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(54) CLAMPING DEVICE FOR A DRAWING-IN MACHINE, DRAWING-IN MACHINE INCLUDING SUCH A CLAMPING DEVICE AND CORRESPONDING DRAWING-IN METHOD

(57) This clamping device comprises a frame structure (10) movable along a longitudinal direction with respect to a drawing-in unit of a drawing-in machine, a first clamping rail (20A) and a second clamping rail for clamping a first yarn layer (L1), secured with the frame structure (10) along the longitudinal direction, a third clamping rail (22A) and a fourth clamping rail for clamping a second yarn layer (L2), connected to the frame structure (10) through a slide link (88) and movable with respect to the frame structure (10) along the longitudinal direction (LD). A switch element (100) longitudinally secured to the third clamping rail (22A) is movable between a first position, where it longitudinally secures the third clamping rail to the first clamping rail (20A), and a second position, where it allows a relative longitudinal movement of the third clamping rail relative to the first clamping rail and does not cooperate neither with the frame structure nor with the first and second clamping rails.

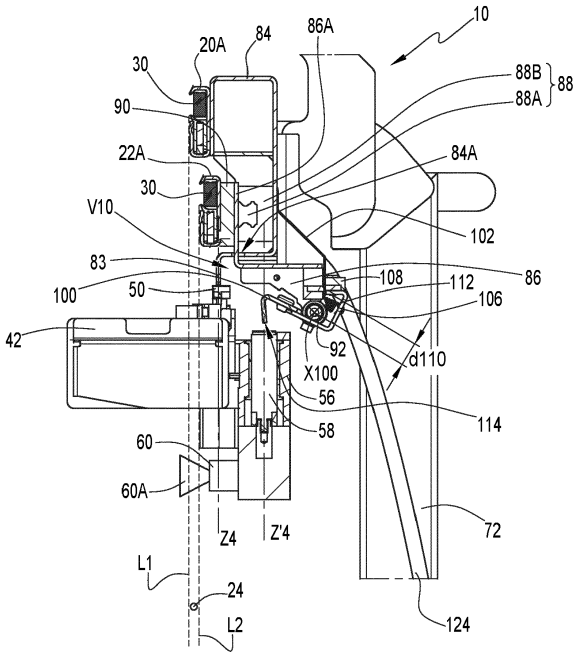

FIG.9

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Description

[0001] The present invention relates to a clamping device for a drawing-in machine. The present invention also relates to a drawing-in machine including, amongst others, such a clamping device and to a drawing-in method for drawing-in, in a drawing-in machine, two yarn layers clamped on a clamping device.

BACKGROUNG OF THE INVENTION

[0002] The technical field of the invention is the one of drawing-in equipment and methods used for the preparation of equipment for weaving looms.

[0003] In this technical field, it is known to automatically draw-in warp yarns into a harness with yarns being alternatively separated, according to a drawing-in pattern, from two separate yarn layers. The harness generally includes heddles and sometimes includes dropwires and a reed. For example, the drawing-in pattern requires the drawing-in sequence to occur with ten yarns of the first layer, then fifty yarns of the second layer, then twenty-five yarns of the first layer, etc.

[0004] A single separation device can be used for alternately separating yarns of the first yarn layer and yarns of the second yarn layer, according to the drawing-in pattern. In such a case, when one layer shall be selected, the one layer must be correctly placed relative to the separation device and the other layer shall be spread away from the separation device, in order to enable the yarn separation. Yarns separation must occur when the selected layer faces the separation device along a longitudinal direction and its front-most yarn is within a separation range that the yarn separation device can reach.

[0005] A consequence of the use of a single separation device is that the two layers must move along the longitudinal direction and relative to one another at appropriate times during the drawing-in process. This movement is sometimes called layer compensation.

[0006] Such a drawing-in sequence can be implemented with the drawing-in machine known from EP4033020A1, which operates satisfactorily. In this known drawing-in machine, a first yarn layer is clamped in first upper and lower clamping rails fixed relative to a structure of a clamping device. The clamping device includes a layer compensation device, with an upper adjusting device and a lower adjusting device for individually moving, with respect to a frame structure, respectively an upper second clamping rail and a lower second clamping rail configured to clamp a second yarn layer. The layer compensation device is manually driven and its operation requires time, for a period during which the working process should be stopped. Moreover, compensation can be different for the top and bottom rails.

[0007] In case the clamping device moves in a preparation room during the drawing-in process, there is a risk that the movable second clamping rails slightly longitudinally move with regard to the frame structure and with regard to each other, which involves more frequent layer compensation and some yarn separation errors.

[0008] Thus, there is a need for a clamping device and a drawing-in machine allowing an automatic and optimized layer compensation for two layers.

SUMMARY OF THE INVENTION

[0009] The present invention aims at addressing the above mentioned issue by providing an optimized clamping device, which allows high drawing-in performances via automatic adjustment of each of two yarn layers with respect to a separation device of a drawing-in unit in a drawing-in machine.

[0010] With this respect, the present invention relates to a clamping device for a drawing-in machine, the clamping device being configured to clamp a first yarn layer and a second yarn layer and comprising

- a frame structure movable along a longitudinal direction with respect to a drawing-in unit of the drawing-in machine;
- a first pair of clamping rails for clamping the first yarn layer, the first pair of clamping rails comprising a first clamping rail and a second clamping rail which are secured with the frame structure, along the longitudinal direction;
- a second pair of clamping rails for clamping the second yarn layer, the second pair of clamping rails comprising a third clamping rail and a fourth clamping rail which are connected to the frame structure through a slide link so that the third and the fourth clamping rails are movable with respect to the frame structure along the longitudinal direction.

According to the invention, the clamping device includes a switch element longitudinally secured to the third clamping rail and movable with respect to the frame structure between

- a first position, where the switch element cooperates with the frame structure or with the first clamping rail to longitudinally secure the third clamping rail to the first clamping rail; and
- a second position, where the switch element allows a relative movement, along the longitudinal direction, of the third clamping rail relative to the first clamping rail and where the switch element does not cooperate neither with the frame structure nor with the first pair of clamping rails.

[0011] Thanks to the invention, the switch element allows the clamping device to work into different configurations. In the first configuration corresponding to the first position of the switch element, the second clamping rail is longitudinally secured with the first clamping rail, so that the two yarn layers clamped in these two clamping

rails can be moved together along the longitudinal direction relative to the drawing-in unit. This allows adjusting the position of the two yarn layers with respect to the yarn selection device at the same time, in particular for working phases of a drawing-in method using the clamping device. In the second configuration of the clamping device, which corresponds to the second position of the switch element, one of the first and second clamping rails can be moved along the longitudinal direction without moving the other clamping rail, which allows adjusting the position of one only of the two yarn layers with respect to the yarn selection device and adjusting the position of the first yarn layer relative to the second yarn layer, for an offset compensation phase.

[0012] According to further advantageous aspects of the invention, this clamping device might incorporate one or several of the following features, taken in any technically compatible configuration:

- The switch element rotates relative to the frame structure and relative to the third clamping rail between its first position and its second position, around an axis of rotation, the axis of rotation being preferably parallel to the longitudinal direction.
- At least a guiding bearing is secured to the third clamping rail so as to guide the switch element in rotation, between its first position and its second position, around the axis of rotation.
- The clamping device is equipped with at least one elastic return member, in particular a spring, which urges the switch element toward its first position.
- The switch element includes a gripping surface, preferably a toothed gripping surface, configured to cooperate with the drawing-in unit when the switch element is in its second position and the gripping surface of the switch element extends on a longitudinal gripping length, which is at least as long as a longitudinal clamping length of the third clamping rail.
- In the first position of the switch element, a clutch surface of the switch element cooperates, preferably by friction, with the frame structure to longitudinally secure the switch element with respect to the frame structure, wherein the clutch surface extends on a longitudinal clutch length which is strictly smaller than the longitudinal clamping length of the third clamping rail and wherein the clutch surface covers a longitudinal level of a mid-point of the longitudinal clamping length, this midpoint being situated, along the longitudinal direction, halfway between two longitudinal ends of the third clamping rail.
- The frame structure includes a driving surface, in particular a toothed driving surface;
- The driving surface is configured to cooperate with a layer transport device which belongs to the drawing-in unit, for a relative longitudinal movement between the frame structure and the drawing-in unit;
- At least one bracket longitudinally secures the switch element to the third clamping rail;
- Each bracket extends through an elongated hole of the frame structure so that the switch element is located on a side of the driving surface opposite to the first yarn layer and to the second yarn layer along a lateral direction extending perpendicular to the yarn layers.
- The clamping device includes a transmission member, in particular a cable, whose ends are respectively fixed on the third clamping rail and on the fourth clamping rail for synchronizing their movements with respect to the frame structure, along the longitudinal direction; and the transmission member is deformable to adapt to an adjustment of a relative position of the third clamping rail and the fourth clamping rail in a direction perpendicular to the longitudinal direction.
- The frame structure is pivotally mounted on a truck of the clamping device equipped with wheels for moving the truck on a ground surface.

[0013] According to a second aspect, the invention relates to a drawing-in machine including

- a clamping device according to any one of the previous claims;
- a drawing-in unit equipped with
    - ◦ a unit frame;
    - ◦ a layer selection device configured to select one yarn layer amongst a first yarn layer and a second yarn layer clamped on the clamping device;
    - ◦ a yarn separation device configured to separate yarns of the yarn layer selected by the layer selection device;
- a layer transport device configured to cause a relative longitudinal movement of the frame structure of the clamping device with respect to the unit frame;
- a layer compensation device including a part movable with respect to the frame structure of the clamping device and configured to move the switch element at least from its first position to its second position;
- a controller controlling at least the layer selection device, the yarn separation device, the layer transport device and the layer compensation device;

whereas, in the second position of the switch element, the switch element is secured, along the longitudinal direction, with the unit frame of the drawing-in unit.

[0014] This drawing in machine provides the same advantages as the clamping device of the invention. Moreover, since the drawing-in unit and the switch element are longitudinally secured together when the switch element is in its second position, the longitudinal position of the switch element, and of any component longitudinally fixed with this switch element along the longitudinal

direction, is precisely controlled.

[0015] Advantageously,

- the drawing-in unit includes the layer compensation device;
- the movable part of the layer compensation device is movable relative to the unit frame of the drawing-in unit, only in a direction, perpendicular to the longitudinal direction, between an inactive position and an active position;
- in its active position, the movable part of the layer compensation device cooperates with the switch element and is secured, along the longitudinal direction, with the switch element, the switch element being in its second position;
- in its inactive position, the movable part of the layer compensation device does not cooperate with the clamping device.

[0016] According to advantageous aspects of the invention,

- the drawing-in machine includes a yarn detection device, preferably a camera, configured to detect a front-most yarn of the selected yarn layer;
- the yarn detection device is connected to the controller;
- the controller is configured to determine a longitudinal position of the front-most yarn of the selected yarn layer relative to the unit frame, based on an output signal of the yarn detection device; and
- the drawing-in machine includes a memory for storing an information about the longitudinal position of the front-most yarn in relation with the yarn layer to which the front-most yarn belongs.

[0017] According to another advantageous aspect of the invention, the third clamping rail is closer to the yarn separation device than the fourth clamping rail.

[0018] According to a third aspect, the invention also relates to a drawing-in method for drawing-in, in a drawing-in machine, a first yarn layer and a second yarn layer clamped on a clamping device of the drawing-in machine, the clamping device including

- a frame structure movable along a longitudinal direction with respect to a drawing-in unit of the drawing-in machine;
- a first pair of clamping rails for clamping the first yarn layer, the first pair of clamping rails comprising a first clamping rail and a second clamping rail which are secured with the frame structure, along the longitudinal direction;
- a second pair of clamping rails for clamping the second yarn layer, the second pair of clamping rails comprising a third clamping rail and a fourth clamping rail which are connected to the frame structure so that the third and the fourth clamping rails are movable with respect to the frame structure along the longitudinal direction;

the drawing-in unit including

- a unit frame;
- a layer selection device configured to select one yarn layer, amongst the two first and second yarn layers, from which yarns are to be separated;
- a yarn separation device configured to separate yarns of the yarn layer selected by the layer selection device;

the drawing-in machine including a controller for controlling at least the layer selection device and the yarn separation device;

the drawing-in method comprising at least an alternation of working phases and of offset compensation phases;

whereas, during each working phase, the first clamping rail of the first pair of clamping rails and the third clamping rail of the second pair of clamping rails are moved together relative to the unit frame along the longitudinal direction;

wherein

- a working phase includes at least the following steps consisting in:

  a) securing, along the longitudinal direction, the third clamping rail to the first clamping rail or to the frame structure so that there is no possibility of longitudinal relative movement between the first clamping rail and the third clamping rail;

  b) with the layer selection device, selecting the yarn layer from which yarns are to be separated by the yarn separation device and unselecting the other yarn layer;

- an offset compensation phase includes at least the following steps consisting in:

  c) allowing a longitudinal movement of the third clamping rail relative to the first clamping rail and to the frame structure and securing the third clamping rail with the unit frame of the drawing-in unit in the longitudinal direction; and

  d) moving the first clamping rail relative to the unit frame along the longitudinal direction to adjust a longitudinal distance between a front-most yarn of the first yarn layer and a front-most yarn of the second layer.

[0019] Owing to the method of the invention, the two pairs of clamping rails can be used to longitudinally move the first and second yarn layers, either together or one at a time, to allow working phases and offset compensation phases to occur when necessary.

[0020] According to further advantageous aspects of the invention, this method might incorporate one or several of the following features, taken in any technically compatible configuration.

