in the feeding position P1 within the two end loops 62 of the heddle 60. This results in tensioning the heddle 60 between the nails 138 of the pair of heddle-support elements.

[0070] As visible on figure 5, the nail 138 of each heddle-support element 122 is not parallel to the horizontal plane defined by axes X and Y but inclined with respect to this plane by a non-zero angle α.

[0071] The nail 138 of an upper heddle-support element 122 diverges upwardly, by an angle α, when going away from the corresponding pin 136, whereas the nail 138 of a heddle-support element 122 of the lower conveyor portion 104 diverges downwardly, by the same angle α, when going away from the corresponding pin 136. Thus, the two nails 138 diverge.

[0072] Advantageously, the angle α is between 0 and 8°, preferably equal to 5°.

[0073] Due to the divergence of the two nails 138, the elastic force exerted by the two springs 140 of a pair of heddle-support elements 122 contributes to hooking a heddle 60 between these two elements. This contributes to keeping a heddle 60 stable on a pair of heddle-support elements 122 when it is moved along the closed sorting path 106 by the sorting conveyor 100.

[0074] Two non-represented sensors are integrated within the sorting device 10 and provide the controller 16 with an information about the position of each endless belt 108 of the upper and lower sorting conveyor portions 102 and 104 relative to the frame 120. This allows the controller 16 to know, at any time, the position of each heddle-support element 122 along the closed sorting path 106.

[0075] The heddles-detection device 14 is configured to detect if a heddle 60 is a left heddle 60L or a right heddle 60R.

[0076] A detection position P4 is defined between the stack 6 of heddles 60 and the feeding position P1.

[0077] Preferably, the heddles-detection device 14 includes a camera 142 mounted on the frame of the drawing-in machine so that its field of view 144 covers a zone around the eyelet of a right heddle 60R located in the detection position P4 and a zone around the eyelet of a left heddle 60L located in the detection position P4.

[0078] The region of a heddle 60 around its eyelet 64 allows differentiating a left heddle 60L from a right heddle 60R. Thus, the camera 142 is configured to detect at least one parameter of a heddle 60 present in the detection position P4, this parameter being different, depending on whether the heddle is a left heddle 60L or a right heddle 60R. This parameter can be given by the geometry of the heddle around its eyelet.

[0079] In practice, the heddles-detection device 14 sends to the controller 16 a signal S14 including the at least one parameter of the heddle, which allows differentiating a left heddle 60L from a right heddle 60R.

[0080] Advantageously, the signal S14 also includes an information as to whether the heddle eyelet 64 is correctly oriented, if it is worn, how much it is worn and at which position the eyelet 64 is located relative to the upper and lower heddle loops 62 of the heddle, depending on some wear within the end loops 62. All this information can be derived from a picture taken by the camera 142 and included within the signal S14 sent to the controller 16.

[0081] Preferably, the detection position P4 is located on the path of a heddle 60 after this heddle has been separated from the stack 6 and before this heddle is transferred onto the heddles-sorting device 10.

[0082] Advantageously, the controller 16 sends a signal to the heddles-detection device 14 in order to take a picture of each separated heddle 60 as soon as it is separated from the stack 6 but still held by the heddles-separating device 8.

[0083] Advantageously, the heddles-detection device 14 can also be used as a separation detection device in order to detect "double heddle separation", i.e. when two heddles are separated from the stack 6 at the same time.

[0084] The heddles-transport device 12 is exclusively dedicated to transporting heddles and includes several transport conveyors.

[0085] In the first embodiment, the heddles-transport device 12 includes three transport conveyors 300A, 300B and 300C. In a variant, the number of transport conveyors can be different, but larger than or equal to two.

[0086] The three conveyors 300A, 300B and 300C are superimposed. More precisely, a first upper conveyor 300A is located above a second intermediate conveyor 300B, which is located above a third lower conveyor 300C along the reference axis Z.

[0087] The first transport conveyor 300A includes an upper conveyor portion 302A and a lower conveyor portion 304A. The second transport conveyor 300B includes an upper conveyor portion 302B and a lower conveyor portion 304B. The third transport conveyor 300C includes an upper conveyor portion 302C and the lower conveyor portion 304C.

[0088] Several heddle-holding elements 322 are secured to, thus co-moved with, each transport conveyor 300A, 300B, 300C along a closed transport path 306 which is common to all transport conveyors 300A, 300B, 300C. Each heddle-holding elements 322 is configured to hold a single harness component, which is, in this first embodiment, a single heddle

60. The harness component-holding elements 322 of the three transport conveyors 300A, 300B and 300C are adjacent to each other along the closed transport path 306. In other words, the harness component-holding elements 322 of each of the transport conveyors 300A, 300B and 300C are shifted along the transport path 306 with regard to the harness component-holding elements 322 of the other transport conveyors 300A, 300B and 300C.

[0089] The several heddle-holding elements 322 of each conveyor portion 302A, 302B, 302C, 304A, 304B or 304C follow the same closed transport path 306 which has, when seen from the top, a polygonal shape, for instance a substantially rectangular shape with four rounded corners, as shown on figure 1.

[0090] Each conveyor portion includes an endless belt 308 forming an endless member and defining the closed transport path 306, when mounted on a frame 320 of the transport device 12. Each endless belt 308 has the same rectangular shape as the closed transport path 306.

[0091] Alternatively, a steel band or a chain can be used as an endless member, instead of a belt. The endless member can take different shapes when not mounted on the frame 320 of the transport device 12.

[0092] The respective endless belts 308 of the three transport conveyors 300A, 300B, 300C are arranged on top of each other. In particular, the upper conveyor portion 302A, the upper conveyor portion 302B and the upper conveyor portion 302C are adjacent along the reference axis Z and the lower conveyor portion 304A, the lower conveyor portion 304B and the lower conveyor portion 304C are adjacent along the reference axis Z. Along this reference axis Z, the distribution of the conveyor portions is as follows, from bottom to top : 304C, 304B, 304A, 302C, 302B, 302A. Each conveyor portion 304C, 304B, 304A, 302C, 302B, 302A extends at one different level along axis Z. The upper conveyor portion 302C and the lower conveyor portion 304A are distant from each other along axis Z, with a distance close to the length of the heddles 60.

[0093] In a non-represented variant of the invention, as the upper and lower heddle-holding elements 322 are identical, the distribution of the conveyor portions around the top frame 320 and around the bottom frame 320 along the reference axis Z axis does not have the same alternation.

[0094] All endless belts 308 are preferably identical and include, on their inner surface, some teeth 309 configured to interact with some wheels 318 provided with external teeth and located at the four corners of the closed transport path 306. As visible on figure 8, each endless belt 308 is also provided, on its external surface, with three protrusions 310, regularly distributed around the periphery of the belt. Each protrusion is equipped with a threaded hole 310B.

[0095] The heddles-transport device 12 also includes the frame 320, which forms guiding rails 320A and 320B. These guiding rails are represented on figure 2 in dotted lines and on figure 9 in solid lines. They extend parallel to the four rectilinear portions of the closed transport path 306 and are interrupted at the level of the 4 corners.

[0096] For the upper conveyor portions 302A, 302B and 302C, three wheels 318 are located at each corner of the closed transport path 306 and rotate around a common axis Z318 parallel to the reference axis Z. The wheels 318 are rotatably mounted on the frame 320 of the heddles-transport device 12. In particular, the corresponding rotation axes Z318 of the wheels are defined by the frame 320, in the four corners of the closed transport path 306.

[0097] In a first corner, a first servomotor 312A is connected via a first gear 316A to a driving wheel 318A which is in meshing engagement with the endless belt 308 of the upper conveyor portion 302A. The two other wheels 318 located in the first corner, below the first driving wheel 318A, freely rotate around the corresponding common axis Z318. In other words, the freely rotatable wheels are not directly connected to a servomotor and their rotation is driven by the movement of the corresponding endless belt 308.

[0098] In a second corner of the closed transport path 306, a second servomotor 312B drives, via a second gear 316B, a second driving wheel 318B in meshing engagement with the endless belt 308 of the second conveyor portion 302B. The two other wheels 318 located in the second corner, above and below the second driving wheel 318B, freely rotate around the corresponding axis Z318, as the two wheels located below the first driving wheel 318A in the first corner.

[0099] In a third corner of the closed transport path 306, a third servomotor 312C drives, via a third gear 316C, a third driving wheel 318C in meshing engagement with the endless belt 308 of the third upper conveyor portion 302C. The other two wheels 318 located in the third corner, above the third driving wheel 318C, freely rotate around the corresponding axis Z318, as the two wheels located below the first driving wheel 318A in the first corner.

[0100] As visible on figure 10, a shaft 319 defines the axis Z318 in the third corner and connects in rotation the third gear 316C and the third driving wheel 318C, through the other two wheels 318. Grabbing means 319A and 319B are provided at both ends of the shaft 319, for connection to the third gear 316C and to the third driving wheel 318C respectively. The same approach is used in the first and second corners.

[0101] In the fourth corner of the transport path 318, three wheels 318 freely rotate around a corresponding axis Z318, as the two wheels located below the first driving wheel 318A in the first corner.

[0102] The same approach is implemented at the level of the lower conveyor portions 304A, 304B and 304C where three servomotors 314A, 314B and 314C are used, respectively in the same corners as servomotors 312A, 312B and 312C and drive non-represented driving wheels. The servomotors 312A, 312B, 312C, 314A, 314B and 314C are mounted on the frame 320. The servomotors 312A, 312B, 312C, 314A, 314B and 314C are separately driven. The servomotors 312A, 312B, 312C are electrically synchronized by the controller 16 respectively with the servomotors 314A, 314B, 314C, preferably with no direct mechanical link between them. Preferably the upper conveyor portions 302A, 302B, 302C

respectively follow the same movement as the lower conveyor portions 304A, 304B, 304C.

[0103] The wheels 318 arranged in a corner of the closed transport path 306 define, at the level of the upper conveyor portions 302A, 302B, 302C, a first set of wheels rotatable with respect to the frame 320 of the heddles-transport device 12 around a common axis Z318 and, at the level of the lower conveyor portions 304A, 304B, 304C, a second set of wheels rotatable around the same common axis Z318. Each wheel of a set of wheels cooperates with a different endless belt 308. The number of wheels 318 in each set of wheels equals the number of transport conveyors of the heddles-transport device 12. In other words, a set of wheels cooperates with one endless belt 308 of all transport conveyors 300A, 300B and 300C. In the embodiment of figures 1 to 10, this number is three.

[0104] At the level of the upper conveyor portions 302A, 302B, 302C three sets of wheels 318 includes a driving wheel 318A, 318B or 318C and two freely rotatable wheels. The fourth set of wheels includes three freely rotatable wheels 318. The same applies at the level of the lower conveyor portions 304A, 304B, 304C.

[0105] The servomotors 312A, 312B, 312C, 314A, 314B and 314C form respective drives for the first, second and third transport conveyors 300A, 300B and 300C.

[0106] Several heddle-holding elements 322 are secured to the endless belt 308 of each conveyor portion 302A, 302B, 302C, 304A, 304B, 304C of each conveyor 300A, 300B, 300C. By convention, a heddle-holding element 322 secured to the endless belt 308 of an upper conveyor portion 302A, 302B, 302C is an upper heddle-holding element and a heddle-holding element 322 secured to the endless belt 308 of a lower conveyor portion 304A, 304B, 304C is a lower heddle-holding element. The number of upper heddle-holding elements 322 of a conveyor is the same as the number of lower heddle-holding elements 322 of the same conveyor. All the transport conveyors 300A, 300B, 300C have the same number of heddle-holding elements 322.

[0107] Advantageously, the upper and lower heddle-holding elements 322 are identical, except for their orientation along the reference Z axis. Advantageously, the heddle-holding elements 322 are identical to heddle-support elements 122.

[0108] All heddle-holding elements 322 are movable along the same closed transport path 306 and are mounted on the corresponding endless belt 308 by a respective screw 324. More precisely, each heddle-holding element 322 is mounted on a protrusion 310, by a screw 324 threaded in the corresponding threaded hole 310B of the protrusion 310. On each corresponding endless belt 308, the number of protrusions 310 equals the number of heddle-holding elements 322.

[0109] As for the heddle-support elements 122 of the heddles-sorting device 10, the heddle-holding elements 322 work by pairs, a pair of heddle-holding elements 322 being formed by an upper heddle-holding element 322 and a lower heddle-holding element 322 aligned on a same axis parallel to the reference axis Z and configured for holding together a single heddle 60 with its axis A60 parallel to the reference axis Z.

[0110] By construction, the endless belts 308 of one transport conveyor are configured to transport individual heddles different from the individual heddles transported by endless belts of the other two transport conveyors. By "different", it is meant that the heddles transported by the endless belts 308 of a transport conveyor are not transported by the endless belts of the other transport conveyors, even if all heddles are of the same type.