- the drawing-in unit comprises a yarn detection device configured to detect a longitudinal position of the front-most yarn of the selected yarn layer relative to the unit frame;
- the working phase includes at least additional steps implemented before step b) and consisting in:

  e) memorizing a last longitudinal position of the front-most yarn of each yarn layer relative to the unit frame before this yarn layer is unselected, this last position depending on an output signal of the yarn detection device;
  f) computing an offset between the two yarn layers, based on the last memorized longitudinal position of the front-most yarn of each yarn layer,
  g) comparing the offset computed at step f) to a predetermined value; and
  h) if the result of step g) is that the offset computed at step f) is larger than the predetermined value, stopping the working phase and launching the offset compensation phase.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The invention will be better understood, based on the following description given as non-limiting example and made in reference to the following figures:

- Figure 1 is a perspective view of a drawing-in machine according to the invention which includes, amongst others, a clamping device according to the invention and a drawing-in unit;
- Figure 2 is a front view of some parts of the clamping device represented on figure 1 and of some parts of a drawing-in unit;
- Figure 3 is an enlarged view of detail III on figure 2;
- Figure 4 is a side view of the parts of the clamping device and some parts of the drawing-in unit, in the direction of arrow IV on figure 2;
- Figure 5 is a back view of the parts of the clamping device;
- Figure 6 is an enlarged view of detail VI on figure 5;
- Figure 7 is a perspective rear view of the frame structure;
- Figure 8 is an enlarged view of detail 8 on figure 7;
- Figure 9 is a detailed transverse cut view at the level of plane IX-IX on figure 2, when a switch element is in a first position;
- [Fig.10] Figure 10 is a detailed transverse cut view similar to figure 9, when the switch element is in a second position.
- [Fig.11] Figure 11 is a partial front view, in the direction of arrow XI on figure 10.

DETAILED DESCRIPTION OF SOME EMBODIMENTS

[0022] The drawing-in machine 2 represented on figure 1 includes a drawing-in unit 4, represented schematically by its outer envelope in axle lines, and a clamping device 6.

[0023] Some parts of the drawing-in unit 4 are represented on figures 2 to 4 and 9 to 11.

[0024] A main unit frame 42 of the drawing-in unit 4 is stationary on a ground surface GS, in a drawing-in room where drawing-in takes place. The unit frame 42 is partly visible on figures 2 and 3. The drawing-in unit 4 comprises a single yarn separation device 5 represented on figure 4 only, a non-represented heddle separation device, a non-represented heddle transport device, a non-represented reed transport device and a non-represented threading device. Optionally, the drawing-in machine also includes a non-represented drop-wire separation device a non-represented drop-wire transport device.

[0025] LD denotes a longitudinal direction of the clamping device 6. Hereafter, "longitudinal" and "longitudinally" refer to a movement parallel to the longitudinal direction LD. A longitudinal position is a position along the longitudinal direction LD.

[0026] The yarn separation device 5 can be a longitudinally movable vacuum gripper, as the one described in WO02/088445A2.

[0027] Alternatively, the yarn separation device is of another type.

[0028] This yarn separation device 5 is configured to separate a front-most yarn from a selected yarn layer, when this front-most yarn is within a separation range defined with respect to the unit frame 42 of the drawing-in unit 4.

[0029] During the drawing-in process implemented with the drawing-in machine 2, the drawing-in unit 4 and a yarn layer selected on the clamping device 6 are moved relative to each other along the longitudinal direction LD.

[0030] In the embodiment of the figures, since the main frame of the drawing-in unit 4 is stationary, the clamping device 6 is moved on the ground surface GS along the longitudinal direction LD.

[0031] The clamping device 6 comprises a movable truck 8 and a frame structure 10, pivotally mounted on the truck 8, around an axis of rotation X6 parallel to the longitudinal direction LD of the clamping device 6.

[0032] The truck 8 is equipped with wheels 12, which allow the displacement of the clamping device 6 in the drawing-in room, on the ground surface GS, in particular along the longitudinal direction LD.

[0033] The frame structure 10 is formed by two vertical posts 70 and 72 and two longitudinal crossbeams 74 and 76.

[0034] The frame structure 10 is equipped with plates 14 for anchoring the frame structure 10 on pins 16 of the truck 8 when the frame structure 10 extends in a vertical

plane for the drawing-in process.

[0035] The clamping device 6, more particularly its frame structure 10, is configured to hold a first yarn layer L1 and a second yarn layer L2 ready for being used by the yarn separation device 5. For the sake of simplicity, the yarn layers L1 and L2 are partially represented on figure 1 and represented on figures 4 and 9, in dotted lines.

[0036] Figures 4 and 9 also show a layer cord 24 interposed between the two yarn layers L1 and L2. The layer cord 24 extends parallel to the longitudinal direction LD and separates the yarns of the first yarn layer L1 from the yarns of the second yarn layer L2.

[0037] The clamping device 6 includes a first pair 20 of two clamping rails, namely a first upper clamping rail 20A and a first lower clamping rail 20B for the clamping of the first yarn layer L1. The warp yarns of yarn layer L1 extend, between the first upper clamping rail 20A and the first lower clamping rail 20B for drawing-in, along a vertical direction. These yarns are adjacent to one another along the longitudinal direction LD. A front-most yarn FY1 of yarn layer L1 is the warp yarn situated at the edge of the yarn layer L1, on yarn separation device side along the longitudinal direction LD.

[0038] The clamping device 6 also includes a second pair 22 of two clamping rails, namely a second upper clamping rail 22A and a second lower clamping rail 22B for the clamping of the second yarn layer L2. The warp yarns of yarn layer L2 extend, between the second upper clamping rail 22A and the second lower clamping rail 22B for drawing-in, along a vertical direction. These yarns are adjacent to one another along the longitudinal direction LD. A front-most yarn FY2 of yarn layer L2 is the warp yarn situated at the edge of the yarn layer L2, on yarn separation device side along the longitudinal direction LD.

[0039] The clamping rails 20A, 20B, 22A and 22B are respectively a first clamping rail, a second clamping rail, a third clamping rail and a fourth clamping rail of the clamping device 6.

[0040] On figures 1 to 3, the yarn separation device side is on the left of each yarn layer.

[0041] The second upper clamping rail 22A and second lower clamping rail 22B are situated between the first upper clamping rail 20A and the first lower clamping rail 20B in a vertical direction.

[0042] When clamped in the corresponding pair of clamping rails, each layer L1, L2 extends in a vertical plane.

[0043] Each clamping rail is configured with a longitudinal internal clamping volume to accommodate a clamping bar 30 for clamping yarns of one yarn layer, L1 or L2 in the corresponding clamping rail. The clamping bars 30 are received respectively in the clamping rails 20A, 20B of the first pair 20 and in the clamping rails 22A, 22B of the second pair 22.

[0044] For the sake of simplicity, the clamping bars 30 are not represented on figure 10.

[0045] The drawing-in unit 4 comprises a layer selection device 18, represented on figure 4 only, configured to select one of the two yarn layers L1 and L2 by moving the layer cord 24 relative to the frame structure 10 and to unselect the other of the two yarn layers L1 and L2 by pushing the unselected yarn layer away from the yarn separation device 5.

[0046] This layer selection device can be as disclosed in CN211036281U.

[0047] Alternatively, the layer selection device can be of a different type.

[0048] The drawing-in unit includes a controller 44 mounted on the unit frame 42, a threaded rod 46 pivotally mounted on the unit frame 42 and which rotates around an axis of rotation X4. A nut 48 is mounted on the threaded rod 46 and moves along the axis X4, depending on the rotation of this threaded rod 46. The only movement of the nut 48 is a translation movement on the threaded rod 46 along the axis X4. The threaded rod 46 and the nut 48 together belong to a nut-and-worm mechanism which also includes a non-represented actuator, such as an electric motor, for driving the threaded rod 46 in rotation around the axis X4.

[0049] A head 50 is mounted on the nut 48 and is movable along a vertical axis Z4 perpendicular to the axis of rotation X4. The movable head 50 is driven along the vertical axis Z4 by another non-represented actuator, such as an electric motor.

[0050] The movable head 50 is provided with teeth 52 oriented upwards along the vertical axis Z4.

[0051] Parts 46, 48 and 50 together form a layer transport device 54 capable of moving the frame structure 10, and selectively yarn layer L1 or the yarn layers L1 and L2 along the longitudinal direction LD as it will be apparent from the following description.

[0052] The drawing-in unit 4 also includes a layer compensation device 56 which comprises a piston 58 movable, with respect to the unit frame 42, only along an axis Z'4 parallel to the vertical axis Z4.

[0053] Axes Z4 and Z'4 are perpendicular to the longitudinal direction LD.

[0054] The drawing-in unit 4 also includes a yarn detection device 60 which, in the example of the figures, is a camera and which is configured to detect at least the front-most yarn FY1 of the first yarn layer L1 or at least the front-most yarn FY2 of the second yarn layer L2 , preferably the front-most yarn of the selected yarn layer, by taking a picture of this front-most yarn. For the sake of simplicity, this camera 60 is represented on figure 9 only.

[0055] This camera 60 is used to detect the longitudinal position of the selected yarn layer, based on the longitudinal position of its front-most yarn, with regards to a reference position of the unit frame 42 of the drawing-in unit 4. The camera 60 is also configured to detect if a single yarn has been separated from the selected yarn layer by the yarn separation device 5. Since the camera is fixedly mounted on the unit frame 42, it remains stationary with the drawing-in unit 4 and moves relative to the frame structure 10 during the drawing-in process.

[0056] Advantageously, the field of view 60A of the camera 60 is located, with respect to the frame structure 10, such that the non-selected yarn layer, which has been pushed away by the layer cord 24, by action of the yarn selection device 18, is out of this field of view.

[0057] Components 42 to 60 of the drawing-in machine are not visible on figure 1 since they are integrated in the outer envelope of the stationary drawing-in unit 4.

[0058] The first upper clamping rail 20A and the first lower clamping rail 20B are longitudinally secured with the frame structure 10.

[0059] Advantageously, rail 20A is screwed on an armature 84 of the frame structure 10. Alternatively, other technics can be used for securing this rail onto the frame structure, e.g riveting or welding. Securing of rail 20B on the clamping device 6 is removable in order to enable installation of the yarn layer L2 in the second pair 22 of clamping rails.

[0060] The frame structure 10 also includes a driving surface 80 extending along the longitudinal direction LD. This driving surface 80 is provided with teeth 82 adjacent to one another along the longitudinal direction LD. It is a toothed driving surface. This driving surface 80 is made by a longitudinal edge of a folded part 83 of the armature 84 of the frame structure 10.

[0061] L80 denotes the length of the toothed driving surface 80, measured in a direction parallel to the longitudinal direction LD. This length L80 is a longitudinal driving length of the toothed driving surface 80.

[0062] L20 denotes the longitudinal clamping length of the clamping rails 20A, 20B, 22A and 22B, measured in a direction parallel to the longitudinal direction LD. These clamping rails are, in practice, identical and have the same length L20, which is the longitudinal clamping length of these rails. The longitudinal clamping length L20 of the second upper clamping rail 22A is measured, along the longitudinal direction LD, between the two longitudinal ends of the second upper clamping rail 22A.

[0063] Advantageously, the longitudinal driving length L80 is at least as long as the longitudinal clamping length L20 of all clamping rails.

[0064] Preferably, the longitudinal driving length L80 is strictly larger than the length L20.

[0065] Advantageously, the teeth 82 of the driving surface 80 are complementary to the teeth 52 of the movable head 50. Thus, the movable head 50 and the driving surface 80 can be in meshing engagement, as shown on figure 3.

[0066] In meshed configuration of the layer transport device 54 with the driving surface 80, that is when the teeth 52 of the layer transport head 50 are engaged within the teeth 82 of the tooth driving surface 80, the layer transport head 50 is longitudinally secured with the driving surface 80 and the longitudinal movement of the nut 48 of the nut-and-worm mechanism of the layer transport device 54 relative to the unit frame 42 of the drawing-in unit 4 causes the same longitudinal movement of the armature 84. This longitudinal movement of the armature 84 is the same as the longitudinal movement of the frame structure 10, relative to the unit frame 42 of the drawing-in unit, to the yarn separation device 5, to the layer selection device 18 and to the yarn detection device 60 of this drawing-in unit 4.

[0067] When the nut 48 reaches a first longitudinal end of its path, defined by the nut-and-worm mechanism, the movable head 50 is retracted into an unmeshed configuration of its teeth 52 with the teeth 82 of the driving surface 80. Then, the head 50 is shifted by the layer transport device 54, toward a second longitudinal end of the path and away from the first longitudinal end. The movable head 50 is then brought again into meshed configuration of its teeth 52 with the teeth 82 of the driving surface 80. Then the nut-and-worm mechanism is actuated and moves the nut 48 along the threaded rod 46, which allows further longitudinal movement of the driving surface 80, thus of the armature 84, relative to the frame 42 of the drawing-in unit 4.

[0068] By this meshed and unmeshed configurations, the driving surface 80 is configured to selectively cooperate with the layer transport device 54.

[0069] On the other hand, each of the second upper and lower clamping rails 22A and 22B is connected to the frame structure 10 via a slide link 88. Each slide link 88 includes a rib 88A fixed to the corresponding clamping rail and engaged in a ribbed profile 88B longitudinally secured to the frame structure 10. Due to the slide links 88, the upper and lower second clamping rails 22A and 22B can slide along the longitudinal direction LD with respect to the frame structure 10 and to the first upper and lower clamping rails 20A and 20B longitudinally secured to this armature when such relative movement is allowed as it will be apparent from the following description.

[0070] Advantageously, several brackets 86 are secured to a longitudinal beam 90 fixed to the second upper clamping rail 22A. In the example of the figures, five brackets are provided over the longitudinal clamping length L20 of the second upper clamping rail 22A .

[0071] The number of brackets 86 is not limitative.

[0072] The clamping device also comprises a switch element 100.

[0073] Advantageously, this switch element 100 is in the form of a bar and made of a folded sheet of metal.

[0074] L100 denotes the length of the switch element 100 along the longitudinal direction.

[0075] This length is at least as long as the longitudinal clamping length L20 of the clamping rails, in particular of the clamping rails of the second pair 22.

[0076] The switch element 100 is movable in rotation around an axis of rotation X100, with respect to the brackets 86 and to the frame structure 10. The axis of rotation X100 is preferably parallel to the longitudinal direction LD.

[0077] One or several non represented warp beam(s) provide the yarns for forming the yarn layers L1 and L2 clamped on the clamping rails 20A, 20B, 22A and 22B. They are located on a backside of the frame structure 10

and provide the yarn layers L1, L2 from the bottom of the clamping device 6.

[0078] The switch element 100 is located on the backside of the frame structure 10, that is on the side of warp beam(s) with regard to the yarn layers L1 and L2 and with regard to the toothed driving surface 80, along a lateral direction LA perpendicular to the longitudinal direction LD and to the vertical direction, i.e. perpendicular to the yarn layers L1, L2. In particular, each bracket 86 is configured so that the switch element 100 is located on a side of the driving surface 80 opposite to the first and second yarn layers L1 and L2 along the lateral direction LA.

[0079] In a vertical direction parallel to the posts 70 and 72, the switch element 100 is located between the upper clamping rails and the lower clamping rails. Preferably, the second upper clamping rail 22A, on which the switch element 100 is mounted, is closer to the yarn separation device 5 than the second lower clamping rail 22B. This guarantees a high precision of the position of the second yarn layer L2 relative to the yarn separation device 5.

[0080] The brackets 86 extend from the longitudinal beam 90 into an intermediate volume V10 defined by the frame structure 10 between the two upper clamping rails and the lower two clamping rails, in a direction parallel to the posts 70 and 72, and between these posts along the longitudinal direction LD. This is possible because an upper vertical leg 86A of each bracket 86 crosses an elongated hole 84A of the armature 84.

[0081] The main dimension of each elongated hole 84A is parallel to the longitudinal direction LD. The main dimension of each elongated hole 84A allows a relative longitudinal movement between the upper vertical legs 86A and the armature 84, when the second upper clamping rail 22A moves longitudinally with respect to the armature 84.

[0082] The switch element 100 is pivotally mounted on each bracket 86 with possibility of rotation around the axis of rotation X100 and is guided in this rotation by guiding bearings 92 born by each bracket 86.

[0083] The switch element 100 is secured longitudinally to the brackets 86. To this end, advantageously, at the level of each bracket 86, a rod 118 is screwed with the switch element 100 and extends, along longitudinal direction LD, through the bracket 86 and the guiding bearings 92 born by this bracket 86. The rod 118 longitudinally maintains the two flanges of a bracket 86 sandwiched in a longitudinal recess of the switch element 100. Since the brackets 86 are longitudinally secured to the second upper clamping rail 22A via the longitudinal beam 90, the brackets 86 longitudinally secure the switch element 100 to the second upper clamping rail 22A.

[0084] The switch element 100 is movable in rotation around the axis X100 between a first position represented on figures 4, 8 and 9 and a second position represented on figures 10 and 11.

[0085] Movements of the switch element 100 between its first and second positions are controlled by the layer compensation device 56.

[0086] Here, a "position" of the switch element means an angular position of the switch element 100 around the axis of rotation X100. The first and second positions of the switch element are thus independent of the actual location of the switch element along the longitudinal direction.

[0087] In its first position, the switch element 100 cooperates with the frame structure 10 to longitudinally secure the second upper clamping rail 22A to the first upper clamping rail 20A. In the first position of the switch element, there is no possibility of longitudinal relative movement between the first clamping rail 20A and the second clamping rail 22A.

[0088] As visible on figure 8, an extension plate 102 is secured to the upper crossbeam 74. This extension plate forms a friction surface 104 which extends at approximatively mid-length of the upper longitudinal crossbeam 74.

[0089] On the other hand, the switch element 100 carries a folded tab 106, which carries a contact block 108. The contact block 108 forms a clutch surface 110 configured to cooperate with the friction surface 104 born by the extension plate 102. The clutch surface 110 extends on a longitudinal clutch length L110, taken along the longitudinal direction LD, which is strictly smaller, preferably at least 20 times smaller, than the longitudinal clamping length L20 of the second upper clamping rail 22A.

[0090] In the first position of the switch element 100, the clutch surface 110 cooperates with the friction surface 104 and the switch element 100 longitudinally secures the second upper clamping rail 22A to the first upper clamping rail 20A.

[0091] One considers a central bracket 86, that is a bracket at least located halfway between the two longitudinal ends of the second upper clamping rail 22A along the longitudinal direction LD. Advantageously, the folded tab 106 and the clutch surface 110 are located, along the longitudinal direction LD, at the level of the central bracket 86. In other words, the clutch surface 110 covers a longitudinal level of a mid-point of the longitudinal clamping length L20, this midpoint being situated, along the longitudinal direction LD, halfway between two longitudinal ends of the third clamping rail 22A. This guarantees a minimal torsion of the switch element 100, when the piston 58 cooperates with the switch element 100 at one longitudinal end of the switch element 100.

[0092] Two springs 112 extend between the central bracket 86 and the folded tab 106 and exert on the switch element 100 a torque around the axis of rotation X100, which urges by default the switch element 100 toward its first position, where the clutch surface 110 is applied against, and in contact with, the friction surface 104.

[0093] The number of springs 112 is not limitative. It can be equal to one or larger than or equal to three.

[0094] In a non-represented variant of the invention, torsion springs mounted around axis of rotation X100 can be used to urge back the switch element 100 toward its first position.

[0095] The applied contact between the friction surface

104 and the clutch surface 110 results in securing, along the longitudinal direction LD, the switch element 100 with the extension plate 102, thus with the upper crossbeam 74 of the frame structure 10.

[0096] The switch element 100 also forms an elongated gripping surface 114 provided with teeth 116. As visible, for instance on figures 9 and 10, the gripping surface 114 forms a longitudinal edge of a band 118 of the switch element opposite to the contact block 108. The teeth 116 are adjacent to one another along the longitudinal direction LD.

[0097] L114 denotes the length of the gripping surface 114 along the longitudinal direction LD.

[0098] In the example of the figures, lengths L100 and L114 are identical.

[0099] The length L114 is at least as long as the longitudinal length L20 of the clamping rails, in particular of the clamping rails of the second pair 22.

[0100] L82 denotes the length of the teeth 82 of the driving surface 80, that is the interspace between two adjacent teeth 82, along the longitudinal direction LD.

[0101] L116 denotes the length of the teeth 116 of the gripping surface 114, that is the interspace between two adjacent teeth 82, along the longitudinal direction LD.

[0102] Advantageously, the length L116 is strictly smaller than length L82, preferably at least three times smaller.

[0103] d110 denotes a distance, measured radially to the rotation axis X100, between this axis and the clutch surface 110.

[0104] d114 denotes a distance, measured radially to the rotation axis X100, between this axis and the gripping surface 114.

[0105] Advantageously, distance d110 is strictly smaller than distance d114. Thus, the lever arm, with respect to the axis of rotation X100, of an effort exerted on the gripping surface 114 is larger than the lever arm of an effort exerted on the clutch surface 110.

[0106] In its first position, the switch element 100 cooperates by friction, between surfaces 110 and 104, with the extension plate 102. Thus, when the armature 84 and the first upper clamping rail 20A are moved along the longitudinal direction LD by the layer transport device 54, relative to the structure of the drawing-in unit 4, this longitudinal movement is transmitted to the extension plate 102, to the switch element 100, to the brackets 86 and to the second upper clamping rail 22A.

[0107] This transmission of longitudinal movement is all the more efficient that, in order to increase the friction between surfaces 104 and 110, the friction surface 104 is provided with adjacent openings or recesses and the clutch surface 110 is made up of rubber. Advantageously, the clutch surface 110 cooperates with at least two adjacent openings of the friction surface 104 when the switch element 100 is in its first position. These adjacent openings are optional.

[0108] The fact that the two clamping rails of the second pair 22 are mounted on the frame structure 10 with the possibility of longitudinal movement with regard to the frame structure allows layer compensation, when the switch element 100 is in its second position. This is why each second clamping rail 22A, 22B is supported by a slide link 88 on the frame structure.

[0109] L102 denotes the length of the extension plate 102 measured parallel to the longitudinal direction LD. This length is relatively small as compared to length L20 and L80 so that only a limited layer compensation longitudinal movement can occur between the clutch surface 110 and the friction surface 104. The extension plate 102 is located halfway between the posts 70 and 72, along the longitudinal direction LD.

[0110] The frame structure 10 also includes a brush 120. This brush 120 is used to stretch the yarns before they are clamped in the clamping rails of the first and second pairs 20 and 22 by the clamping bars 30. When the brush 120 is not used to stretch the yarns, it can be retracted with regard to the frame structure 10 in order to reduce the overall dimensions of this frame structure. A non-represented sensor of the drawing-in machine 2 can detect the position of the brush 120 relative to the frame structure 10, in order to detect if the brush is retracted or not retracted.

[0111] A cable 124 connects the second upper clamping rail 22A and the second lower clamping rail 22B and enables a co-movement of these two rails along the longitudinal direction LD, relative to the frame structure 10. In other words, the cable 124 is a transmission member between the clamping rails of the second pair 22 and synchronizes a longitudinal movement of the second upper clamping rail 22A relative to the frame structure 10 with a longitudinal movement of the second lower clamping rail 22B relative to the frame structure 10 in any sense of movement along the longitudinal direction LD. The cable 124 allows the second upper clamping rail 22A to pull the second lower clamping rail 22B along the longitudinal direction LD. The cable 124, or a sheath surrounding the cable, is also stiff enough to allow the second upper clamping rail 22A to push the second lower clamping rail 22B along the longitudinal direction LD. Because of its flexibility and its deformability, the cable 124 authorizes and adapts a vertical relative movement, that is a movement along a transverse direction with respect to the longitudinal direction LD, between the second upper clamping rail 22A and the second lower clamping rail 22B, this vertical relative movement being used for tensioning the second yarn layer L2, when necessary.

[0112] As visible on figures 1, 2, 5 and 7, the cable 124 is placed on the backside of the frame structure 10 along the lateral direction LA with regard to the clamping rails 20A, 20B, 22A and 22B and a first extremity of the cable 124 is linked to one of the brackets 86 of the second upper clamping rail 22A, for example the bracket 86 which is the closest to the vertical post 72. An opposite extremity of the cable 124 is linked to a connector plate 126 secured to the second lower clamping rail 22B on vertical post 70

side, for instance screwed on this rail, which protrudes from the second lower clamping rail.

[0113] Alternatively, another type of transmission member can be used instead of the cable 124, such as a semi-flexible rod.

[0114] The first upper clamping rail 20A and the second upper clamping rail 20B are mounted on the frame structure 10 without possibility of movement in the vertical direction. In order to allow individual tensioning of each of the two yarn layers L1 and L2, the first lower clamping rail 20B and the second lower clamping rail 22B are each mounted on the frame structure 10 with a possibility of individual vertical movement, parallel to the posts 70 and 72, as shown by double arrows A20 and A22 on figure 5.

[0115] The first lower clamping rail 20B comprises at least two supporting bases 130. A nut 140 is secured in rotation and in the vertical direction with each supporting base 130. The second lower clamping rail 22B is mounted via the slide link 88 onto at least two supporting bases 132 for a possible longitudinal movement of the second lower clamping rail 22B relative to the supporting bases 132. A nut 142 is secured in rotation and in the vertical direction with each supporting base 132. For instance, the nuts are soldered on the supporting bases. Each nut 140 cooperates with a threaded rod 150 and each nut 142 cooperates with a threaded rod 152. The threaded rods 150 are used for moving up and down the first lower clamping rail 20B and driven together in rotation by a set of chains 160 and gear wheels 170 controlled by a common respective wrench 180. Similarly, the threaded rods 152 are used for moving up and down the second lower clamping rail 22B and driven together in rotation by a set of chains 162 and gear wheels 172 controlled by a respective common wrench 182. The chains 160, 162 and the gear wheels 170, 172 are supported by the frame structure 10, in particular by the lower crossbeam 76. The vertical movement of each lower clamping rail is guided, near the two vertical posts 70 and 72, by guiding vertical columns 190, respectively 192, of the frame structure 10 cooperating with corresponding grooves of the supporting bases 130, respectively 132. The supporting bases 130, 132 cannot longitudinally move relative to the frame structure 10. The second lower clamping rail 22B is thus connected to the frame structure 10 through the slide link 88, for a possible relative longitudinal movement, and through the cooperation of the guiding vertical columns 192 and the supporting bases 132, for a possible relative vertical movement. The wrenches 180 and 182 are located on one longitudinal side of the frame structure 10, in the example close to the vertical post 72. They are actuated manually and individually by the operator when a clamped yarn layer L1 or L2 needs more tension or less tension.

[0116] The cable 124 is compatible with vertical movements of the lower clamping rails 20B and 22B relative to the frame structure 10 that are initiated trough the wrenches 180 and/or 182.

[0117] The piston 58 is the movable part of the layer compensation device 56 and has an end surface 58A turned upward and provided with teeth 59 of a shape allowing them to come into meshing engagement with the teeth 116 of the gripping surface 114 of the switch element 100.

[0118] The piston 58 is movable, relative to the unit frame 42, between an inactive or lower position represented on figure 9, where it does not interact with the clamping device 6, and an active or upper position represented on figures 10 and 11, where it interacts with the switch element 100. When the piston 58 moves from its inactive position to its active position, its toothed end surface 58A comes into cooperation with the gripping surface 114 of the switch element 100 and pushes this gripping surface upwardly, which makes the switch element 100 rotates in the direction arrow A100 on figure 10, around the axis X100, against the efforts exerted by the springs 112. As a result, the clutch surface 110 of the switch element 100 is brought out of engagement with the friction surface 104 of the extension plate 102. In other words, when the piston 58 of the layer compensation device 56 is in its active position, it brings the switch element 100 in its second position, where the switch element does not hold the second upper clamping rail 22A secured in translation with the armature 84 or with the first upper clamping rail 20A, along the longitudinal direction LD.