[0111] Preferably, the heddle-support elements 122 and heddle-holding elements 322 are identical. They only differ by the part of the heddle module they belong to, i.e. the heddles-sorting device 10 for the heddle-support elements 122 and the heddles-transport device 12 for the heddle-holding elements 322.

[0112] In the following description, a part of a heddle-holding element 322 identical to a part of a heddle-support element 122 is designated by the same reference plus 200.

[0113] In particular, each heddle-holding elements 322 includes a polymer body 326, which forms upper and lower guiding parts 328 and 330 configured to slide within slots 332 and 334 respectively defined by the guiding rails 320A and 320B.

[0114] Alternatively, the body 326 of a heddle-holding element 322 can be made of another material, e.g. metal.

[0115] Each heddle-holding element 322 also includes a pin 336 equipped with a nail 338 and loaded by a spring 340 towards a return position. The springs 340 of the upper heddle-holding elements 322 urge the corresponding pins 336 upwardly, whereas the springs 340 of the lower heddle-support elements 322 urge the corresponding pins 336 downwardly.

[0116] Each body 326 is provided with three superimposed bores 326B adjacent to one another along the reference axis Z, one screw 324 being received in one of these bores, depending on which belt 308 the heddle-holding element 322 is secured. More precisely, a screw 324 crosses the upper bore 326 of a first heddle-holding element 322 secured to the endless belt 308 of the first conveyor 300A, a screw 324 crosses the intermediate bore 326 of a second heddle-holding element 322 secured to the endless belt 308 of the second conveyor 300B and a screw 324 crosses the lower bore 326 of a third heddle-holding element 322 secured to the endless belt 308 of the third conveyor 300C.

[0117] An internal surface 326C forming an end of a recess 326A of each heddle-holding element 322 thus faces three belts 308, namely one belt 308 of each transport conveyor.

[0118] The pins 336 work as the pins 136 of the heddle-support elements 122 for loading and unloading a heddle on or from the heddles-transport device 12 and at the transport transfer position P3, they are piloted by release means 362

similar to the release means 162.

[0119] In particular, the heddle-holding elements 322 are grouped by pairs of two vertically aligned heddle-holding elements 322, i.e. two heddle-holding elements aligned to hold a heddle 60 with its axis A60 parallel to the reference axis Z. The two heddle-holding elements 322 of a pair are respectively secured to the endless belts 308 of the top and bottom portions of a conveyor 300A, 300B, and 300C.

[0120] When a heddle must be moved from the sorting transfer position P2 to the transport transfer position P3, the release means 362 actuate the pins 336 of the pair of heddle-holding elements 322 located at the transport transfer position P3. In this configuration the release means 362 pushes the pins 336 against their spring 340. The nails 138 of the pair of heddle-support elements 122 in the sorting transfer position P2 overlap the nails 338 of the pair of heddle-holding elements 322 in the transport transfer position P3. The nails 138 and 338 are located at different heights along the reference axis Z and aligned along the longitudinal axis A60 of a heddle transferred between the positions P2 and P3.

[0121] Advantageously, three heddle-holding elements 322 are secured to each endless belt 308. Thus, three pairs of upper and lower heddle-holding elements 322 are secured to each conveyor 300A, 300B and 300C.

[0122] In a non-represented variant of the invention, the number of heddle-holding elements per endless belt 308 can be larger than or equal to three.

[0123] More precisely, three upper heddle-holding elements 322A1, 322A2 and 322A3 are secured to the endless belt 308 of the first upper conveyor portion 302A, three upper heddle-holding elements 322B1, 322B2 and 322B3 are secured to the endless belt 308 of the second upper conveyor portion 302B and three other heddle-holding elements 322C1, 322C2 and 322C3 are secured to the endless belt 308 of the third upper conveyor portion 302C.

[0124] Advantageously, the heddle-holding elements 322Aj, 322Bj and 322Cj are arranged alternately along the closed transport path 306 with the same distribution along the whole transport path, with j equal to 1, 2 or 3. In other words, each heddle-holding element of a first conveyor is adjacent along the closed transport path 306 with a heddle-holding element of a second conveyor and with a heddle-holding element of a third conveyor.

[0125] The pairs of heddle-holding elements 322 are configured to be successively loaded with one heddle at the transport transfer position P3.

[0126] Preferably, the heddle-holding elements 322Aj, 302Bj and 302Cj are regularly distributed along the closed transport path 306. In other words, the heddle-holding elements 322Aj, 302Bj and 302Cj are regularly distributed along their corresponding belt 308.

[0127] A similar distribution of lower heddle-holding elements 322 is used at the level of the lower conveyor portions 304A, 304B, 304C.

[0128] Thus, at the level of the upper conveyor portions 302A, 302B, 302C and at the level of the lower conveyor portions 304A, 304B, 304C, each heddle-holding element 322 secured to one endless belt 308 is located, along the closed transport path 306, between two other heddle-holding elements 322 secured to the two other endless belts and the pairs of heddle-holding elements 322 are alternately distributed along the whole closed transport path 306 with the same distribution. An upper heddle-holding element 322 is aligned along the reference axis Z with a lower heddle-holding element 322 of the same transport conveyor so that their nails 338 are aligned along the reference axis Z.

d322 denotes a distance, along the closed transport path 306, between two adjacent harness-holding elements 322 secured to a given endless belt 308.

[0129] The heddles-transport device 12 is configured to carry a heddle 60 loaded at the transport transfer position P3, where a heddle 60 has been loaded onto the heddle-transport device 12, to a threading position P5, where a yarn from the warp-clamping frame 24 is inserted into the eyelet 64 of this heddle by the thread-insertion device 18. The thread-insertion device 18 is typically a gripper having a reciprocate linear movement along a threading path passing through the heddle eyelet 64 of a heddle 60 held by a heddle-holding element 322 at the threading position P5, catching a warp yarn of the warp-clamping frame 24 and moving back with the warp yarn through the heddle 60.

[0130] The spacing between two heddle-holding elements 322 carried by the same endless belt 308 is equal to the distance, measured along the closed transport path 306, between the transport transfer position P3 and the threading position P5. Thus, two pairs of such heddle-holding elements 322 carried by the same transport conveyor can be located at the same time in these two positions, like the pairs including heddle-holding elements 322B1 and 322B2 in the configuration of figures 1 to 3.

[0131] The heddles-transport device 12 is also configured to carry each heddle 60 from the threading position P5 to one of several discharge positions P6, a discharge position being defined in front of each support rod 202 along direction Y.

[0132] The transport transfer position P3, the threading position P5 and each discharge position P6 are distributed on different straight portions of the polygonal closed transport path 306. The closed transport path 306 goes successively through the transport transfer position P3, through the threading position P5 and through the discharge positions P6.

[0133] As shown by the single arrow A2 on figure 1, the servomotors 312A, 312B, 312C, 314A, 314B and 314C can drive the endless belts 308, and thus the heddle-holding elements 322 , in one direction only, along the closed transport path 306, namely from the transport transfer position P3 to the threading position P5 and then to the discharge positions P6, then to the transport transfer position P3 without passing again at the threading position P5.

[0134] In the direction of movement along the closed transport path 306, represented by the arrow A2, the distribution of heddle-holding elements 322 is as follows: 322C1, 322B1, 322A1, 322C2, 322B2, 322A2, 322C3, 322B3, 322A3.

[0135] Several zones can be defined along the closed transport path 306.

[0136] A first waiting zone is defined along the closed transport path 306, between the transport transfer position P3 and the threading position P5.

[0137] A discharge zone DZ is defined along axis X, along the closed transport path 306, between the first discharge position P6 aligned with the first support rod 202, and the last discharge position P6 aligned with the twentieth support rod 202_{20}. The first discharge position is the discharge position P6 that a heddle-holding element 322 reaches first when moving, from the threading position P5, in the direction of the arrow A2. The last discharge position is the discharge position P6 that a heddle-holding element 322 reaches at the latest when moving, from the threading position P5, in the direction of the arrow A2. In other terms, the discharge zone DZ extends from the first discharge position P6 to the last discharge position P6. In particular, a first discharge subzone DZ1 is defined between the first discharge position P6 aligned with the first support rod 202, and the tenth discharge position P6 aligned with the tenth support rod 202_{10}. A second discharge subzone DZ2 is defined between the eleventh discharge position P6 aligned with the first support rod 202_{11} and the twentieth discharge position P6 aligned with the tenth support rod 202_{20}.

[0138] LDZ denotes the length of the discharge zone DZ, which is its dimension along the closed path 306.

[0139] The distance d322 along the closed transport path 306 between two adjacent harness component-holding elements 322 secured to a given endless belt 308 is greater than the length LDZ of the discharge zone DZ along the closed transport path 306.

[0140] A second waiting zone is defined between the last discharge position P6 and the transport transfer position P3.

[0141] In the configuration of figures 1 to 3, the heddle-holding elements 322A2 and 322C3 are each in a discharge position P6, respectively a first discharge position corresponding to the first support rod 202, and located in the first discharge subzone DZ1 and a second discharge position corresponding to the twentieth support rod 202_{20} and located in the second discharge subzone DZ2.

[0142] The heddles-discharging device 28 includes two pushers 282 and 284, each pusher being movable relative to the frame 320 parallel to the reference axis Y between a retracted position represented in solid lines on figure 1 and an extended position represented in dotted line in the lower portion of figure 1, for the pusher 282. Each pusher moves independently of the endless belts 308. In other words, the pushers are not co-moved with the heddle-holding elements 322 along the transport path 306.

[0143] Each pusher 282, 284 is constantly aligned, along a direction parallel to the reference axis Y, with at most half of the several discharge positions P6, that is ten of the twenty discharge positions P6 represented by the twenty support rods 202_k in the current embodiment. In the example of the figures, each pusher 282, 284 is constantly aligned with ten adjacent discharge positions P6 which belong either to the first discharge subzone DZ1 or to the second discharge subzone DZ2. Each pusher 282, 284 is configured to push a heddle from a heddle-holding element 322 located at one of the ten discharge positions P6 onto one of the ten support rods 202_k in one of the two discharge subzones. In other words, each pusher 282 or 284 constantly extends at the level of several discharge positions and covers at most half of the discharge positions P6.

[0144] In practice, each pusher 282, 284 can be made of a pair of two pusher-elements, aligned along a direction parallel to the reference axis Z, as shown with top pusher-element 282T and bottom pusher element 282B of pusher 282 on figure 3. The other pusher 284 as the same structure with a pair of non-represented top and bottom pusher elements. Thus, a group of top pusher elements, 282T and equivalent, is located next to the upper conveyor portions 302A, 302B and 302C and another group of pusher elements, 282B and equivalent, is located next to the lower conveyor portions 304A, 304B and 304C.

[0145] Three sensors 352A, 352B and 352C are integrated within the heddles-transport device 12 and allow knowing the position of each endless belt 308 of the upper conveyor portions 302A, 302B and 302C relative to the frame 320, i.e. knowing, at any time, the position of each upper heddle-holding element 322 along the closed transport path 306. Similarly, three sensors 354A, 354B and 354C are integrated within the heddles-transport device 12 and allow knowing the position of each endless belt 308 of the lower conveyor portions 304A, 304B and 304C relative to the frame 320, i.e. knowing, at any time, the position of each lower heddle-holding element 322 along the closed transport path 306.

[0146] The sensors 352A, 352B, 352C, 354A, 354B and 354C are preferably encoders associated to the drives of the transport conveyors 300A, 300B and 300C.

[0147] The controller 16 is connected to the heddles-detection device 14 and receives the signal S14.

[0148] The controller 16 is also connected to the sensors 352A, 352B, 352C, 354A, 354B and 354C and receives from these sensors six control signals S352A, S352B, S352C, S354A, S354B and S354C.

[0149] The controller 16 is also connected to the drives 112, 114, 312A, 312B, 312C, 314A, 314B and 314C, so that it can pilot the movement of the endless belts 108 and 308 respectively along the closed sorting path 106 and along the closed transport path 306. The controller 16 also controls the drives of the heddles-transfer device 26 and of the heddles-discharging device 28.

[0150] The controller 16 includes a processor 16A configured to process information coming from the heddles-detection

device 14 so that it can determine the heddle type, among left heddle and right heddle, from the parameter detected for each heddle by the heddles-detection device 14. The processor 16A can also determine a heddle sequence, that is a succession of heddle types among left heddle and right heddle, from a drawing-in draft. The processor 16Acan also process information from the encoders of the heddles-sorting device 10 and is configured to control the movements of the heddles-sorting conveyor 100 according to the heddle sequence, in such a way that it automatically feeds a correct heddle, namely a left heddle 60L or a right heddle 60R, at the sorting transfer position P2, ready to be transferred to the transport transfer position P3. The controller 16 also includes a memory 16B where a heddle sequence and the configuration of each pair of heddle-support elements 122 are stored.

[0151] A configuration of a pair of heddle-support elements 122 is representative of whether this pair is free, i.e. does not support a heddle 60, whether this pair supports a left heddle 60L or whether this pair supports a right heddle 60R.