[0119] The cooperation between the gripping surface 114 and the piston 58 occurs via the teeth 59 and 116 which enables the switch element 100 to be longitudinally fixed with the layer compensation device 56 in active position of the piston 58, thus with the unit frame 42 of the drawing-in unit when the switch element is in its second position. Since the switch element 100 is fastened with the second upper clamping rail 22A along the longitudinal direction LD in its second position, the fact that the switch element is fixed longitudinally with respect to the unit frame 42 induces that the second clamping rail 22A is also fixed longitudinally with the unit frame 42. The second lower clamping rail 22B is also fixed longitudinally with the unit frame 42, due to the action of the cable 124.

[0120] When the piston 58 is brought back into inactive position, the switch element 100 rotates in the direction opposite to arrow A100, as it is elastically urged by springs 112. The switch element 100 follows the downwardly oriented movement of the piston 58 until the cooperation between the piston 58 and the switch element 100 ends, and the clutch surface 110 of the switch element 100 is brought again in engagement with the friction surface 104 of the extension plate 102. The switch element 100 is back in its first position.

[0121] The gripping surface 114 and the driving surface 80 are oriented in the same direction, in particular downwardly in the example of the figures. The gripping surface 114 is shifted with regard to the driving surface 80 towards the back of the frame structure 10, along the lateral direction LA, by a non-zero distance d1. The gripping surface 114 is also shifted downwardly with

respect to the driving surface 80, by a non-zero height difference h1 taken along vertical direction.

[0122] The gripping surface 114 works as an actuating surface configured to work with the layer compensation device 56 for the movement of the switch element 100 from its first position to its second position.

[0123] When the switch element 100 is in its second position, the first upper clamping rail 20A and the first lower clamping rail 20B follow, with respect to the unit frame 42, a longitudinal movement set to the frame structure 10 by the layer transport device 54, whereas the second upper clamping rail 22A and the second lower clamping rail 22B do not move longitudinally relative to the frame 42 of the drawing-in unit 4, since they are locked in position with respect to the unit frame 42, by the cooperation of the teeth 59 and 116.

[0124] As a consequence, the first and second yarn layer L1 and L2 have a relative longitudinal movement, which makes it possible to adjust a longitudinal offset distance between the front-most yarn FY1 of the first yarn layer L1 and the front-most yarn FY2 of the second yarn layer L2. In this relative longitudinal movement, the second clamping rails 22A, 22B are moved longitudinally with respect to the first clamping rails 20A, 20B, and vice-versa. This is called an offset compensation phase.

[0125] Irrespective if it is in its first position or in its second position or in-between, the switch element 100 does not directly cooperate neither with the layer transport device 54 nor with the toothed driving surface 80 of the frame structure 10.

[0126] During operation of the drawing-in machine 2, a common longitudinal movement of the first and second yarn layers L1 and L2 relative to the drawing-in unit 4 is necessary when the camera 60 detects that the front-most yarn of the selected yarn layer is not in the separation range, that is in the range along the longitudinal direction LD where the yarn separation device 5 is operational.

[0127] An offset compensation phase is necessary, before selecting the layer for which yarns are to be separated by the yarn separation device 5, if the longitudinal offset distance between the front-most yarns FY1, FY2 of the two yarn layers L1 and L2 exceeds a predetermined value. For example, this predetermined value is 50 mm.

[0128] Advantageously, the controller 44 is configured for processing an output signal of the yarn detection device or camera 60. Optionally, the controller 44 is also configured for processing the drawing-in pattern and the output signals of different other sensors mounted on the drawing-in machine 2. The processor 44 includes a memory 45 and controls the layer selection device 5, the yarn separation device 18, the layer transport device 54, the layer compensation device 56 and the yarn detection device 60. Optionally, the processor 44 controls the heddle detection device, the drop-wire separation device, the heddle transport device, the drop-wire transport device, the reed transport device and the threading device.

[0129] Since the frame structure of a clamping device for two layers is bulkier than the frame structure of a clamping device for a single layer, the drawing-in machine comprises a non-represented sensor connected to the controller 44 and configured to detect if the frame structure is for a single layer or for two layers. In case of a single layer frame structure, the layer compensation device 56 is inhibited by the controller 44 during the drawing-in process. In case of a two layers frame structure, the layer compensation device 56 is controlled by the controller, in order for the two layers to be correctly and efficiently drawn-in, as explained here above.

[0130] Operating of the drawing-in machine, for a two layers drawing-in process, is as follows: At the beginning of the two layers drawing-in process, the switch element 100 is in its first position. The clutch surface 110 is centered longitudinally on the extension plate 102 and in engagement with the friction surface 104. The longitudinal position of the front-most yarn of each yarn layer L1 and L2 with regard to a reference position of the unit frame 42 of the drawing-in unit 4 is detected by the yarn detection device 60 and determined by the controller 44 on the basis of the output of the yarn detection device 60. An information about the longitudinal position of the front-most yarn FY1 or FY2 of each yarn layer L1 and L2 with regard to a reference position of the frame 42 of the drawing-in unit 4 is memorized in the memory 45 in relation with the corresponding yarn layer L1, L2. This information can be the output of the yarn detection device 60, for example the picture, or the determination of the controller 44.

[0131] The drawing-in method can be implemented automatically by the controller 44 and comprises an alternation of working phases, where yarn separation and threading of the yarns into the harness takes place, and offset compensation phases, where longitudinal adjustments of the longitudinal positions of the yarn layers L1 and L2 relative to one another occurs, in order to enable the working phases to take place later on.

[0132] During the working phases, the switch element 100 is in its first position, the layer compensation device 56 is in inactive position, the piston 58 doesn't cooperate with the clamping device 6 and yarns from the first yarn layer L1 and from the second yarn layer L2 are successively separated and drawn-in, according to the drawing-in pattern. To this end, the front-most yarn of the selected layer is brought into the separation range by longitudinal movement of the frame structure 10 relative to the drawing-in unit 4. The layer transport device 54 longitudinally moves together the first and second pairs of clamping rails 20 and 22, i.e. with exactly the same longitudinal movement as the switch element 100 is in the first position, this longitudinal movement being based on the output signal of the yarn detection device 60. The front-most yarn of the selected yarn layer, L1 or L2, is separated by the yarn separation device 5 and transferred to the threading device, in order to be inserted into a separated

heddle, or possibly into a separated drop-wire and/or in the reed. This operation is repeated for the next front-most yarn of the selected layer, according to the number of yarns of this selected layer to be separated, according to the drawing-in pattern.

[0133] Just before the other layer is selected, that is when the previously selected yarn layer is about to be unselected, i.e. just before the layer cord 24 is moved in a direction transverse to the yarns, in order to enable separation of yarns of the other layer according to the drawing-in pattern, , the new longitudinal position of the front-most yarn of the previously selected layer with regard to the reference position of the drawing-in unit is determined by the controller 44 on the basis of an output signal of the yarn detection device 60 and this information is memorized in relation with the layer to which the front-most yarn belongs in the memory 45, where it overwrites the information on the longitudinal position detected before for the same yarn layer. The offset, that is the longitudinal distance between the front-most yarns FY1, FY2 of the two yarn layers L1, L2, is calculated, based on the last memorized longitudinal position of the front-most yarn of each layer and on the longitudinal co-movement of the two layers that occurred during the working phases, between these memorizations. If this offset exceeds a predetermined value, the working phase is stopped and an offset compensation phase is launched with the following steps:

- If the next layer to be selected is the first layer L1 :
    - freeing the second pair 22 of clamping rails from the first pair 20 of clamping rails, along the longitudinal direction LD, by allowing a relative longitudinal movement between the first pair 20 and the second pair 22, and avoiding any relative longitudinal movement between the second pair 22 of clamping rails and the unit frame 42. This occurs by longitudinally securing the second upper clamping rail 22A with the unit frame 42via the switch element 100, which is brought into its second position. The layer compensation device 56 is brought into its active position and the movable head 50 of the layer transport device 54 is in meshed configuration with the driving surface 80.
    - longitudinally retracting the first yarn layer L1 away from the separation device 5, in a backward longitudinal movement. For this backward longitudinal movement, the movable head 50 of the layer transport device 54 is in meshed configuration with the driving surface 80 and the nut-and-worm mechanism is activated. The layer compensation device 56 is in active position and the switch element 100 is in its second position. The longitudinal retracting movement of the first layer L1 has a stroke corresponding to the offset computed previously. By this backward longitudinal movement, the longitudinal distance between front-most yarn FY1 and front-most yarn FY2 is reduced.
- If the next layer to be selected is the second layer L2 :
    - longitudinally retracting both yarn layers L1 and L2 away from the yarn separation device 5, in a backward longitudinal movement. For this backward longitudinal movement, the movable head 50 of the layer transport device 54 is in meshed configuration with the driving surface 80 and the nut-and-worm mechanism is activated. The layer compensation device 56 is maintained in inactive configuration and the switch element 100 is in its first position. Here again, the layer compensation longitudinal movement has a stroke corresponding to the offset calculated previously.
    - freeing the second pair 22 of clamping rails from the first pair 20 of clamping rails, along the longitudinal direction LD, by allowing a relative longitudinal movement between the first pair 20 and the second pair 22, and avoiding any relative longitudinal movement between the second pair 22 of clamping rails and the unit frame 42. Here, the second upper clamping rail 22A is longitudinally secured with the unit frame 42via the switch element 100, which is in its second position. The layer compensation device 56 is brought in active configuration and the movable head 50 of the layer transport device 54 is in meshed configuration with the driving surface 80.
    - bringing the first layer L1 towards the yarn separation device 5, into its original longitudinal position before the offset compensation phase, in a forward longitudinal movement. This forward longitudinal movement has a stroke corresponding to the offset computed previously. For this forward longitudinal movement, the movable head 50 of the layer transport device 54 is in meshed configuration with the driving surface 80 and the nut-and-nut-and-worm mechanism is activated. By this forward longitudinal movement, the longitudinal distance between front-most yarn FY1 and front-most yarn FY2 is reduced.

[0134] Then, the working phase can start again, after the offset compensation phase. Irrespective if the next layer to be selected is the first or the second layer, the working phase starts with a step of longitudinally securing the first and the second pairs 20 and 22 of clamping rails by bringing the switch element 100 in its first position, under the action of the springs 112 and with movement of the piston 58 into its inactive position. The movable head 50 of the layer transport device 54 is in meshed config-

uration with the driving surface 80 when the layer compensation device 56 moves into its inactive configuration.

[0135] After the offset compensation phase, when the switch element 100 is back into its first position, the clutch surface 110 can cooperate again with the friction surface 104 of the extension plate 102, at a position which is different from the position before the offset compensation phase.

[0136] For two offset compensation phases following each other, with a working phase in-between, the piston 58 of the layer compensation device 56 will come into cooperation with the switch element 100 at different positions along the gripping surface 114, that is along the length of the frame structure 10. The relative small dimensions of the teeth 116 and the corresponding teeth 59 allow the cooperation of parts 58 and 114 at any position along the length of the switch element 100.

[0137] In order to improve the safety of the drawing-in operation, the controller 44 may be configured to provide that:

- when the movable head 50 of the layer transport device 54 is in a unmeshed configuration with respect to the driving surface 80, the switch element 100 is always in its first position, so that no relative longitudinal movement of the first and second pairs 20 and 22 of clamping rails is possible;
- when the layer selection device 18 is actuated, in particular when the layer cord 24 is moved, the switch element 100 is always in its first position, which guarantees that the relative position of the two yarn layers L1 and L2 along the longitudinal direction LD is maintained.

[0138] The invention provides many advantages, in particular an optimized offset compensation between the yarn layers L1 and L2.

[0139] Some other advantages of the clamping device, drawing-in machine and method of the invention may include :

- During the working and offset compensation phases, because of the selective mechanical coupling of the second pair 22 of clamping rails with the frame structure 10 or with the drawing-in unit 4, there is no risk of combined movements of the clamping rails, i.e. offset compensation movements and longitudinal movements of the frame structure 10 relative to the unit frame 42 occurring at the same time, whereas such combined movements may occur with the drawing-in unit of EP4033020A1. Moreover, there is no risk of floating/parasite relative longitudinal movement between the first and second pairs 20 and 22 of clamping rails.
- With the present invention, the current position of each yarn layer can be accurately known and no specific braking mechanism is needed to hold the yarn layers in position.
- Because of the selective mechanical coupling of the second pair 22 of clamping rails with the first pair 20 of clamping rails, the offset between the yarn layers can be computed without detecting the current position of the non-selected layer, whereas such detection would require selecting the other layer, taking a picture before computing the offset and would be time consuming.
- The offset compensation phase, and the actuation of the layer selection device are launched only when they are needed, which provides more time for the working phases and increases the overall drawing-in performances.
- As the non-selected layer has not to be selected for computing the offset and for launching the offset compensation phase, this allows the non-selected layer to adopt a more advanced position relative to the selected layer. Thus, depending on the drawing-in pattern, this can reduce the number of offset compensation phases to be launched during the drawing-in process. Here again, this gives more time for the working phases and increases the drawing-in performances of the drawing-in machine.
- The invention also provides a simplified design. With regard to conventional clamping devices for one layer, the only additional actuator is a two position up and down actuator forming the layer compensation device 56. Moreover, this actuator does not require a highly accurate control. No motor or actuator is mounted on the clamping device 6. Indeed, all the powered devices are installed on the drawing-in unit 4, which is particularly advantageous when the drawing-in unit is static, in the room where drawing-in takes place and the clamping device moves along the longitudinal direction, as in the example of the figures. This allows the drawing-in unit to stay compact, with no elongated gripping surface on the drawing-in unit. Moreover, the transmission cable 124 allows only one actuator to synchronously and longitudinally move the upper and lower second clamping rails. This light design is also compatible with vertical adjustment between the clamping rails, for layer tensioning.
- Moreover, since the switch element 100 has an elongated gripping surface 114, it can be actuated at any longitudinal position of the drawing-in unit or with regard to the clamping device 6. The drawing-in unit 4 can be compact and the switch element 100 does not increase the longitudinal dimension of the clamping device 6. The springs 112 ensure, by default, a correct engagement between the clutch surface 110 and the frame structure 10 since their action does not depend on the longitudinal position of the contact between the layer compensation device 56 and the gripping surface 114 along the length of the frame structure 10. The fact that the switch element 100 rotates between its two positions guarantees a correct disengagement between the clutch surface

110 and the frame structure 10, since a rotational movement is more tolerant on the position of the contact between the layer compensation device 56 and the gripping surface 114, along the length of the frame structure 10, than a translational movable switch element. The respective lever arms induced by distances d110 and d114 are useful here.