[0152] The drawing-in draft defines the heddle sequence with which the heddles shall be brought to the threading position P5 and, from there, to the heddles-receiving module 20. Since duplex heddles 60 are used, the heddle sequence consists of a sequence of left heddles 60L and right heddles 60R, because each support rod 202_k shall be fed with a regular alternation of left and right heddles.

[0153] When a heddle 60 is separated from the heddle stack 6 by the heddles-separating device 8, the controller 16 controls the heddles-sorting device 10 in order to bring a free pair of heddle-support elements 122 into the feeding position P1. A free pair of heddle-support elements 122 is a pair which does not support a heddle. It may also be called an empty pair of heddle-support element. It is devoid of a heddle 60.

[0154] The actual configuration of the pair of heddle-support elements 122, i.e. the fact that it is free or not, is controlled by a non-represented inductive sensor, which senses the position of at least one of the pins 136 of this pair. The position of the pin 136 depends on whether its nail 138 abuts against the end loop 62 of a heddle 60 or against the body 126 of this heddle-support element. This position can be detected by the inductive sensor and the corresponding information also provided to the controller 16.

[0155] At the beginning of the drawing-in process, the default setting for the configuration of the pair of heddle-support elements 122 is equal to "free".

[0156] When a heddle 60 is separated from the stack 6, it is detected by the heddles-detection device 14, which sends to the controller 16 an information, for instance a partial picture of this heddle, included in the signal S14. The controller 16 processes this information in order to determine at least the left or right geometry of this heddle 60.

[0157] When the separated heddle is loaded on the pair of heddle-support elements 122 present at the feeding position P1, the information relating to the fact that this heddle is a left heddle 60L or a right heddle 60R is associated to the location of the pair of support elements 122 along the two belts 108. This information is stored in the memory 16B.

[0158] Therefore, at all time, the controller 16 knows which pairs of heddle-support elements 122 are free, which pairs heddle-support elements 122 support a left heddle 60L and which pairs heddle-support elements 122 support a right heddle 60R. Moreover, the controller 16 knows the position of each pair of heddle-support elements 122 along the sorting path 108.

[0159] During a drawing-in process, the heddles-sorting device 10 is loaded with heddles. In practice, heddles 60 are separated, one by one, from the stack 6 and placed, one by one, in the detection position P4. For each separated heddle 60, a signal S14 is sent to the processor 16A of the controller and the memory 16B is updated with the information contained in, or derived from, the signal S14 about the left or right geometry of this heddle in association with the pair SEi of heddle support-elements 122, with i an integer between 1 and 24, that will be loaded with this heddle : for this pair SEi of heddle support-elements 122, the free configuration is replaced by right heddle 60R or by left heddle 60L. When the heddle is loaded onto the pair SEi of heddle support-elements 122, release means 162 are activated for this pair SEi of heddle support-elements 122.