[0140] The invention is not limited to the example of the figures.

[0141] In a non-represented variant of the invention, the switch element 100 may cooperate directly with a clamping rail of the first pair 20 of clamping rails, instead of with the frame structure 10.

[0142] In a non-represented variant of the invention, the yarn detection device 60 is formed with light barrier(s) or capacitive sensors instead of a camera.

[0143] In a non-represented variant of the invention, the computation of the offset compensation may also be based on yarn density of each layer and on the drawing-in pattern instead of only on the new memorized position. In such a case, the new position of the front-most yarn can be equal to the last memorized position plus a yarn interspace multiplied by the number of separated yarns.

[0144] In a non-represented variant of the invention, the shape of the switch element 100 is different from the one represented on the figures and/or the switch element 100 is not made of a folded sheet of metal.

[0145] The cooperation between the switch element 100 and the frame structure 10, at the level of the surfaces 104 and 110, can be made by cooperation of shapes, with teeth or other reliefs on these two surfaces, instead of by friction;

[0146] In a non-represented variant of the invention, the layer compensation device 56 is supported by the clamping device 6. In particular, it can be longitudinally secured to the second upper clamping rail 22A, with no relative movement between the second clamping rail and the layer compensation device 56 along the longitudinal direction LD. The layer compensation device 56 can be mounted at the level of the central bracket 86. In such a case, the gripping surface with which the layer compensation device cooperates in order to move the switch element 100 from its first position to its second position is different from the gripping surface with which the switch element cooperates with the drawing-in unit in the second position. The layer compensation device 56 may move horizontally between its active and inactive configurations. The gripping surface of the switch element may cooperate with a static surface of the drawing-in unit in its second configuration. The layer compensation device 56 can positively move the switch element 100 from its second position to its first position. In other words, one does not rely on springs to bring back the switch element to its first position.

[0147] Instead of springs, other elastic return means can be used to bring the switch element 100 by default into its first position.

[0148] In a non-represented variant of the invention, the clamping device 6 is fixed in the room, whereas the drawing-in unit 4 is movable on the ground surface GS in the room, along the longitudinal direction, during the drawing-in process.

[0149] In a non-represented variant of the invention, the switch element 100 is longitudinally secured to and pivotally mounted on the second lower clamping rail 22B.

[0150] In a non-represented variant of the invention, the second first pair 22 of clamping rails is secured with the frame structure 10, along the longitudinal direction LD, while the first pair 20 of clamping rails is movable with respect to the frame structure 10 along the longitudinal direction LD. In that case, the switch element 100 is longitudinally secured to and pivotably mounted on the first upper clamping rail 20A or on the first lower clamping rail 20B.

[0151] Some additional sensors can be provided on the frame structure 10 and connected to the controller 44 in order to detect:

- an initial position of the clutch surface 110 relative to the extension plate 102, with regard to a central position of the extension plate 102;
- directly on the clamping rails, a longitudinal position difference of the clamping rails, without consideration of the yarns clamped in these clamping rails. If a predetermined maximum longitudinal position difference is exceeded, the controller 44 stops the drawing-in method;
- any parasite longitudinal relative movement between the two clamping rails of a pair of clamping rails 20 or 22. If such a parasite movement occurs, the controller 44 stops the drawing-in method.

[0152] The above listed embodiments and variants may be combined to generate new embodiments of the invention, within the scope of the appended claims.

Claims

1. A clamping device (6) for a drawing-in machine (2), the clamping device being configured to clamp a first yarn layer (L1) and a second yarn layer (L2) and comprising

   - a frame structure (10) movable along a longitudinal direction (LD) with respect to a drawing-in unit (4) of the drawing-in machine;
   - a first pair (20) of clamping rails for clamping the first yarn layer (L1), the first pair of clamping rails comprising a first clamping rail (20A) and a second clamping rail (20B) which are secured with the frame structure (10), along the longitudinal direction;
   - a second pair (22) of clamping rails for clamping the second yarn layer (L2), the second pair of

clamping rails comprising a third clamping rail (22A) and a fourth clamping rail (22B) which are connected to the frame structure (10) through a slide link (88) so that the third and the fourth clamping rails (22A, 22B) are movable with respect to the frame structure (10) along the longitudinal direction (LD);

characterized in that the clamping device includes a switch element (100) longitudinally secured to the third clamping rail (22A) and movable (A100) with respect to the frame structure (10) between

- a first position, where the switch element (100) cooperates with the frame structure (10) or with the first clamping rail (20A) to longitudinally secure the third clamping rail (22A) to the first clamping rail (20A); and
- a second position, where the switch element (100) allows a relative movement, along the longitudinal direction (LD), of the third clamping rail (22A) relative to the first clamping rail (20A) and where the switch element (100) does not cooperate neither with the frame structure (10) nor with the first pair (20) of clamping rails.

2. The clamping device according to claim 1, wherein the switch element (100) rotates (A100) relative to the frame structure (10) and relative to the third clamping rail (22A) between its first position and its second position, around an axis of rotation (X100), the axis of rotation being preferably parallel to the longitudinal direction (LD).

3. The clamping device according to claim 2, wherein, at least a guiding bearing (92) is secured to the third clamping rail (22A) so as to guide the switch element (100) in rotation, between its first position and its second position, around the axis of rotation (X100).

4. The clamping device according to any preceding claim, wherein the clamping device (6) is equipped with at least one elastic return member (112), in particular a spring, which urges the switch element (100) toward its first position.

5. The clamping device according to any preceding claim, wherein

- the switch element (100) includes a gripping surface (114), preferably a toothed gripping surface, configured to cooperate with the drawing-in unit (4) when the switch element is in its second position; and
- the gripping surface (114) of the switch element extends on a longitudinal gripping length (L114), which is at least as long as a longitudinal clamping length (L20) of the third clamping rail (22A).

6. The clamping device according to claim 5, wherein, in the first position of the switch element (100), a clutch surface (110) of the switch element (100) cooperates, preferably by friction, with the frame structure (10) to longitudinally secure the switch element (100) with respect to the frame structure, wherein the clutch surface (110) extends on a longitudinal clutch length (L110) which is strictly smaller than the longitudinal clamping length (L20) of the third clamping rail (22A) and wherein the clutch surface (110) covers a longitudinal level of a mid-point of the longitudinal clamping length, this midpoint being situated, along the longitudinal direction (LD), halfway between two longitudinal ends of the third clamping rail (22A).

7. The clamping device according to any preceding claim, wherein

- the frame structure (10) includes a driving surface (80), in particular a toothed driving surface;
- the driving surface (80) is configured to cooperate with a layer transport device (54) which belongs to the drawing-in unit (4), for a relative longitudinal movement between the frame structure (10) and the drawing-in unit (4);
- at least one bracket (86) longitudinally secures the switch element (100) to the third clamping rail (22A);
- each bracket (86) extends through an elongated hole (84A) of the frame structure (10) so that the switch element (100) is located on a side of the driving surface (80) opposite to the first yarn layer (L1) and to the second yarn layer (L2) along a lateral direction (LA) extending perpendicular to the yarn layers (L1, L2).

8. The clamping device according to any preceding claim, wherein

- the clamping device (6) includes a transmission member (124), in particular a cable, whose ends are respectively fixed on the third clamping rail (22A) and on the fourth clamping rail (22B) for synchronizing their movements with respect to the frame structure (10), along the longitudinal direction (LD); and
- the transmission member (124) is deformable to adapt to an adjustment of a relative position of the third clamping rail (22A) and the fourth clamping rail (22B) in a direction (A22) perpendicular to the longitudinal direction (LD).

9. The clamping device according to any preceding claim, wherein the frame structure (10) is pivotally mounted on a truck (8) of the clamping device (6) equipped with wheels (12) for moving the truck on a

ground surface (GS).

10. Drawing-in machine (2) including

- a clamping device (6) according to any one of the previous claims;
- a drawing-in unit (4) equipped with
  - ◦ a unit frame (42);
  - ◦ a layer selection device (18) configured to select one yarn layer amongst a first yarn layer (L1) and a second yarn layer (L2) clamped on the clamping device (6);
  - ◦ a yarn separation device (5) configured to separate yarns of the yarn layer selected by the layer selection device;
- a layer transport device (54) configured to cause a relative longitudinal movement of the frame structure (10) of the clamping device (6) with respect to the unit frame (42);
- a layer compensation device (56) including a part (58) movable with respect to the frame structure (10) of the clamping device (6) and configured to move the switch element (100) at least from its first position to its second position;
- a controller (44) controlling at least the layer selection device (18), the yarn separation device (5), the layer transport device (54) and the layer compensation device (56);

wherein, in the second position of the switch element (100), the switch element (100) is secured, along the longitudinal direction (LD), with the unit frame (42) of the drawing-in unit (4).

11. The drawing-in machine according to claim 10, wherein

- the drawing-in unit (4) includes the layer compensation device (56);
- the movable part (58) of the layer compensation device (56) is movable relative to the unit frame (42) of the drawing-in unit (4), only in a direction (Z'4), perpendicular to the longitudinal direction (LD), between an inactive position and an active position;
- in its active position, the movable part (58) of the layer compensation device (56) cooperates with the switch element (100) and is secured, along the longitudinal direction (LD), with the switch element (100), the switch element (100) being in its second position;
- in its inactive position, the movable part (58) of the layer compensation device does not cooperate with the clamping device (6).

12. The drawing-in machine according to any one of claims 10 and 11, wherein

- the drawing-in machine (2) includes a yarn detection device (60), preferably a camera, configured to detect a front-most yarn (FY1, FY2) of the selected yarn layer;
- the yarn detection device (60) is connected to the controller (44);
- the controller (44) is configured to determine a longitudinal position of the front-most yarn (FY1, FY2) of the selected yarn layer relative to the unit frame (42), based on an output signal of the yarn detection device; and
- the drawing-in machine includes a memory (45) for storing an information about the longitudinal position of the front-most yarn (FY1, FY2) in relation with the yarn layer (L1, L2) to which the front-most yarn (FY1, FY2) belongs.

13. The drawing-in machine according to any oneof claims 10, 11 or 12, wherein the third clamping rail (22A) is closer to the yarn separation device (5) than the fourth clamping rail (22B).

14. A drawing-in method for drawing-in, in a drawing-in machine (2), a first yarn layer (L1) and a second yarn layer (L2) clamped on a clamping device of the drawing-in machine,

the clamping device including

- a frame structure (10) movable along a longitudinal direction (LD) with respect to a drawing-in unit (4) of the drawing-in machine;
- a first pair (20) of clamping rails for clamping the first yarn layer (L1), the first pair of clamping rails comprising a first clamping rail (20A) and a second clamping rail (20B) which are secured with the frame structure (10), along the longitudinal direction (LD);
- a second pair (22) of clamping rails for clamping the second yarn layer (L2), the second pair of clamping rails comprising a third clamping rail (22A) and a fourth clamping rail (22B) which are connected to the frame structure (10) so that the third and the fourth clamping rails (22A, 22B) are movable with respect to the frame structure (10) along the longitudinal direction (LD);

the drawing-in unit including

- a unit frame (42);
- a layer selection device (18) configured to select one yarn layer, amongst the two first and second yarn layers (L1, L2), from which

yarns are to be separated;
- a yarn separation device (5) configured to separate yarns of the yarn layer selected by the layer selection device;

the drawing-in machine including a controller (44) for controlling at least the layer selection device (18) and the yarn separation device (5);
the drawing-in method comprising at least an alternation of working phases and of offset compensation phases;
whereas, during each working phase, the first clamping rail (20A) of the first pair (20) of clamping rails and the third clamping rail (22A) of the second pair (22) of clamping rails are moved together relative to the unit frame (42) along the longitudinal direction (LD); wherein

- a working phase includes at least the following steps consisting in:

a) securing, along the longitudinal direction (LD), the third clamping rail (22A) to the first clamping rail (20A) or to the frame structure (10) so that there is no possibility of longitudinal relative movement between the first clamping rail (20A) and the third clamping rail (22A);
b) with the layer selection device (18), selecting the yarn layer (L1, L2) from which yarns are to be separated by the yarn separation device (5) and unselecting the other yarn layer (L1, L2);

- an offset compensation phase includes at least the following steps consisting in:

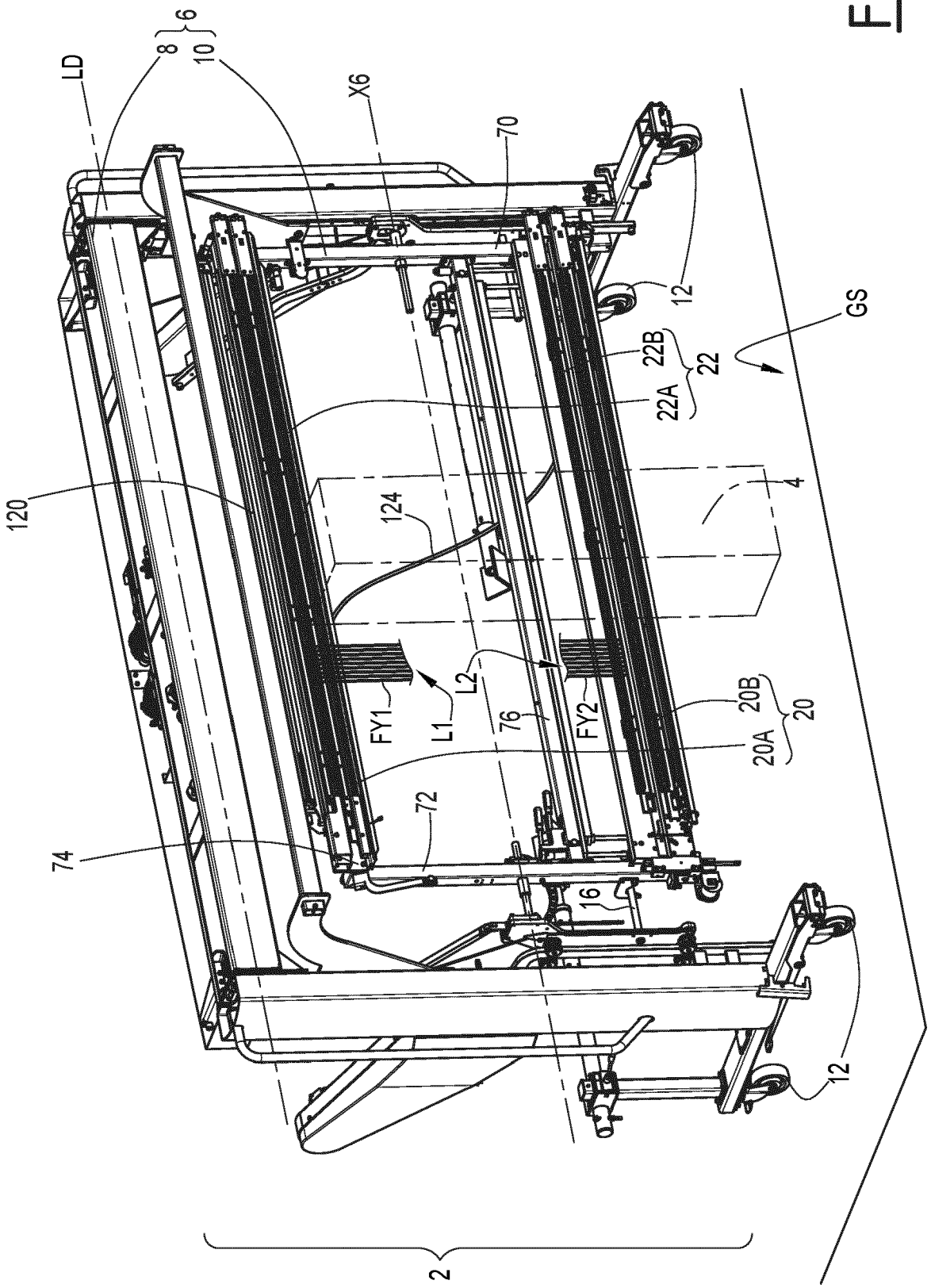
c) allowing a longitudinal movement of the third clamping rail (22A) relative to the first clamping rail (20A) and to the frame structure (10) and securing the third clamping rail (22A) with the unit frame (42) of the drawing-in unit (4) in the longitudinal direction (LD); and
d) moving the first clamping rail (20A) relative to the unit frame (42) along the longitudinal direction (LD) to adjust a longitudinal distance between a front-most yarn (FY1) of the first yarn layer (L1) and a front-most yarn (FY2) of the second layer (L2).

15. The drawing-in method according to claim 14, wherein

- the drawing-in unit (4) comprises a yarn detection device (60) configured to detect a longitudinal position of the front-most yarn (FY1, FY2) of the selected yarn layer relative to the unit frame (42);
- the working phase includes at least additional steps implemented before step b) and consisting in:

e) memorizing a last longitudinal position of the front-most yarn (FY1, FY2) of each yarn layer relative to the unit frame (42) before this yarn layer is unselected, this last position depending on an output signal of the yarn detection device (60);
f) computing an offset between the two yarn layers, based on the last memorized longitudinal position of the front-most yarn (FY1, FY2) of each yarn layer (L1, L2),
g) comparing the offset computed at step f) to a predetermined value; and
h) if the result of step g) is that the offset computed at step f) is larger than the predetermined value, stopping the working phase and launching the offset compensation phase.