[0160] As an example, one considers a heddle sequence, starting at a 15^{th} heddle and where the heddles-transport device 12 must provide left and right heddles on different support rods 202_1, 202_2, 202_3 and 202_4 of the heddles-receiving module 20 as specified here below:

```
... ... ... ...
15th heddle : right heddle 60R - support rod 2023
16th heddle : right heddle 60R - support rod 2021
17th heddle : right heddle 60R - support rod 2022
18th heddle : left heddle 60L - support rod 2021
19th heddle : left heddle 60L - support rod 2023
20th heddle : right heddle 60R - support rod 2024
21th heddle : right heddle 60R - support rod 202,
22th heddle : left heddle 60L - support rod 2022
23 ...
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[0161] When the 15^{th} heddle is to be loaded on the heddles-transport device 12, the heddles-sorting device 10 is already loaded with a number of heddles, as shown in table 1 here below where "SE1" to "SE24" represent the twenty four pairs of

heddle-support elements (SE) on the sorting conveyor 100, "60L" represents a left heddle, "60R" represents a right heddle and "FREE" means that no heddle is supported by the corresponding pair SEi of heddle-support elements 122, with i an integer between 1 and 24.

[0162] In this table 1, which corresponds to the information memorized in memory 16B, line P1 identifies a pair SEi of heddle-support elements in the feeding position P1 and line P2 identifies another pair of heddle-support elements 122 in the sorting transfer position P2. In this example, for these positions of the sorting belts 108 on the sorting path 106, these two pairs are respectively SE1 and SE13.

POSITION	SUPPORT ELEMENT	HEDDLE 15
P1	SE1	60L
	SE2	FREE
	SE3	FREE
	SE4	60R
	SE5	60L
	SE6	FREE
	SE7	60R
	SE8	60L
	SE9	FREE
	SE10	60R
	SE11	FREE
	SE12	60L
P2	SE13	60R →FREE
	SE14	60L
	SE15	FREE
	SE16	FREE
	SE17	60R
	SE18	60L
	SE19	60R
	SE20	FREE
	SE21	60L
	SE22	FREE
	SE23	FREE
	SE24	FREE

Table 1

[0163] Starting from the configuration shown here above of the sorting device 10, the following sequence is implemented.

[0164] For the 16th heddle, since a right heddle 60R is needed at the transfer position, SE10 which supports the closest right heddle 60R is brought into the sorting transfer position P2, which brings SE22, which is free, in the feeding position P1, ready for feeding the next heddle onto the sorting device 10. A left heddle 60L is loaded on SE22. The right heddle 60R of SE10 is transferred by the pusher 262 onto the heddle-holding element which is at the transport-transfer position P3. For this transfer, the release means 362 are activated. SE10 is now in free configuration. This is shown in the second and third columns of table 2 here below. The memory 16B is updated for SE10 and SE22.

[0165] This goes on for the next heddles, with the same approach.

[0166] For the 17th heddle, since a right heddle 60R is needed, SE7 could be brought into the sorting transfer position P2 but this would bring SE19 into the feeding position P1, whereas SE19 already supports a right heddle 60R. Alternatively, the controller 16 could select SE17, which supports the second closest right heddle 60R and bring it into the sorting transfer position P2 but this would bring SE5 into the feeding position P1, whereas SE5 already carries a left heddle 60L. Then, the controller 16 selects a third option, where SE4, which supports the third closest right heddle 60R is brought into the sorting transfer position P2 whereas SE16, which is free, is brought into the feeding position P1. This is shown in the fourth and fifth columns of table 2 here below.

[0167] For the 18th heddle, the same strategy is applied. A rotation bringing SE5 into the transfer position could not work since SE17 is already loaded with a right heddle 60R. Then, the controller 16 selects another approach where SE1 is brought into the sorting transfer position P2 and SE13, which is free, is brought into the feeding position P1. This is shown in the sixth and seventh columns of table 2 here below.

[0168] This is summarized in the table 2 here below, which also covers the 19th heddle, in its eighth and ninth columns.

POSITION	SUPPORT ELEMENT	HEDDLE 16 →60R	SUPPORT ELEMENT	HEDDLE 17 →60R	SUPPORT ELEMENT	HEDDLE 18 →60L	SUPPORT ELEMENT	HEDDLE 19 →60L
P1	SE22	FREE→60L	SE16	FREE→60R	SE13	FREE→60R	SE10	FREE→60L
	SE23	FREE	SE17	60R	SE14	60L	SE11	FREE
	SE24	FREE	SE18	60L	SE15	FREE	SE12	60L
	SE1	60L	SE19	60R	SE16	60R	SE13	60R
	SE2	FREE	SE20	FREE	SE17	60R	SE14	60L
	SE3	FREE	SE21	60L	SE18	60L	SE15	FREE
	SE4	60R	SE22	60L	SE19	60R	SE16	60R
	SE5	60L	SE23	FREE	SE20	FREE	SE17	60R
	SE6	FREE	SE24	FREE	SE21	60L	SE18	60L
	SE7	60R	SE1	60L	SE22	60L	SE19	60R
	SE8	60L	SE2	FREE	SE23	FREE	SE20	FREE
	SE9	FREE	SE3	FREE	SE24	FREE	SE21	60L
P2	SE10	60R →FREE	SE4	60R→FREE	SE1	60L→FREE	SE22	60L→FREE
	SE11	FREE	SE5	60L	SE2	FREE	SE23	FREE
	SE12	60L	SE6	FREE	SE3	FREE	SE24	FREE
	SE13	FREE	SE7	60R	SE4	FREE	SE1	FREE
	SE14	60L	SE8	60L	SE5	60L	SE2	FREE
	SE15	FREE	SE9	FREE	SE6	FREE	SE3	FREE
	SE16	FREE	SE10	FREE	SE7	60R	SE4	FREE
	SE17	60R	SE11	FREE	SE8	60L	SE5	60L
	SE18	60L	SE12	60L	SE9	FREE	SE6	FREE
	SE19	60R	SE13	FREE	SE10	FREE	SE7	60R
	SE20	FREE	SE14	60L	SE11	FREE	SE8	60L
	SE21	60L	SE15	FREE	SE12	60L	SE9	FREE

Table 2

[0169] This goes on for the next heddles, with the same approach.

[0170] With this process, the heddle-transport device 12 has been successively loaded and has fed the receiving module 20 with the predetermined heddle sequence.

[0171] Refering to the example given above, the 15th right heddle 60R has been transported by a pair of heddle-holding elements 322 onto the threading position P5, drawn-in with a warp yarn when at the threading position P5, and then transported onto the discharge position P6 corresponding to the support rod 202_3 in which the pusher 282 has pushed the 15th right heddle onto the support rod 202_3. The 16th right heddle 60R has been has been transported by another pair of heddle-holding elements 322, which was adjacent to the pair which has transported the 15th heddle, onto the threading position P5, drawn-in with a warp yarn when at the threading position P5, and then transported onto the discharge position P6 corresponding to the support rod 202, in which the pusher 282 has pushed the 16th right heddle onto the support rod 202_1

[0172] This shows that the controller 16 can apply a strategy in order to selectively bring one pair SEi of heddle-support element 122 at the sorting transfer position P2, while making sure that the opposite pair of heddle-support elements, SEi+12 or SEi-12, is free, so that it can be brought to the feeding position P1 to be loaded with a heddle 60.

[0173] As a summary, the heddle sequence states the type of the next heddle needed at the sorting transfer position P2 and the controller 16 synchronically drives the sorting belts 108 in order to move into the sorting transfer position P2 the heddle with the correct heddle type, i.e. a left or right heddle, which is the closest from the transfer position along the closed sorting path 106, regardless of the direction A1 of movement along the sorting path 106, at the condition that this movement of the sorting conveyor 100 also brings a free pair of heddle-support elements 122 at the feeding position P1. If not, the controller 16 controls the heddles-sorting device 10 to move the second closest heddle of the right type into the sorting transfer position P2, at the condition that this also brings a free pair of heddle-support elements 122 at the feeding position P1. This can be iterated until a correct configuration of the sorting conveyor 100 is reached. In other words, if, from the configuration of the heddles 60 on the heddle-support elements 122 of the heddle sorting device 10, at least two different movements of the sorting conveyor 100 are possible to place a free heddle-support element 122 in the feeding position P1, and, at the same time, a heddle-support element 122, supporting a heddle whose detected parameter corresponds to the predetermined heddle type depending on the heddle sequence in the sorting transfer position P2, then the controller 16 controls movement of the sorting conveyor 100 to place, at the sorting transfer position P2, the heddle-support element 122 holding a heddle whose detected parameter corresponds to the type of heddle needed by the heddle sequence and being the closest to the sorting transfer position P2.If two movements of same amplitude are possible, i.e. if two equal

displacements of two heddles 60L or 60R of the selected type are possible, a main direction of displacement can be selected by the controller 16.

[0174] If the movement of any correct heddle present on the sorting device 10 into the sorting transfer position P2 doesn't bring a free pair of heddle-support elements 122 at the feeding position P1, the controller 16 synchronically drives the sorting belts 108 in order to move the correct heddle which is the closest from the transfer position along the closed sorting path 106 and during transfer of this heddle onto the transport device 12, no heddle is loaded onto the sorting device at the feeding position P1.

[0175] This optimization of the movements of the pairs SEi of heddle-support elements 122 is possible because the controller 16 knows from its memory 16B and in real time for each pair SEi of heddle-support elements 122 where this pair SEi is along the path, if it is free, if it supports a left heddle 60L or if it supports a right heddle 60R and because movements of the sorting conveyor 100 in both directions is possible, as shown by arrow A1.

[0176] As a summary, the method explained here above includes at least the following steps consisting in:

a) moving the heddle-support elements 122 of the sorting device 10 along the sorting path 106 up to placing a free heddle-support element at a feeding position P1;
b) separating a heddle 60 from the at least one stack 6;
c) detecting a parameter representative of the geometry of the heddle, the parameter differing depending on whether the heddle is a left heddle or a right heddle;
d) feeding the free heddle-support element 122 located at the feeding position P1 with the heddle, at the feeding position P1;
e) moving the heddle-support elements 122 of the heddles-sorting device along the sorting path 106 in order to place, in the sorting transfer position P2, a heddle-support element holding a heddle whose detected parameter corresponds to a predetermined value, the predetermined value depending on the heddle sequence; and
f) moving the heddle out of the heddle-support element 122 located at the sorting transfer position P2 onto a heddle-holding element 322 of the heddles-transport device 12 located at a transport transfer position P3.

[0177] The order of the steps a) to f) is not imperative. For instance, step b) and/or c) can occur before step a). For instance, step c) can occur before or after step b). Preferably the end of step a) occurs at the same moment as the end of step e).In other words, steps a) and e) end at the same moment.

[0178] In the present description, HEAi, designate pairs of heddle-holding elements (HE) of the first conveyor 300A, HEBi, designate pairs of heddle-holding elements of the second conveyor 300B and HECi designate pairs of heddle-holding elements of the third conveyor 300A, with i an integer between 1 and 3. A pair HEAi includes the upper heddle-holding element 322Ai, a pair HEBi includes the upper heddle-holding element 322Bi and a pair HECi includes the upper heddle-holding element 322Ci, with i an integer between 1 and 3.

[0179] When a pair HEAi of heddle-holding elements 322 has been loaded with a heddle 60 in the transport transfer position P3, then it can be moved by the two belts of the first conveyor 300A into a waiting position located in the first waiting zone, as shown on figure 1 for the pair HEA1 including the upper heddle-holding element 322A1.

[0180] This waiting position is determined in view of the discharge position P6 chosen for another pair of holding elements moved by the same conveyor 300A, namely the pair HEA2 including the upper heddle-holding element 322A2, which is in the first discharge position P6, aligned with the first support rod 202_1.

[0181] On the other hand, from the first waiting zone, all pairs HEAi, HEBi and HECi of heddle-holding elements 322 are successively moved to the threading position P5. As mentioned here-above, when one such pair is in this position, another pair moved by the same conveyor is in the transport transfer position P3, ready to be loaded with a heddle 60.

[0182] After a heddle 60 carried by one pair of heddle-holding elements 322 has be threaded at the threading position P5, it is moved in one of the discharge positions P6, depending on the drawing-in draft.

[0183] Then, one of the two pushers 282 and 284 is used to push the heddle out of the pair of heddle-holding elements 322 onto one of the support rods 202 aligned with the discharge position P6 where this pair of heddle-holding elements has been stopped.

[0184] Once it has been discharged from its heddle 60, each pair HEAi, HEBi or HECi of heddle-holding elements 322 moves into the second waiting zone. From the second waiting zone, it is brought back into the transport transfer position P3, when a new heddle 60 must be transferred on this pair of heddle-holding elements.

[0185] The respective movements and stops of the pairs HEAi, HEBi or HECi of heddle-holding elements 322 along the closed transport path 306 is controlled by the controller 16 which commands the drives 312A, 312B, 312C, 314A, 314B, 314C. For each transport conveyor 300A, 300B or 300C, these movements between two stops along the closed transport path 306 can vary in amplitude, acceleration and speed.

[0186] Advantageously, these drives are actuated at the same time, so that all endless belts 308 are moved at the same time. Thus, the transport conveyors 300A, 300B and 300C move and stop at the same time, which reduces the risks of collision between the different pairs of heddle-holding elements.

[0187] The amplitude and speed of the movements of each pair of endless belts 308 of a same transport conveyor 300A, 300B or 300C depend on the position of each belt along the closed transport path 306. For instance, a longer movement is needed if a heddle 60 needs to be brought in front of the last discharge position P6 than if it needs to be brought in front of the first discharge position. At any time, the movements of the transport conveyors 300A, 300B and 300C may have different speeds and accelerations.

[0188] Advantageously, to reduce the amplitude of the accelerations of each belt, after a heddle 60 carried by one pair of heddle-holding elements 322 has be threaded at the threading position P5, depending on the drawing-in draft and the discharge position of this heddle 60, it is moved in one of the discharge positions P6 of the first discharge subzone DZ1, where it is unloaded by the pusher 282, or at the tenth discharge position P6, where it waits for further movement before unloading. This pair of heddle-holding elements 322 is then respectively moved at the twentieth discharge position P6, where it waits for further movement, or in one of the discharge positions P6 of the second discharge subzone DZ2, where it is unloaded by the pusher 284. Thus, a pair of heddle-holding elements 322 can be at one of the discharge positions P6 without activation of the pusher 282 corresponding to this discharge positions P6.

[0189] Since a pair of heddle-holding elements 322 is present at the transport transfer position P3 when another pair of heddle-holding elements is present at the threading position P5, threading and transfer occur substantially at the same time for two pairs of heddle-holding elements carried by the same conveyor.

[0190] Because of the alternation of the pairs of heddle-holding elements along the closed transport path 306, even if the endless belts of the respective transport conveyors 300A, 300B and 300C can be separately driven, their movement must take into consideration the position of the other endless belts, more particularly of the pairs of heddle-holding elements 322 carried by these other belts.

[0191] In view of the distribution of the positions P3, P5 and P6 along the closed transport path 306, each pair of endless belts 308 of one conveyor can carry two heddles 60 at the same time, one of these heddles being loaded on the pair of heddle-holding elements located at the transport transfer position P3 or waiting in the first waiting zone, whereas the second heddle is carried by the pair of heddle-holding elements located at the threading position P5 or ready to discharge in one of the discharge positions P6.

[0192] According to an advantageous aspect of the invention, the distance between the endless belts 108 of the upper sorting conveyor portion 102 and the lower sorting conveyor portion 104 along the reference axis Z is adjustable in order to adapt to different heddle lengths. With this respect, no part of the frame 120 of the heddles-sorting device 10 is located between these upper and lower sorting conveyor portions 102 and 104, so that nothing hinders a vertical relative movement between these portions. In particular, an upper frame of the heddles-sorting device 10, which is a part of the frame 120 supporting the upper sorting conveyor portion 102, and a lower frame of the sorting device 10, which is also a part of same the frame 120 supporting the lower sorting conveyor portion 104, are not connected by mechanical links within the volume located between the upper sorting conveyor portion 102 and the lower sorting conveyor portion 104.

[0193] According to another advantageous aspect of the invention, the distance between the endless belts 308 of the upper conveyor portion 302A, 302B and 302C, on the one hand, and the endless belts 308 of the lower conveyor portion 304A, 304B and 304C, along the reference axis Z is also adjustable in order to adapt to different heddle lengths. With this respect, no part of the frame 320 of the heddles-transport device 12 is located between these upper and lower portions 302A, 302B, 302C, 304A, 304B and 304C, so that nothing hinders a vertical relative movement between these portions. In particular, an upper frame of the heddles-transport device 12, which is a part of the frame 320 supporting the upper conveyor portions 302A, 302B and 302C, and a lower frame of the sorting device 10, which is also a part of the same frame 320 supporting the lower conveyor portions 304A, 304B and 304C, are not connected by mechanical links within the volume located between the upper conveyor portion 302A, 302B and 302C and the lower conveyor portion 304A, 304B and 304C.

[0194] In the second embodiment of the invention represented on figures 11 and 12, components of the heddle module 30 and of the drawing-in machine 2 of the invention similar to the ones of the first embodiment bear the same references. If a reference is mentioned in this description with respect to the second embodiment without being shown on figures 11 and 12 or if a reference is shown on these figures without being mentioned in the description for the second embodiment, it corresponds to the element with the same reference for the first embodiment. On figures 11 and 12, for the sake of clarity, upper and lower heddle-holding elements 322 are shown without any hold heddles.

[0195] Hereafter, one lists mainly the differences between the first and second embodiments.