FIG.1


LD
6
8
10
X6
70
12
GS
22B
22
22A
120
124
4
L2
FY1
L1
76
FY2
20B
20
20A
72
74
16
12
2

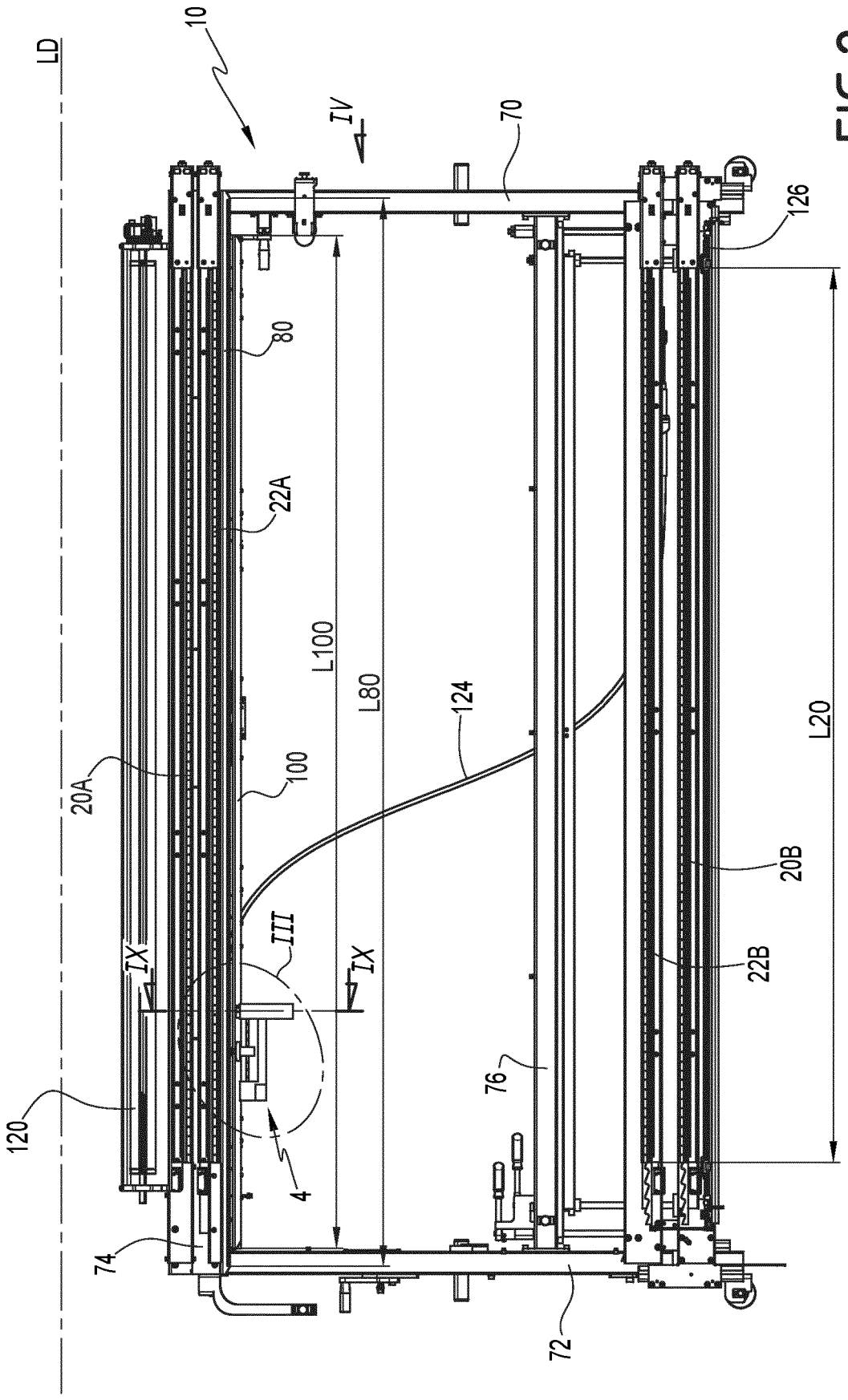

LD
10
IV
70
126
80
22A
L100
L80
124
L20
20A
100
20B
III
IX
IX
22B
76
120
4
74
72

FIG.2

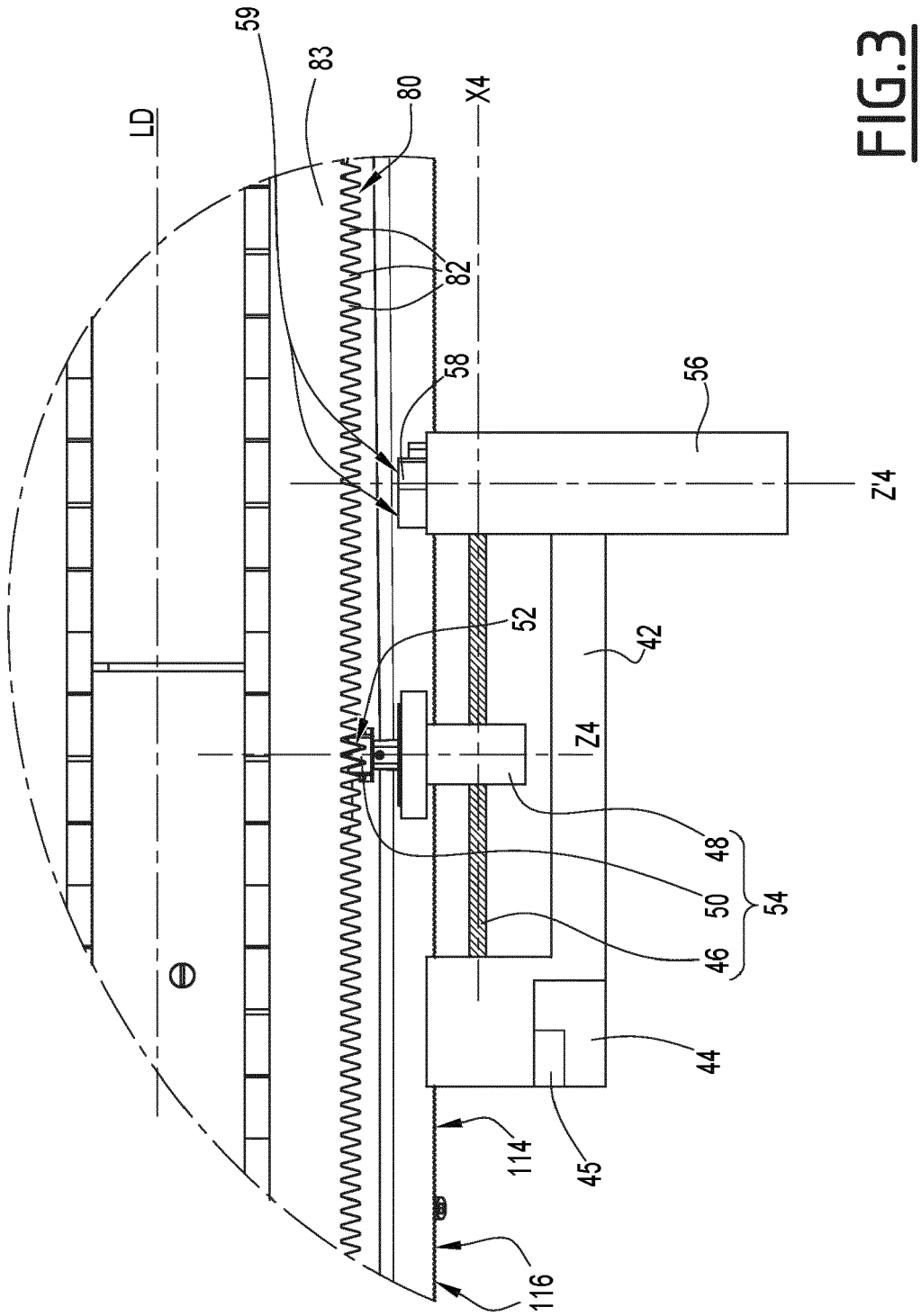


FIG.3

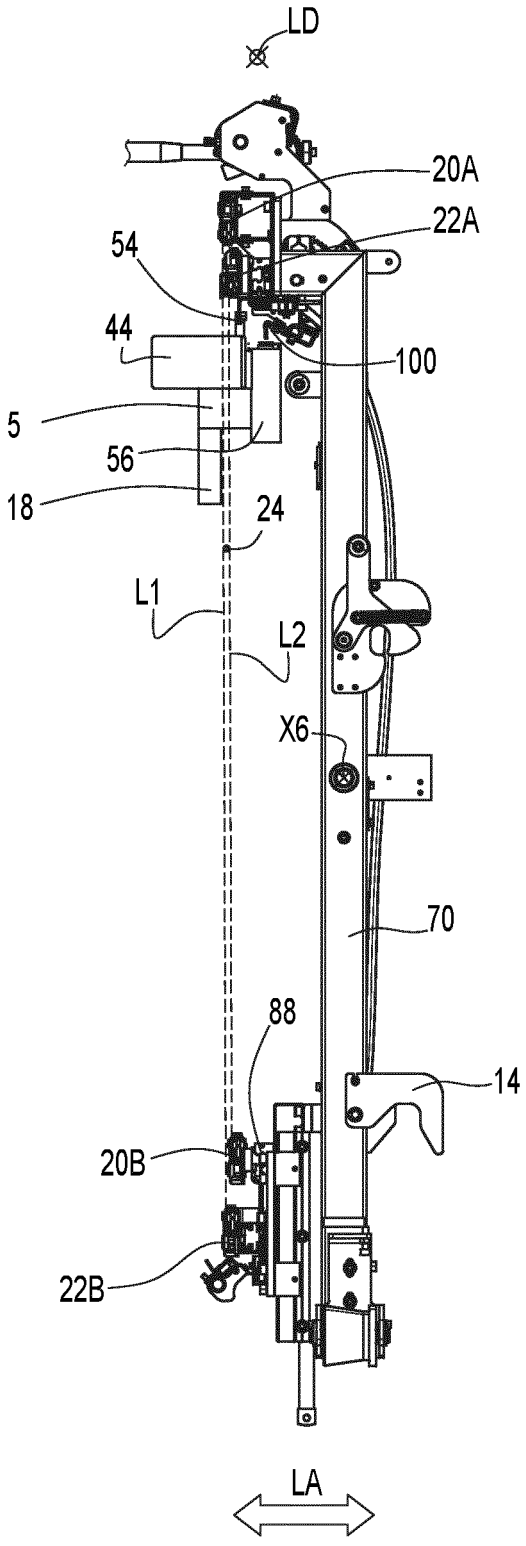
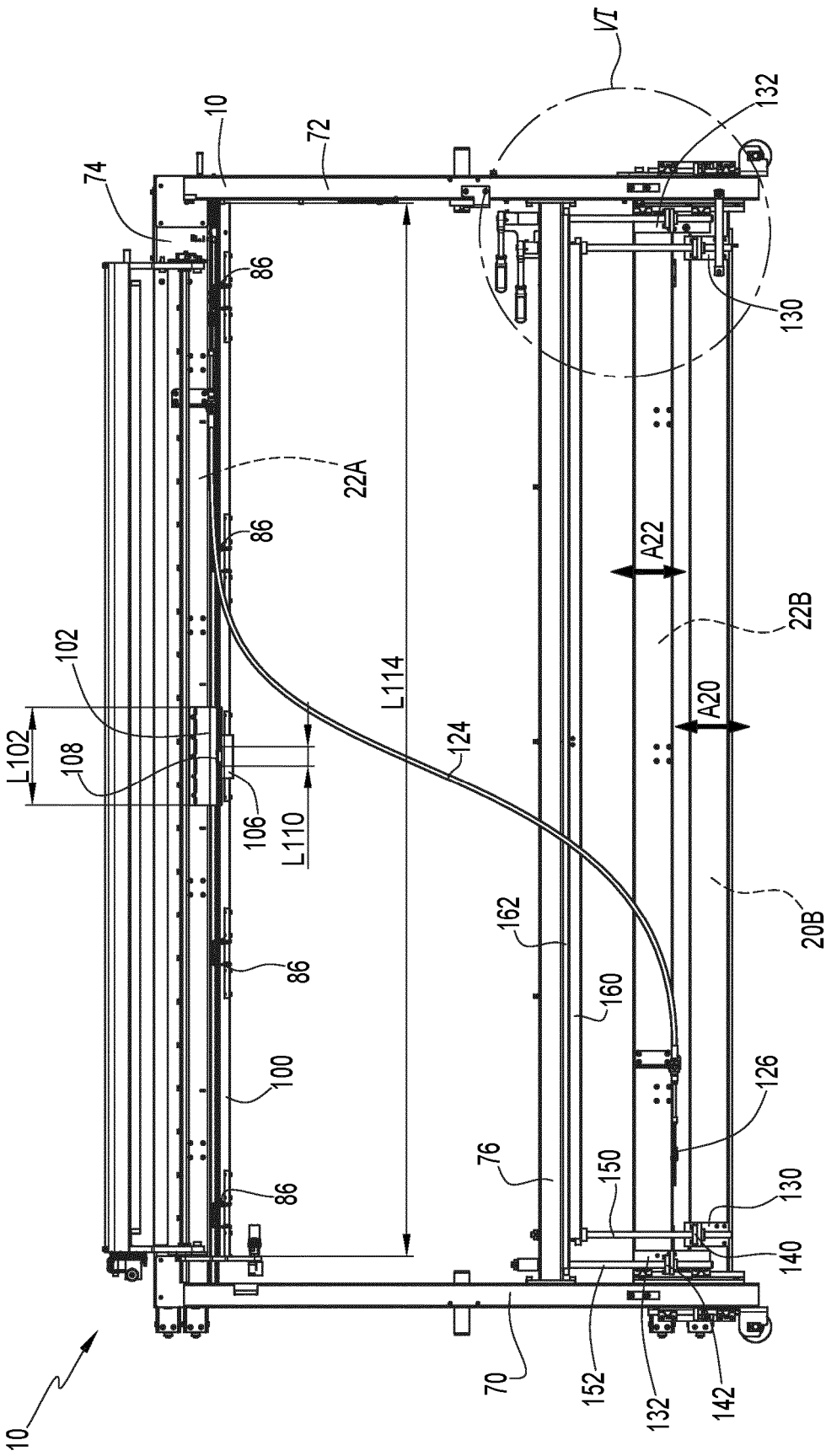


FIG.4


VI
132
10
72
74
86
130
22A
86
A22
22B
102
L114
A20
L102
108
124
106
L110
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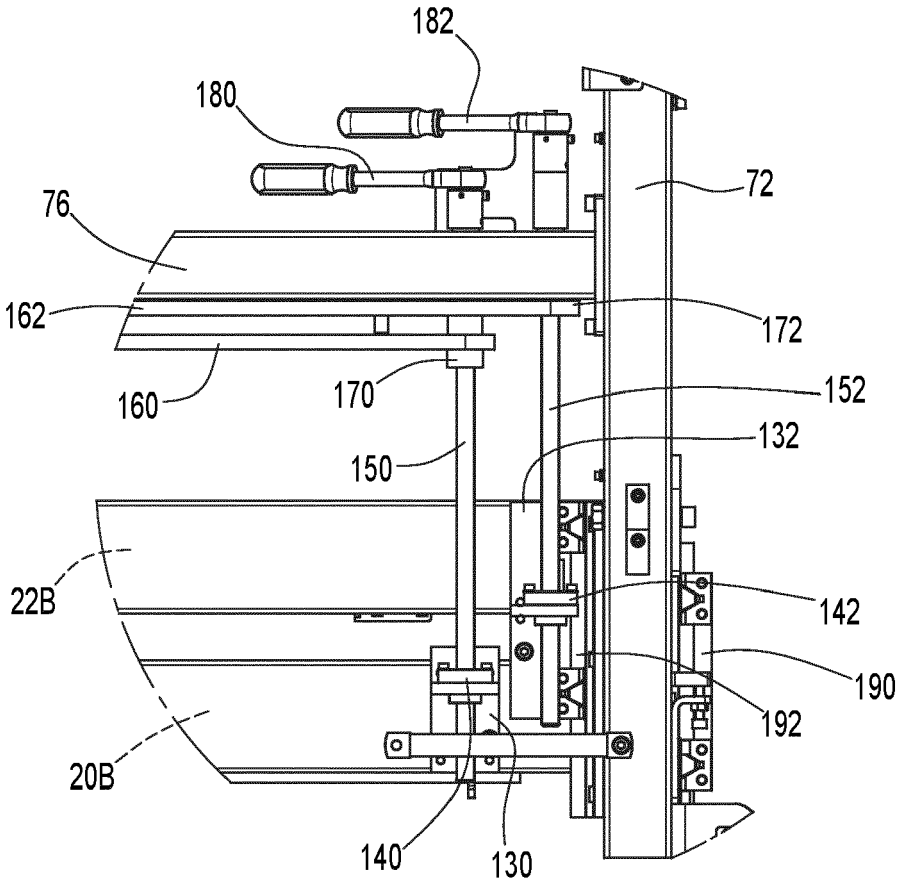
130
86
140
70
152
132
142
10

FIG.5


182
180
72
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162
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152
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132
22B
142
190
192
20B
140
130

FIG.6

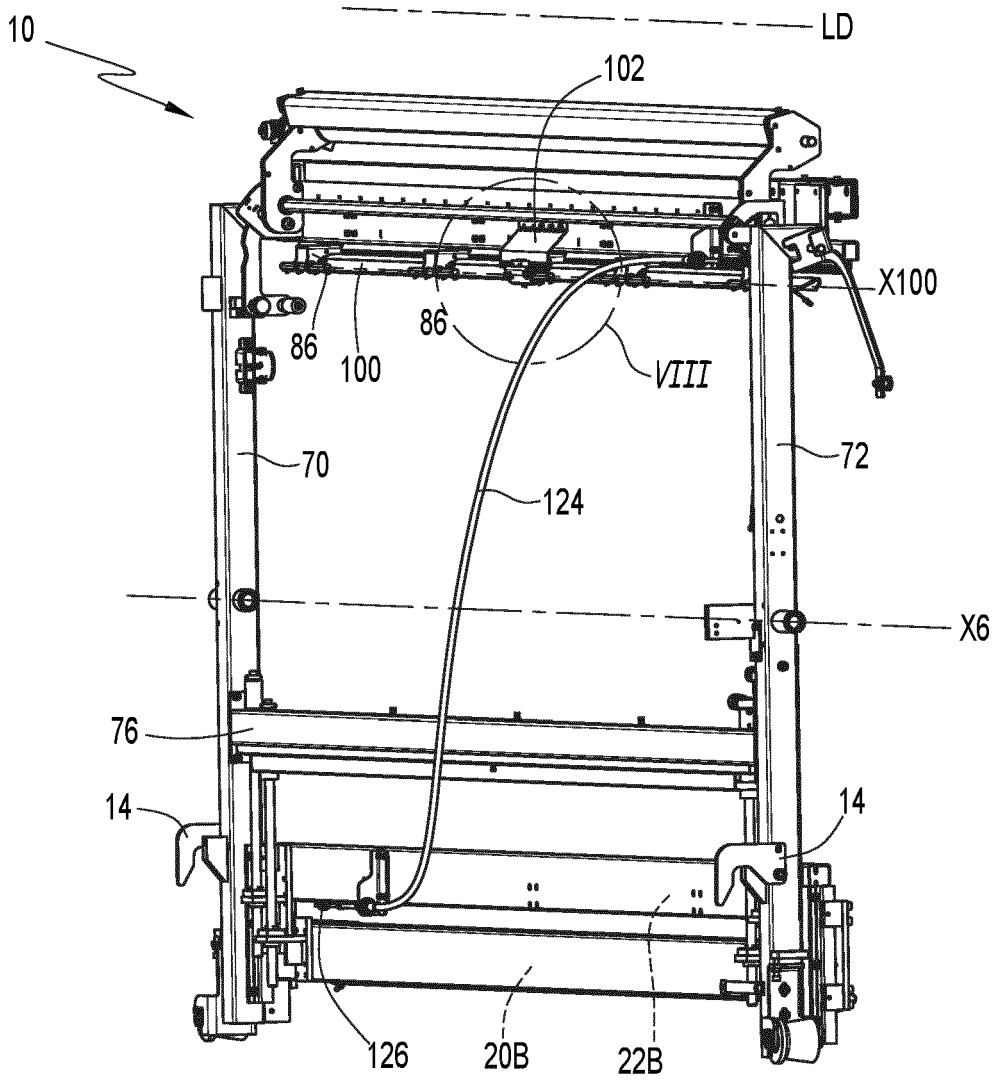


FIG.7

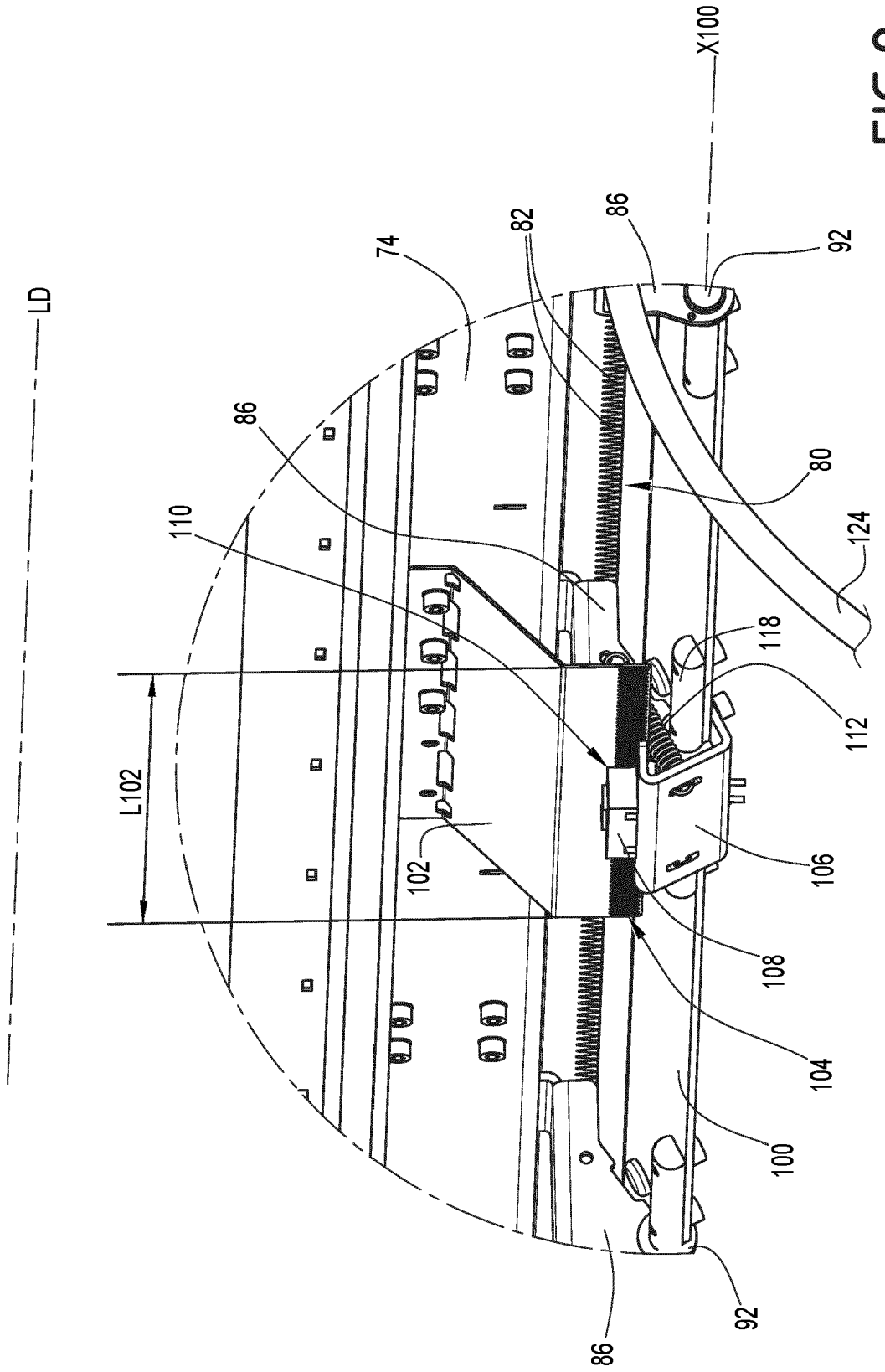

X100
LD
74
82
86
92
86
80
110
124
118
112
L102
102
106
108
104
100
86
92

FIG.8

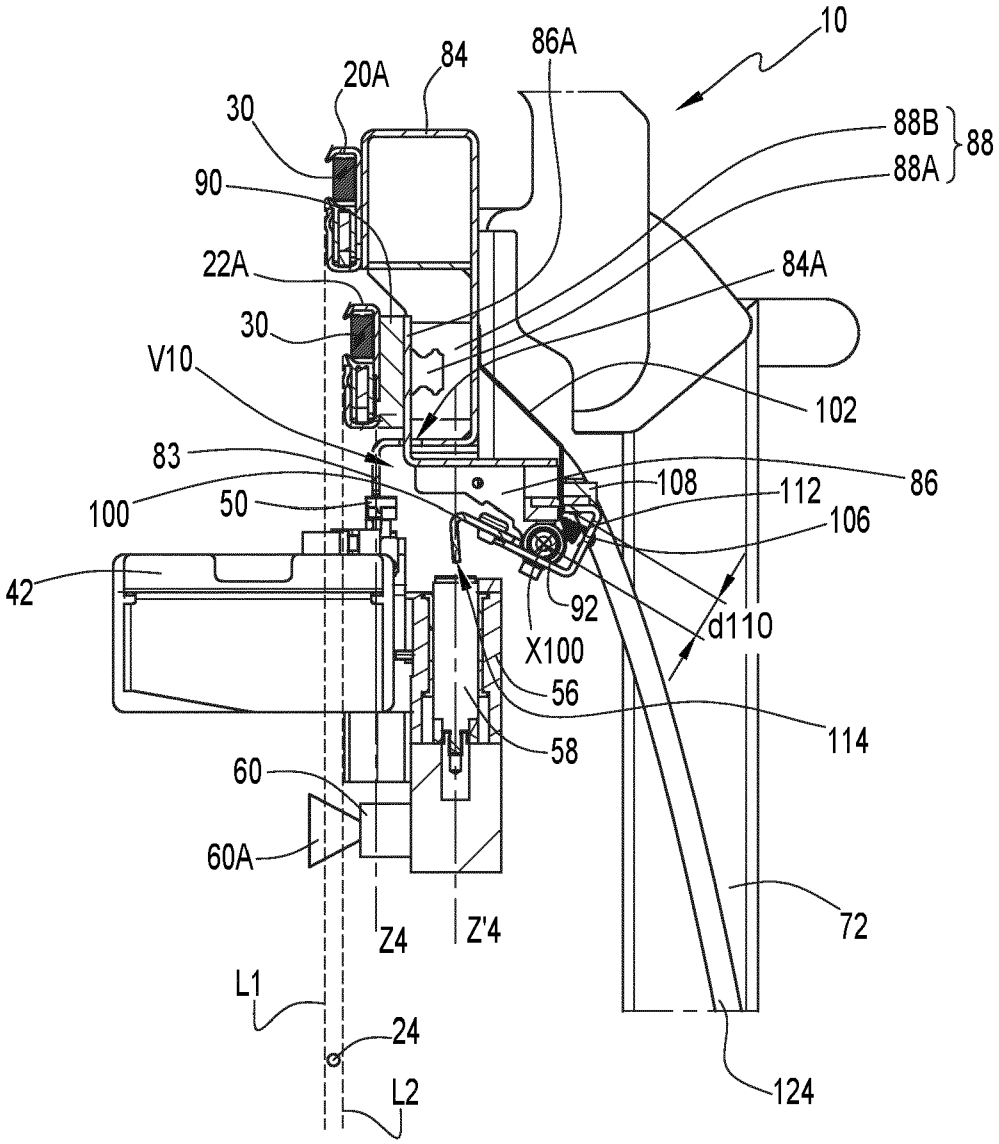
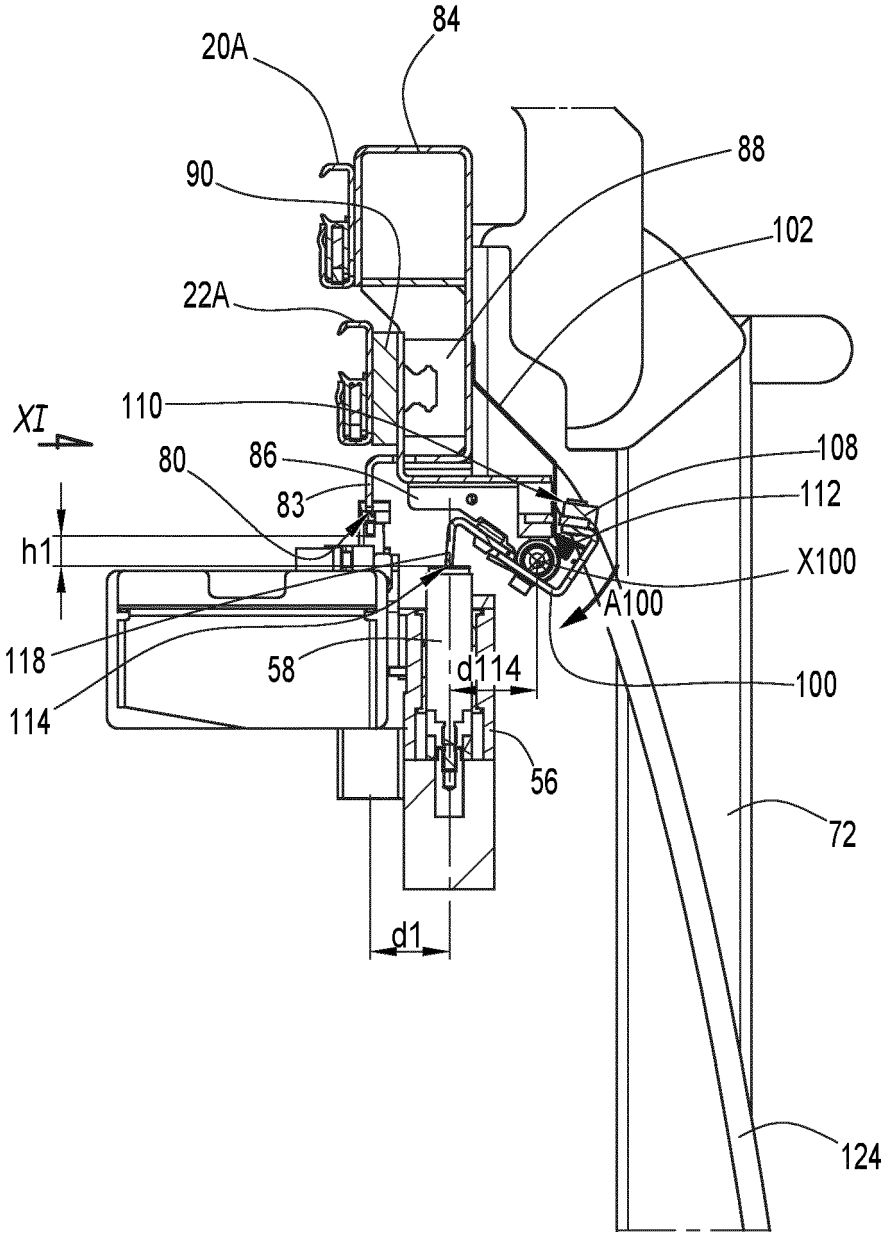

10
86A
84
20A
30
88B
88
88A
90
84A
22A
30
V10
102
83
86
108
112
100
50
106
42
92
d110
X100
56
114
58
60
60A
72
Z4
Z'4
L1
24
L2
124

FIG.9


84
20A
88
90
102
22A
XI
110
108
80
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112
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h1
X100
A100
118
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d114
100
114
56
72
d1
124

FIG.10

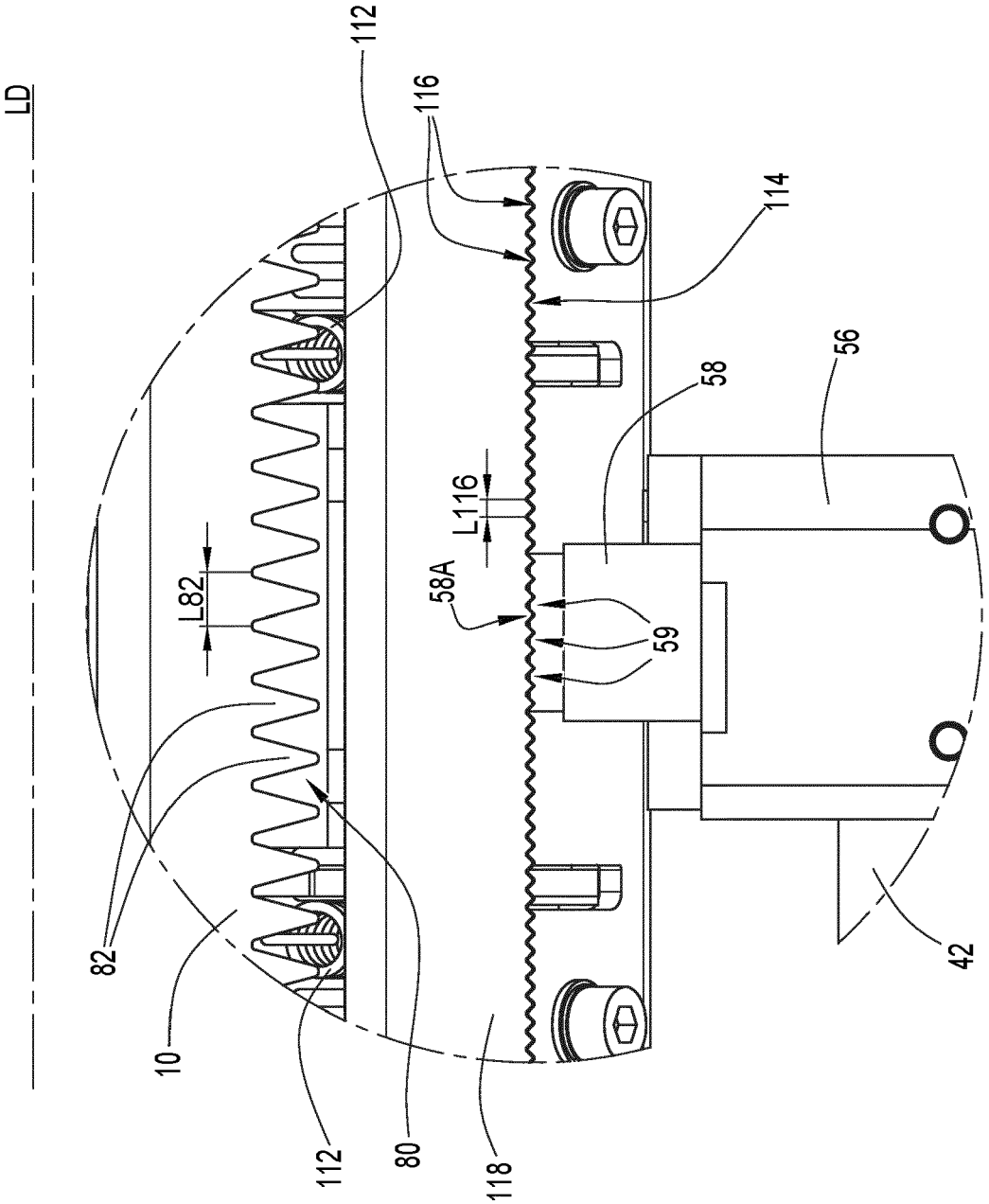

FIG.11

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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 9473

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,D	EP 4 033 020 A1 (STAEUBLI SARGANS AG [CH]) 27 July 2022 (2022-07-27) * claim 1; figures 1-2 * * paragraphs [0098], [0100], [0103] *	1-15	INV. D03J1/14
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TECHNICAL FIELDS SEARCHED (IPC)

D03J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 April 2024	Iamandi, Daniela

CATEGORY OF CITED DOCUMENTS

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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