[0196] In this second embodiment, the heddles-transport device 12 does not include three transport conveyors but only one transport conveyor 300 with a unique upper portion having a unique upper endless belt 308 and a unique lower portion having a unique endless belt 308. Each endless belt 308 carries heddle-holding elements 322, which are not identical to the heddle-support elements 122 of the heddles-sorting device 10, which is the same as the heddles sorting device of the first embodiment and not further described.

[0197] Upper and lower heddle-holding elements 322 are defined as in the first embodiment. The number of upper heddle-holding elements 322 of the unique conveyor 300 is the same as the number of lower heddle-holding elements 322 of this conveyor. The upper and lower heddle-holding elements 322 are identical, but for their orientation along the

reference Z axis. The upper and lower heddle-holding elements 322 form pairs of heddle-holding elements.

[0198] The heddle-holding elements 322 each include a body 326, a pin 336, a nail 338 and a spring 340 for urging the pin into a default position.

[0199] The single conveyor 300 of the heddles-transport device 12 defines a closed transport path 306 for the heddle-holding elements 322. It can be made according to the teachings of WO92/05303A1.

[0200] In this second embodiment, the heddle-holding elements 322 are secured side by side along the closed transport path 306 followed by the two belts 308 of the upper and lower portions of the transport conveyor 300.

[0201] For the rest, the controller 16 controls the heddles-sorting device 10 as explained for the first embodiment.

[0202] In a non-represented variant of the invention, instead of belts, the sorting conveyor 100 can be a rotating carousel with several heddle-support elements at the end of several arms driven by a rotating head.

[0203] In another non-represented variant of the invention, the heddles-sorting device 10 can include several sorting conveyors 100 covering different sorting paths, which implies that the heddles-sorting device 10 serves several sorting transfer positions P2, preferably two sorting transfer positions P2, and that the heddle module 30 comprises several transport transfer positions P3, preferably two transport transfer positions P3.

[0204] In another non-represented variant of the invention, provided that the heddle-support elements 122 firmly grip the heddles 60, the sorting conveyor 100 of the heddles-sorting device 10 has a single portion, not an upper portion and a lower portion. This variant can make use of the pistons mentioned in WO00/11252A1.

[0205] In still another variant, the heddles-sorting device 10 can be provided with several sorting conveyors or several pairs of sorting belts, for instance superimposed sorting belts whose heddle-support elements move along the same sorting path, each sorting belt transporting at least a heddle different from the heddles transported by the other transport sorting belts, each sorting belt carrying several heddle-support elements that are spaced along the sorting path, the heddle-support elements of the several sorting belts being preferably alternately distributed along the sorting path.

[0206] In all embodiments, the heddles-detection device 14 can be used to detect improper heddles 60, for instance heddles with an important wear, simplex heddles, deformed heddles, etc. Such improper heddles can be eliminated by the sorting device 10, so that they are not transferred to the heddles-transport device 12. In particular, the closed sorting path 106 can pass at an ejection position, which is not a transfer position. When an improper heddle is at the ejection position, some non-represented ejection means, in particular a specific pusher, can be actuated to eject the improper heddle out of the sorting belts 108.

[0207] In all embodiments, the number of support rods 202 or pairs of support rods 202 equipping the receiving module 20 depends on the configuration of the heddles-receiving module 20 and of the pattern for the fabric to be woven on the loom. For instance, the heddles-receiving module 20 can be equipped with less than twenty pairs of support rods 202, for instance sixteen or twelve twenty pairs of support rods 202.

[0208] This ejection position can also be used to discharge all heddles carried on the sorting conveyor 100 before changing the type of heddles to be processed, for instance before changing the length of the heddles of the stack 6 and the vertical distance between the upper and lower conveyor portions 102 and 104.

[0209] In another variant of the invention, several magazines can be used in the heddles-feeding device 4. In such a case, several feeding positions are provided on the closed sorting path 106 and several heddles-separating devices 8 are used. This brings the advantage that feeding of the heddles-sorting device 10 is not interrupted when the operator supplies a new stack 6 of heddles 60 to one magazine. This configuration can also be used to selectively feed two heddles at the same time on the sorting conveyor 100 or to feed one heddle at a time, at one of the two feeding positions.

[0210] According to a non-represented variant of the invention, the heddles-detection device 14 has a field of view 144, which covers at least the first heddle of the stack 6, which means that the heddles-detection device 14 detects if the heddle is a right heddle or a left heddle before the heddle is separated from the stack 6.

[0211] According to a non-represented variant of the invention, the heddles-detection device 14 has a field of view 144, which covers heddles supported by several pairs of heddle-support elements 122 around or next to the sorting transfer position P2. This information allows the controller 16 to determine the closest heddle 60 corresponding to the type of heddle to be transferred onto the heddles-transport device 12, in accordance with the heddle sequence. Then, the controller 16 can drive the sorting conveyor 100 to bring this specific heddle 60L or 60R into the sorting transfer position P2. With this approach, there is no need to memorize the type of heddle of each pair Sei of heddle-support elements 122 of the sorting device 10. With this approach, several detection cameras 142 or sensors can be used in the heddles-detection device 14.

[0212] In another non represented variant of the invention, the closed transport path 306 includes several threading positions P5, each heddle being threaded only once at one of these several threading positions P5.

[0213] In another non represented variant of the invention, the heddle sorting device 10 can feed a heddle transport device as described in FR2930950A1.

[0214] Advantageously, the field of view of the heddles-detection device 14 covers heddles 60 before a separated heddle is transferred from the sorting transfer position P2 to the transport transfer position P3.

[0215] Instead of a camera, the heddles-detection device 14 can incorporate a light barrier or a proximity sensor

configured to derive a different information from the heddles, depending on the left or right geometry of each heddle.

[0216] In another non-represented variant of the invention, two sorting transfer positions can be provided on the sorting device 10 and two corresponding transport transfer positions can be provided on the heddles-transport device 12. In such a case, the closed sorting path 106 of the sorting conveyor 100 is straight between these two sorting transfer positions and, for each endless belt 108 of the sorting conveyor 100, when one heddle-support element 122 is at the feeding position P1, another heddle-support element is at the first sorting transfer position and still another heddle-support element 122 is at the second transfer position. This allows optimizing the time needed to load the heddles-transport device 12 with heddles.

[0217] In addition to the type of a heddle, left or right, the heddles-detection device 14 can detect several heddle parameters that may impact its drawing-in capabilities. These parameters can be memorized and used for controlling the heddles-transport device 12 and/or the thread-insertion device 18. For example, the position of the eyelet 64 along a heddle can be used to adjust the height position of the heddle at the threading position P5. This information can be provided to the main controller of the drawing-in machine 2 or to a specific controller driving the different devices of the drawing-in machine.

[0218] In all embodiments of the invention, the time period during which each holding element 322 stays at the threading position P5 can be adapted to the warp thread to be inserted into the harness component held by the holding element. For instance, the insertion can take longer for a coarse warp yarn than for a thin warp yarn. The succession of left and right heddles at the threading position P5 during a drawing-in process corresponds to the heddle sequence.

[0219] In all embodiments, the heddles are preferably transported at substantially the same height level along the reference axis Z, when they are on the sorting device 10, and at substantially the same height level along the reference axis Z, when they are on the transport device 12. The dropwires are preferably transported at substantially the same height level along the reference axis Z, when they are on the transport device 12.

[0220] In all embodiments, some additional sensors, for example proximity switches or cameras, may be used to check the presence or absence of harness components on the harness component-holding elements or of heddles on the heddle-support elements.

[0221] Reducing the interspace between the holding elements 322 in the waiting zone between the transport transfer position P3 and the threading position P5 allows a quick movement of the holding elements between these positions, thus a longer time can be spent at the threading position P5, for this threading operation.

[0222] Alternatively, the waiting zones for the holding elements 322 can be provided just after the transport transfer position P3, and not just before, and after the threading position P5, and not before.

[0223] The warp threads that are drawn-in through the heddles can come from a warp beam or from a bobbin.

[0224] The above-mentioned embodiments and variants of the invention can be combined within the scope of the invention defined by the appended claims.

[0225] Irrespective of the embodiment or variant of the invention, the invention brings at least the following advantages:

- The heddles-sorting device 10 can be used to automatically feed the heddles-transport device 12 with the correct heddle sequence, starting with a single stack 6 of duplex heddles or from several stacks of duplex heddles. This avoids the obligation of separating heddles into right heddles and left heddles before installing the stack of heddles on the heddles-feeding device 4 of the drawing-in machine. The complexity of the drawing-in machine is reduced, since only one heddles-separating device is required.
- The closed sorting path 106 and the memorization in the controller 16 of the heddle type and of the presence or absence of a heddle on a pair SEi of heddle-support elements 122 allows optimizing movements of the sorting conveyor 100 in both directions represented by the double arrow A1. The time for feeding each heddle 60 at the sorting transfer position P2 is reduced. Moreover, the regular distribution of the heddle-support elements 122 on the endless belts 108 allows placing one pair of heddle-support elements 122 at the feeding position P1 and one pair of heddle-support elements 122 at the sorting transfer position P2, at the same time.
- The closed sorting path 106 and the layout of the heddles-sorting device 10 with several heddle-support elements 122 interposed between the feeding position P1 and the sorting transfer position P2 gives more possibilities to ensure that, amongst the several heddles supported by the sorting conveyor 100, a heddle of the type needed by the sequence can be placed at the sorting transfer position P2 at the same time as a free pair of heddle-support elements 122 is based at the feeding position P1.
- The construction of the sorting conveyor 100 with endless members formed by belts 108 is simple and allows using a high number of heddle-support elements 122 in a reduced volume.
- The oblong closed path 106 does not substantially increase the size of the drawing-in machine 2 in a direction parallel to the reference axis Y.
- Since the number of heddle-support elements 122 on each belt 108 is greater than the number of support rods 202 of the heddles-receiving module 20, the risk of not having, on the sorting conveyor 100, a heddle with the geometry needed is reduced. This is important since, otherwise, this would force the operator to eject some heddles out of the sorting conveyor 100 for freeing some pairs of heddle-support elements 122 and getting new heddles 60 on the

heddles-sorting device 10.

- The absence of mechanical link between upper and lower frames of the heddles-sorting device 10 within the volume between upper and lower conveyor portions allows easy access for the operator to any heddle 60 carried by the pair of sorting belts 108 and does not hinder height adjustment between the upper and lower heddle-support elements 122.

Claims

1. A heddle module (30) for a drawing-in machine (2), said heddle module comprising

- a heddles-feeding device (4) where heddles are provided in the form of at least one stack (6);
- a heddles-separating device (8) configured to separate one heddle from the at least one stack;
- a heddles-transport device (12), configured to move heddles (60) according to a predetermined heddle sequence corresponding to a succession of heddle types among left heddle (60L) and right heddle (60R), from at least one transport transfer position (P3) to a threading position (P5), where a thread is inserted into the transported heddle;

characterized in that the heddle module (30) also comprises

- a heddles-sorting device (10) including at least one sorting conveyor (100) equipped with several heddle-support elements (122) adjacent to each other along a sorting path (106), each heddle-support element being configured to hold one separated heddle and to move the separated heddle (60) from at least one feeding position (P1) to at least one sorting transfer position (P2) along the sorting path;
- a heddles-transfer device (26) for transferring a separated heddle (60) out of at least one heddle-support element (122) located at the at least one sorting transfer position (P2) onto the heddles-transport device (12) at the at least one transport transfer position (P3);
- a heddles-detection device (14) configured to detect at least one parameter of a heddle, before the heddle is transferred by the heddles-transfer device (26), the parameter being different depending on whether the heddle is a left heddle (60L) or a right heddle (60R);
- a controller (16) connected at least to the heddles-detection device (14) and to the heddles-sorting device (10) and configured to determine the heddle type from the parameter detected for a heddle by the heddles-detection device (14) and to command the heddles-sorting device (10) to move a heddle (60) carried by the sorting conveyor (100) to the sorting transfer position (P2) according to the heddle type for this heddle and according to the predetermined heddle sequence;

and **in that** the heddles-separating device (8) is interposed between the heddles-feeding device (4) and the sorting conveyor (100) and configured to bring the separated heddle (60) into engagement with at least one heddle-support element (122) in the at least one feeding position (P1).

2. The heddle module of claim 1, wherein the sorting path is a closed sorting path (106), wherein the heddle-support elements (122) that are adjacent to each other along the closed sorting path (106) are regularly distributed along the closed sorting path and wherein, when a first heddle-support element (122) is at the feeding position (P1), a second heddle-support element (122) is at the sorting transfer position (P2) and at least one heddle-support element (122) is located between the first and second heddle-support elements (122), on both sides of the first heddle-support element (122) along the closed sorting path (106).

3. The heddle module of one of the preceding claims, wherein each sorting conveyor (100) includes at least one endless member (108) movably arranged around a frame (120) of the heddles-sorting device (10) and on which the several adjacent heddle-support elements (122) are secured, and wherein at least one drive (112, 114) of the sorting conveyor drives a driving wheel (118) in engagement with the endless member for moving the heddle-support elements (122) of the respective endless member (108) along the sorting path (106).

4. The heddle module of claim 3, wherein, when it is arranged around the frame (120) of the heddles-sorting device (10), the endless member (108) has an elongated shape with two opposite long straight sides and with its longest dimension perpendicular to a longitudinal axis (Y) of the heddles-feeding device (4) and wherein the at least one feeding position (P1) and the at least one sorting transfer position (P2) are respectively arranged on the two opposite long straight sides of the endless member (108).

5. The heddle module of one of claims 3 and 4, wherein the endless member is a belt (108) and wherein each heddle-support element (122) includes a recess (126A) where an external protrusion of the belt is received and is secured to the belt (108) by a screw (124) screwed in the external protrusion.

6. The heddle module of one of the preceding claims, wherein each heddle-support element (122) has upper and lower guiding members (128, 130) configured to cooperate with guiding rails (120A, 120B) of the frame (120) of the heddles-sorting device (10), the rails extending parallel to at least a portion of the sorting path (106).

7. The heddle module of one of the preceding claims, wherein the controller (16) includes a memory (16B) for storing value of the parameter detected by the heddle-detection device (14) or a heddle type information derived from this parameter for each heddle (60) carried by the sorting conveyor (100) in relation to the at least one heddle-support element (122) supporting this heddle.

8. The heddle module of one of the preceding claims, wherein the heddles-transfer device (26) includes at least one motorized pusher (262) housed in the frame (120) of the heddles-sorting device (10) and configured to push a heddle (60) out of the at least one heddle-support element (122) located at the at least one sorting transfer position (P2) into the at least one transport transfer position (P3).

9. The heddle module of one of the preceding claims, wherein the heddles-detection device (14) includes a camera (142) oriented to aim at a zone around an eyelet (64) of the heddle (60) when the heddle is in a detection position (P4).

10. The heddle module of one of the preceding claims, wherein

- each heddle-support element (122) is equipped with a first nail (138);
- the heddles-transport device (12) includes at least one transport conveyor (300A, 300B, 300C; 300) equipped with several heddle-holding elements (322) spaced along a transport path (306);
- each heddle-holding element is equipped with a second nail (338); and
- a first nail (138) of a heddle-support element (122) located at the sorting transfer position (P2) and a second nail (338) of a heddle-holding element (322) located at the transport transfer position (P3) are aligned along a direction parallel to the longitudinal axis (A60) of a heddle, the first nail and the second nail being adapted to penetrate into the same end loop (62) of the heddle when the heddle is transferred by the heddles-transfer device (26) from the sorting transfer position (P2) to the transport transfer position (P3).

11. The heddle module of one of the preceding claims, wherein

- the sorting conveyor (100) includes an upper sorting conveyor portion (102) and a lower sorting conveyor portion (104);
- the upper sorting conveyor portion (102) is arranged on an upper frame of the heddles-sorting device (10) and equipped with several heddle-support elements (122), each adapted to interact with an upper end loop (62) of a heddle;
- the lower sorting conveyor portion (104) is arranged on a lower frame of the heddles-sorting device and equipped with several heddle-support members (122), each adapted to interact with a lower end loop of a heddle;
- a heddle-support element (122) of the upper sorting conveyor portion (102) and a heddle-support element (122) of the lower sorting conveyor portion (102) form a pair of heddle-support elements cooperating with the same heddle (60);
- the heddles-sorting device (10) comprises several pairs of heddle-support elements (122) that are spaced and movable along the sorting path (106); and
- an upper drive (112) of the upper sorting conveyor portion (102) and a lower drive (114) of the lower sorting conveyor portion (114) are synchronized by the controller.

12. A drawing-in machine (2) for drawing-in warp threads into harness components for a loom, wherein said drawing-in machine comprises

- a heddle module (30) according to any preceding claim;
- a thread-insertion device (18) for inserting a warp thread through a heddle (60) located at the threading position (P5); and
- a heddles-receiving module (20) comprising several adjacent heddle-support rods (202);

wherein the heddles-transport device (12) of the heddle module (30) is configured to move heddles (60) according

to the predetermined heddle sequence from the at least one transport transfer position (P3) to one of several discharge positions (P6), where each transported heddle can be transferred out of the heddles-transport device (12) onto the heddles-receiving module (20), each heddle-support rod facing one of the several discharge positions (P6),
and wherein the number of heddle-support elements (122) that can hold different heddles on the heddles-sorting device (10) is strictly larger than the number of discharge positions (P6).

13. A method for feeding heddles (60) to a heddles-transport device (12) of a heddle module (30) of a drawing-in machine, according to a heddle sequence corresponding to a succession of heddle types among left and right heddles and prior to inserting a thread in this heddle, wherein

- said method is implemented with a heddles-sorting device (10) equipped with several heddle-support elements (122) spaced along a sorting path (106) of the heddles-sorting device and co-moved along the sorting path (106) and with a heddles-feeding device (4) in which heddles are provided in the form of at least one stack (6) of left and right heddles;
- each heddle-support element is configured to hold one heddle (60);
- the heddles-sorting device (10) is configured to move several heddles at the same time along the sorting path;
- both left and right heddles (60L, 60R) can be transferred between the sorting transfer position and the transport transfer position; and
- the method includes at least the following steps consisting in:

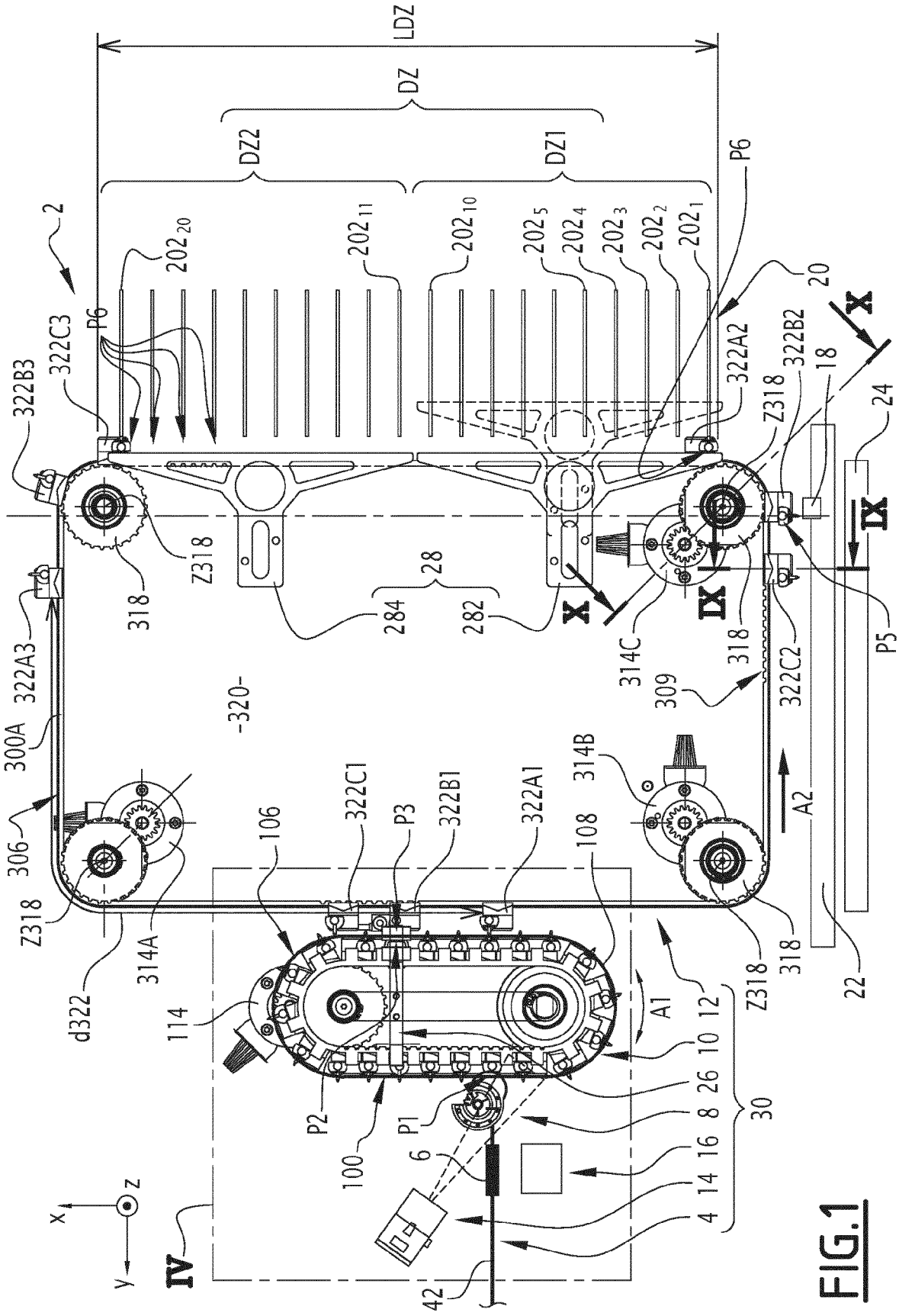
a) moving the heddle-support elements (122) of the sorting device (10) along the sorting path (106) up to placing a free heddle-support element at a feeding position (P1);
b) separating a heddle (60) from the at least one stack (6);
c) detecting a parameter representative of the geometry of the heddle, the parameter differing depending on whether the heddle is a left heddle or a right heddle;
d) feeding the free heddle-support element (122) located at the feeding position (P1) with a heddle, at the feeding position (P1);
e) moving the heddle-support elements (122) of the heddles-sorting device along the sorting path (106) in order to place, in the sorting transfer position (P2), a heddle-support element holding a heddle whose detected parameter corresponds to a predetermined value, the predetermined value depending on the heddle sequence; and
f) moving the heddle out of the heddle-support element (122) located at the sorting transfer position (P2) onto a heddle-holding element (322) of the heddles-transport device (12) located at a transport transfer position (P3).

14. The method of claim 13, wherein the method includes at least the following steps consisting in :

g) memorizing (16B) for each heddle-support element (122) of the heddles-sorting device if a heddle is held or if the heddle-support element (122) is free; and
h) if a heddle is held by a heddle-support element, memorizing (16B), for this heddle-support element, the parameter detected at step c) for this heddle or another parameter representative of the left or right type of this heddle.

15. The method of one of claims 13 and 14, wherein

- the sorting path is a closed sorting path (106); and/or
- during steps a) and e), a movement (A1) of the heddle-support elements (122) is possible in both directions along the closed sorting path.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DZ
DZ2
DZ1
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202_{11}
202_{10}
202_5
202_4
202_3
202_2
202_1
P6
322C3
322B3
322A2
322B2
20
18
24
X
IX
Z318
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284
28
282
314C
309
322C2
P5
322A3
300A
-320-
306
322C1
P3
322B1
322A1
314B
106
108
A2
314A
d322
114
A1
12
10
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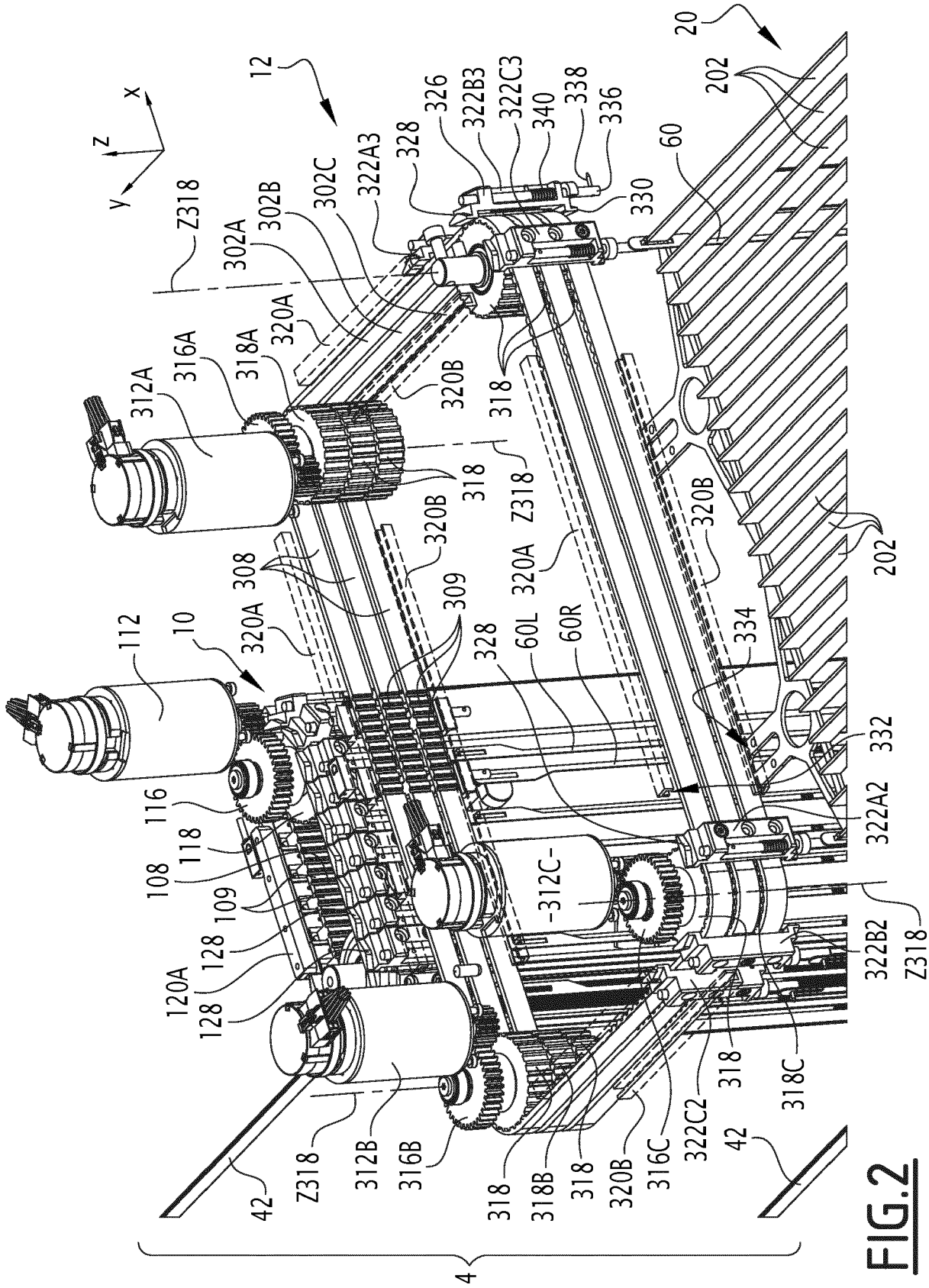
P2
P1
100
6
16
14
4
42
IV
z
x
y
22

FIG.1


4
42
Z318
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320B
316C
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322A2
332
334
60L
60R
328
309
308
320A
10
112
116
118
108
109
128
120A
128
312C
320B
318
Z318
320A
320B
202
202
20
12
Z318
302A
302B
302C
322A3
328
326
322B3
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x
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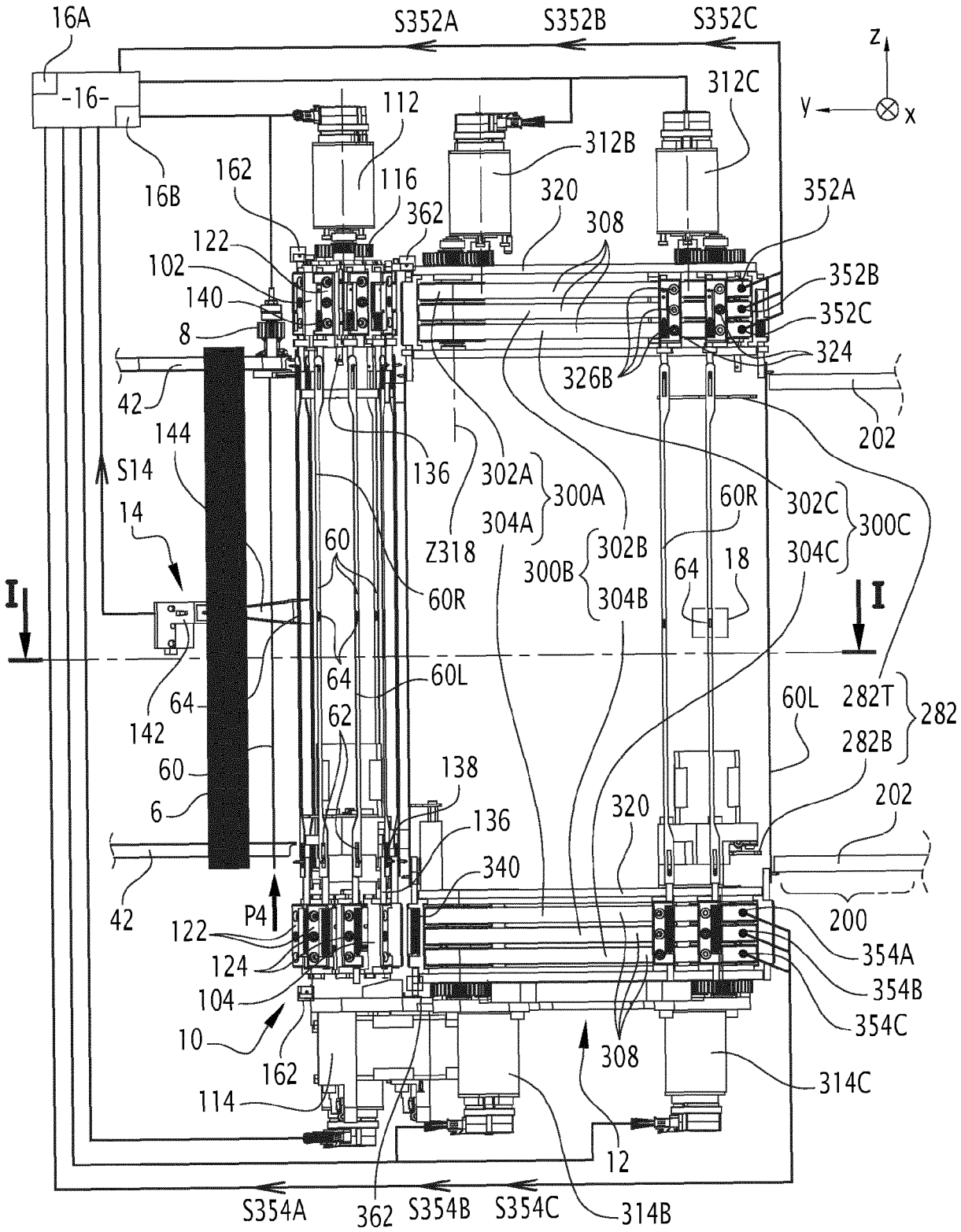
y

FIG.2


16A
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S352C
z
y
x
-16-
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112
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312B
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352A
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308
122
102
140
8
352B
352C
324
326B
42
144
202
S14
136
302A
300A
60R
302C
300C
14
Z318
304A
60
302B
304C
300B
64
18
I
I
60R
64
60L
64
142
62
60L
282T
282
282B
60
138
202
6
320
136
340
42
P4
200
122
354A
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S354B
S354C
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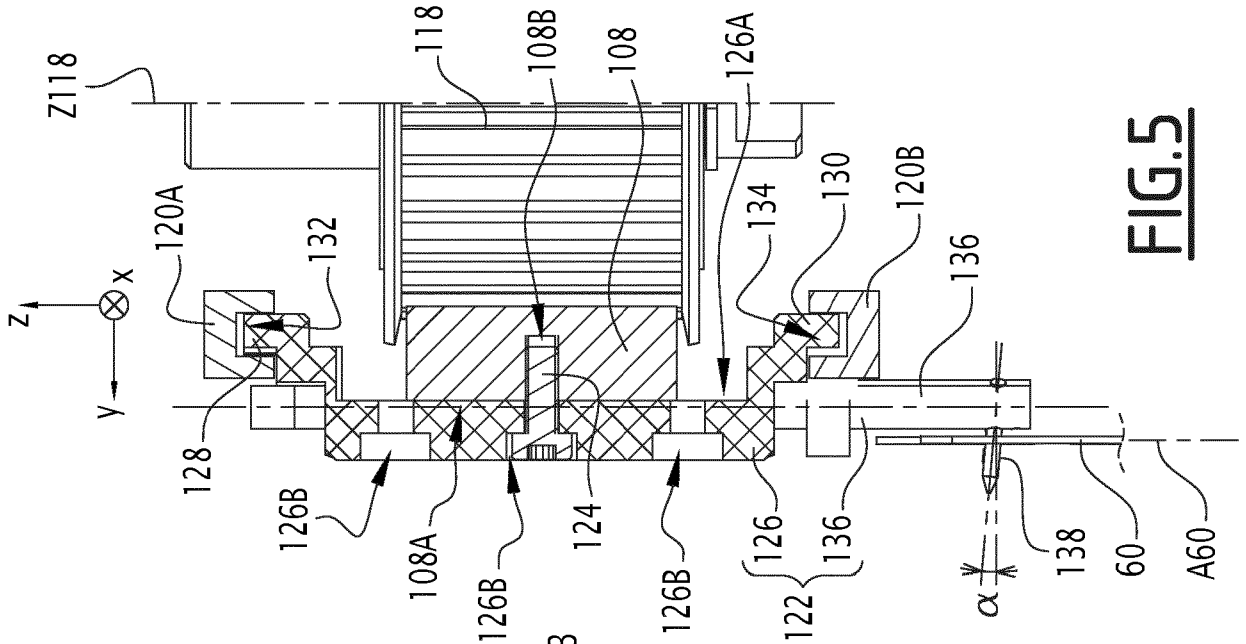
FIG.3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108A
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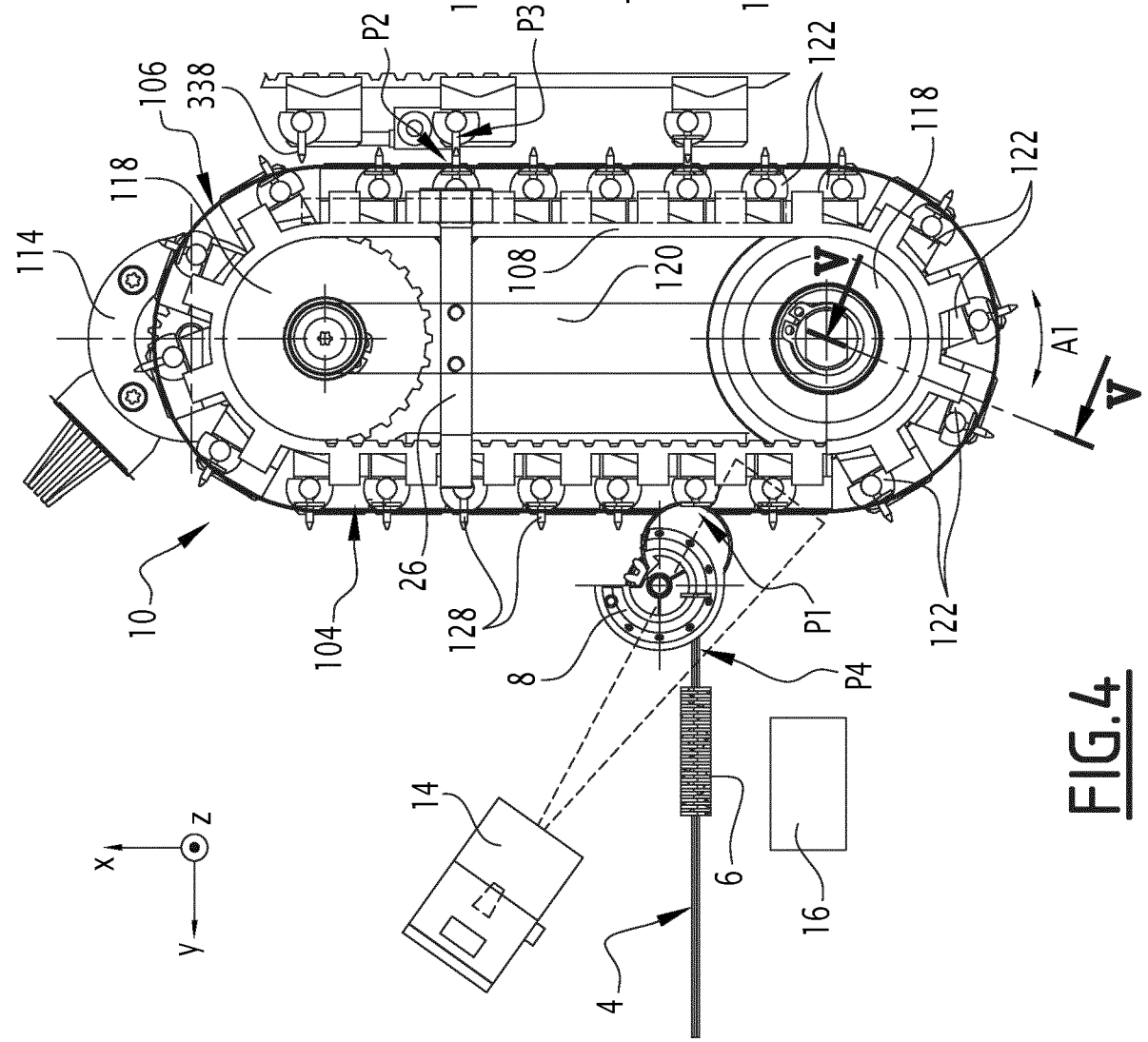
126
136
122
α
138
60
A60

FIG.5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P3
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106
338
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122
114
108
120
V
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A1
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26
128
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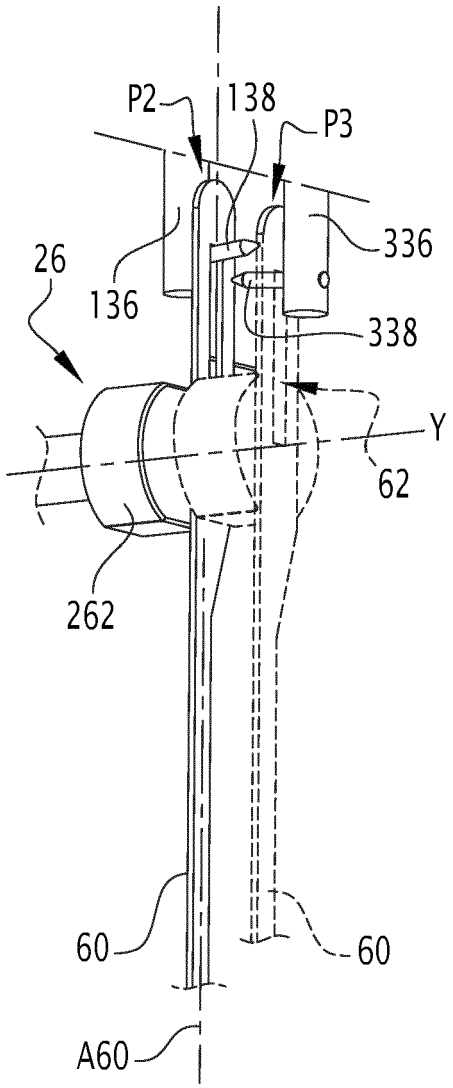
P1
P4
122
14
6
16
4
x
z
y

FIG.4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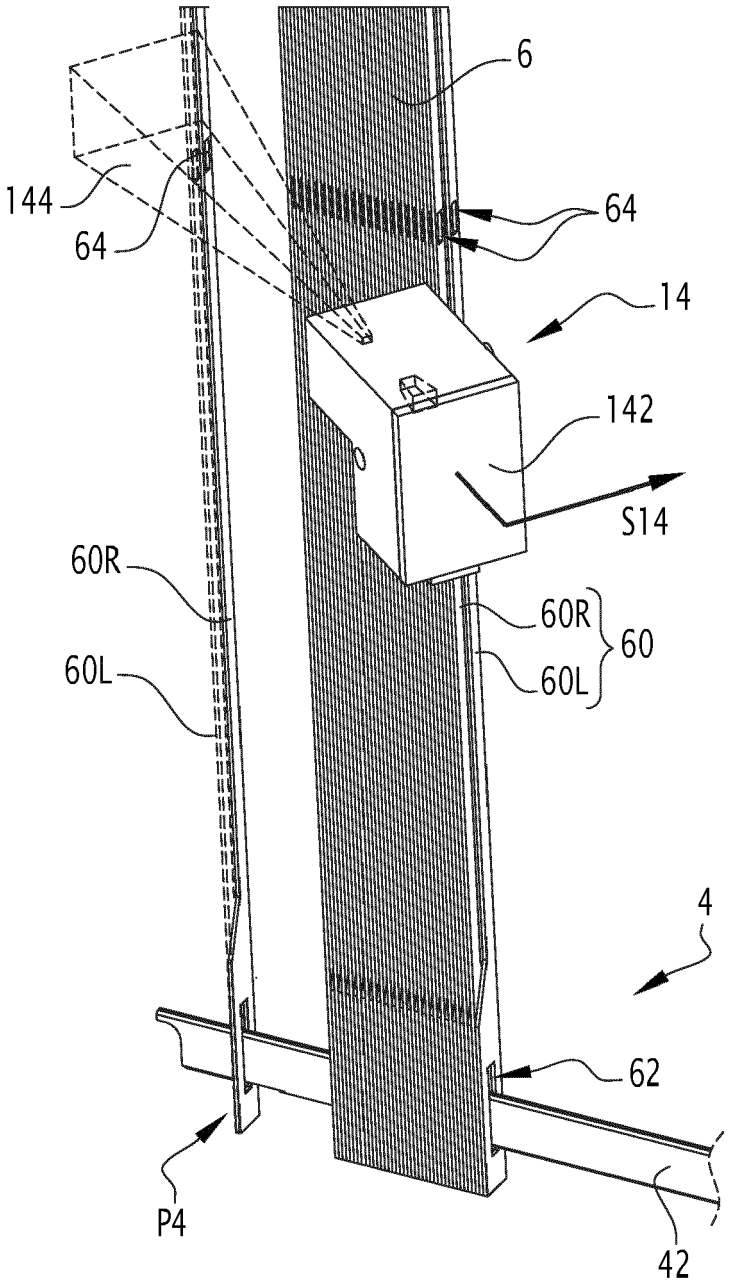
26
136
338
Y
62
262
60
60
A60

FIG.6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144
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14
142
S14
60R
60R
60
60L
60L
4
62
P4
42

FIG.7

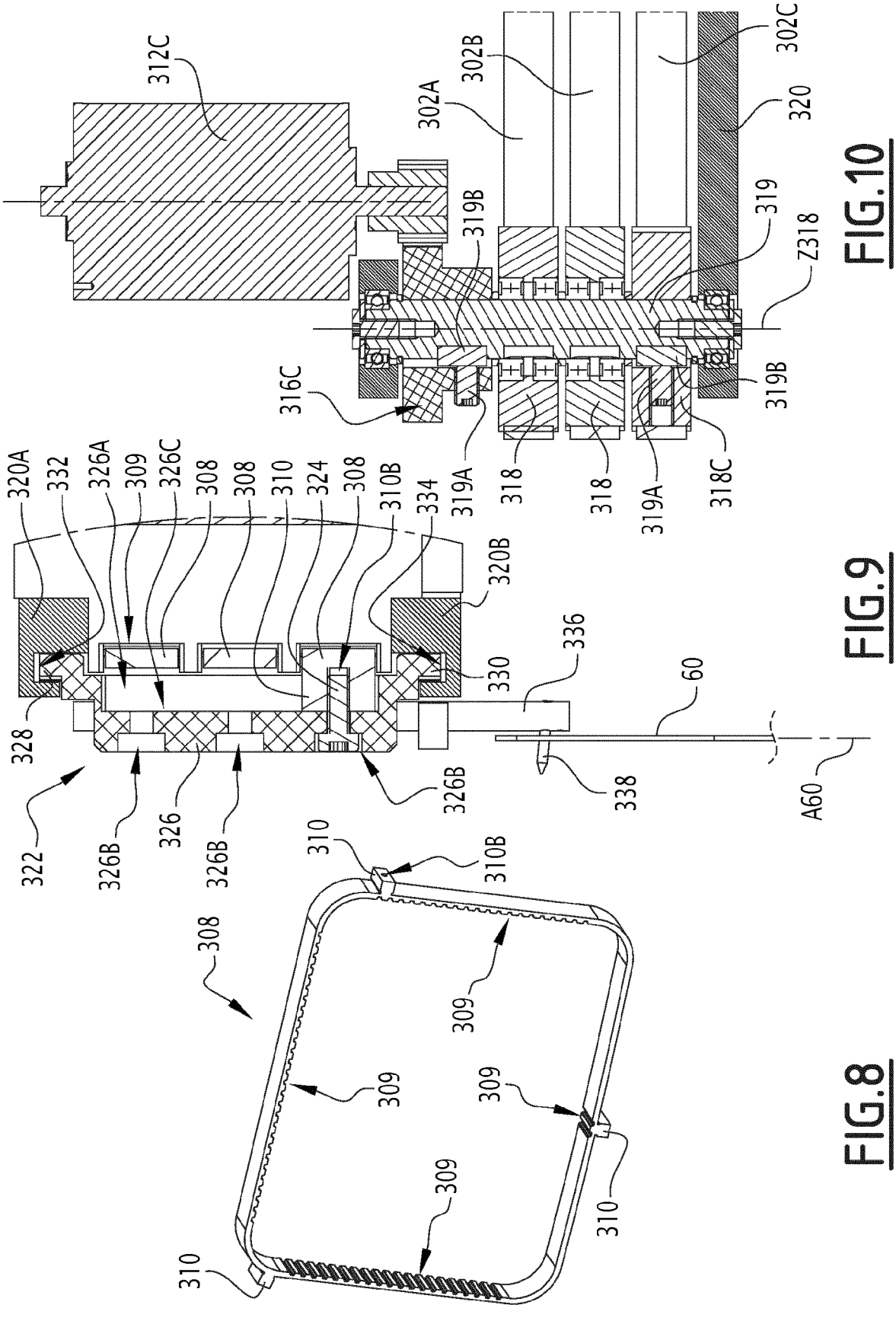
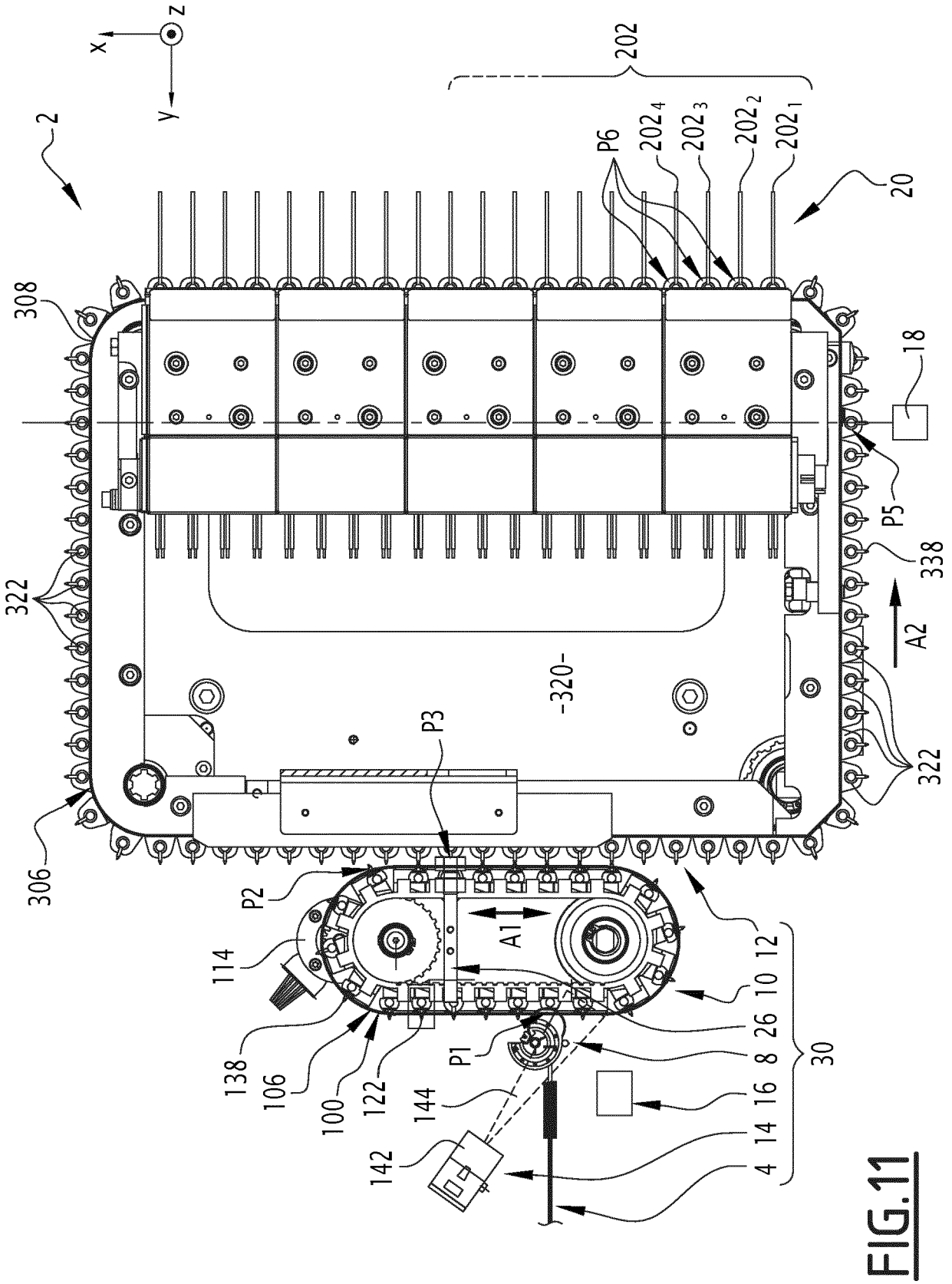


FIG.10

FIG.9

FIG.8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338
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P3
306
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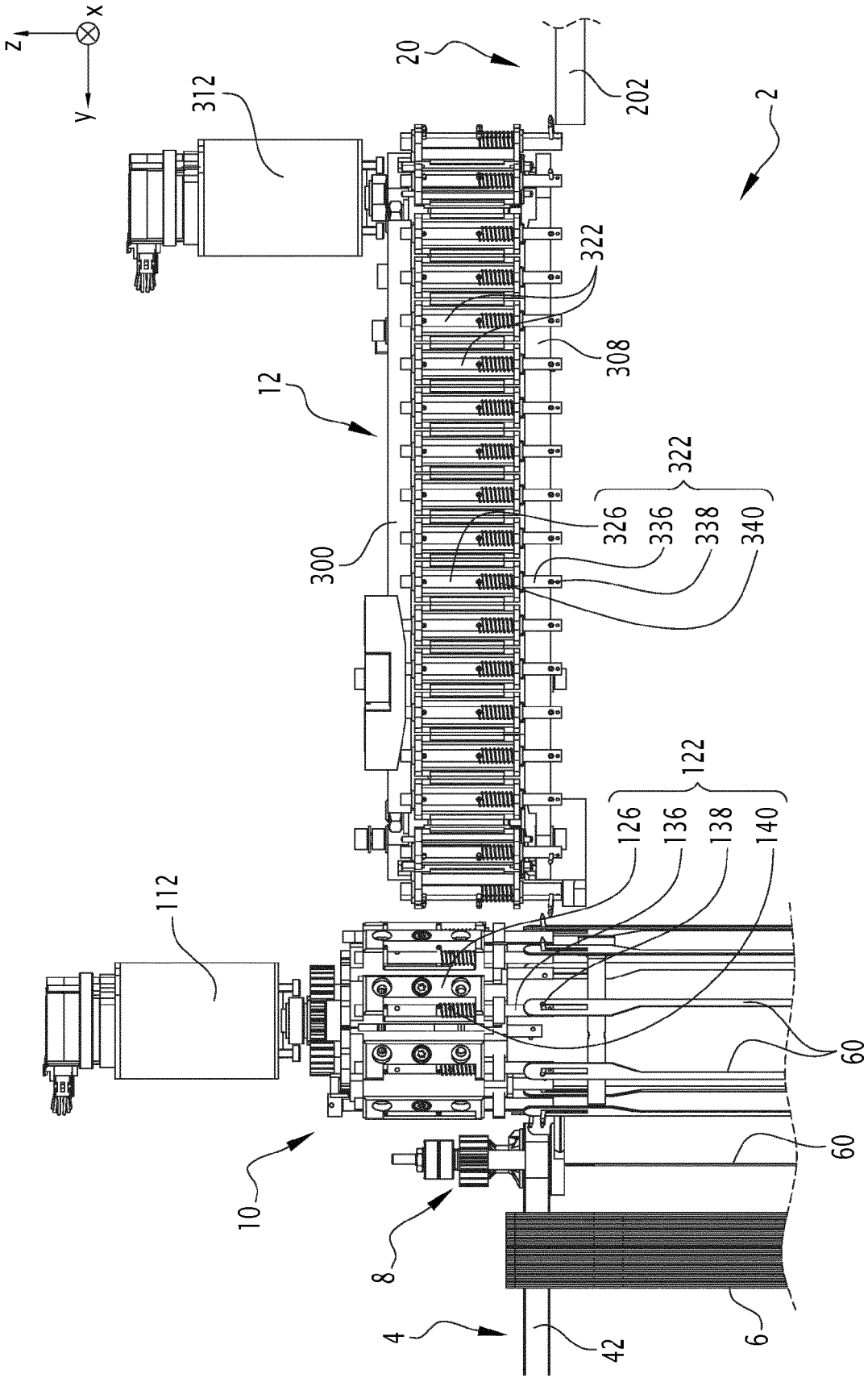
30
138
106
100
122
144
16
142
14
4
P1

FIG.11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202
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12
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122
126
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140
112
60
60
10
8
4
42
6

FIG.12

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EUROPEAN SEARCH REPORT

Application Number
EP 23 17 7705

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 5 274 894 A (WILHELM HANS [CH] ET AL) 4 January 1994 (1994-01-04) * abstract * * claims 1, 2, 6, 7, 10 * * figures 1-7 * * column 1, line 1 - line 39 * * column 1, line 42 - line 57 * * column 2, line 11 - line 26 * * column 2, line 41 - column 3, line 7 * * column 4, line 21 - line 31 * * column 6, line 1 - line 19 * * column 7, line 36 - column 8, line 2 * * column 8, line 26 - line 65 * * column 9, line 21 - line 32 * * column 9, line 41 - line 43 * * column 16, line 50 - column 17, line 4 *	1-15	INV. D03J1/14
A,D	WO 00/11252 A1 (STAEUBLI AG PFAEFFIKON [CH]; KOBLER FELIX [CH] ET AL.) 2 March 2000 (2000-03-02) * abstract * * claims 1, 7-17 * * figures 1-4 * * page 1, line 5 - line 11 * * page 2, line 29 - page 3, line 2 * * page 4, line 17 - page 5, line 14 * * page 5, line 29 - page 6, line 11 * * page 7, line 1 - line 26 * * page 11, line 20 - line 30 * * page 14, line 14 - page 15, line 1 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) D03J D02H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 November 2023	Heinzelmann, Eric

CATEGORY OF CITED DOCUMENTS

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09-11-2023

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