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(54) **YARN ARRANGING MACHINE**

(57) The invention relates to a yarn arranging machine (1) for forming a warp with a desired yarn arrangement from a plurality of yarn layers, each layer comprising a plurality of yarns extending parallel to each other lengthwise along a machining direction of the yarn arranging machine (1), said yarn arranging machine (1) comprising; an open collector comb (50) for receiving the plurality of yarns according to the desired yarn arrangement, the collector comb extending lengthwise along a transverse direction (T) across the width of the plurality of yarn layers transverse to the machining direction; a yarn releasing device (20) comprising at least one support member (22) for supporting the yarns of a respective yarn layer selected from the plurality of yarn layers, said support member

(22) having a free end and being interposable between the yarns of the selected yarn layer and the collector comb (50); releasing driving means (26) configured to move the free end of the support member (22) in the transverse direction (T) relative to the selected yarn layer to free a passage for the supported yarns of the selected yarn layer toward the collector comb (50); collector driving means configured to cause a relative movement between the collector comb (50) and the selected yarn layer at least in the transverse direction (T). The invention further relates to a method for preparing a warp with a desired yarn arrangement from a plurality of separated yarn layers overlapping each other across the width of the plurality of yarn layers.

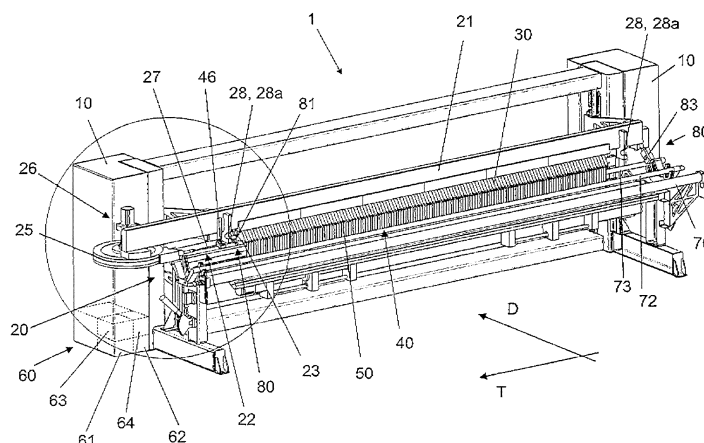


Fig. 1

Description

[0001] The present invention relates to a yarn arranging machine for forming a warp with a desired yarn arrangement from a plurality of separated yarn layers, each layer comprising a plurality of yarns extending lengthwise parallel to each other along a machining direction of the yarn arranging machine. The invention further relates to a method for preparing a warp with a desired yarn arrangement from a plurality of separated yarn layers overlapping each other across the width of the plurality of yarn layers.

[0002] Color and ornamentation in woven fabrics is imparted through the pre-determined arrangement and interlacing of yarns. For example, figured ornamentation is created through the selection of different groups of colored yarns, placed in the warp and/or in the weft. The specific yarn arrangement of the warp is the relative position that the different warp yarns should occupy along the warp width. The specific warp yarn arrangement, e.g. a desired color repeat of the yarns, is usually done by hand before winding the yarns onto the weaving beam. For this, yarns from a plurality of separated yarn layers, each layer comprising a plurality of yarns of one specific color and/or shape extending lengthwise parallel to each other, are manually distributed and arranged into a comb along its longitudinal direction transverse to the longitudinal extension of the yarns in order to have a better repartition along the width direction of the weaving beam according to the fabric to be woven with the weaving beam. Otherwise, yarns may cross or even break during weaving and the automatic drawing-in of yarns from the weaving beam into a subsequent stage of warp preparation may be faulty. As a consequence, the quality and efficiency of the weaving process will decrease. However, due to the large number of yarns to be arranged - which is typical of the order of several thousand yarns - manual yarn arrangement is very time-consuming if a highly accurate arrangement is to be achieved. For this reasons, a solution for preparing a warp with a desired yarn arrangement from a plurality of separated yarn layers with as much automation as possible is highly desirable.

[0003] In CN 103046266 A, it is proposed to use a leasing machine for preparing a warp with a specific yarn arrangement. Yarns are separated in turn from different layers and lease cords are automatically introduced to separate two adjacent yarns of the warp according to the desired yarn arrangement. Subsequently, the yarn arrangement with lease cords is transferred to a comb. However, known leasing machines are not adapted to all kind of color repeats because the number of layers to be handled by a leasing machine as well as the yarn offset realizable with known leasing machines are limited. Yarn offset is the deviation of a yarn from its position in the layer into its position in the warp in the width direction of the layer, i.e. the deviation in the transverse direction relative to the longitudinal extension of the yarns. Besides

that, it is difficult to transfer the yarn arrangement maintained by lease cords into a comb that is needed to wind the warp on the weaving beam.

[0004] Hence, it is an object of the present invention to provide a yarn arranging machine with as much automation as possible and allowing for a large yarn offset and for a large number of yarns to be handled.

[0005] This object is solved by the yarn arranging machine according to claim 1 and by the method according to claim 15. According to the invention, the yarn arranging machine comprises an open collector comb for receiving the plurality of yarns according to the desired yarn arrangement, wherein the collector comb extends lengthwise along a transverse direction across the width of the plurality of yarn layers transverse to the machining direction. The yarn arranging machine further comprises a yarn releasing device comprising at least one support member for supporting the yarns of a respective yarn layer selected from the plurality of yarn layers, said support member having a free end and being interposable between the yarns of the selected yarn layer and the collector comb in order to free a passage toward the collector comb for releasing the yarns of the selected yarn layer therefrom into the yarn collector comb. The yarn arranging machine further comprises releasing driving means configured to move the free end of the support member in the transverse direction relative to the selected yarn layer to free a passage for the supported yarns of the selected yarn layer toward the collector comb. In addition, the yarn arranging machine comprises collector driving means configured to cause a relative movement between the collector comb and the selected yarn layer at least in the transverse direction.

[0006] To cause a relative movement between the collector comb and the selected yarn layer at least in the transverse direction, the collector driving means may be configured to move only the collector comb, while no driving means move the selected layer in the transverse direction, or the collector driving means may be configured to move only the selected yarn layer, while the collector comb remains static in the transverse direction, or the collector driving means may be configured to move both, the collector comb and the selected layer in the transverse direction.

[0007] Arranging the yarns directly into a comb allows a much more accurate yarn arrangement on the weaving beam as compared to using a leasing machine for the yarn arrangement. As a consequence, the weaving beam will have a much better quality and less broken yarns improving subsequent drawing-in and weaving processes. Using a support member with a free end movable relative to the yarns simplifies the release of the yarns into the collector comb and reduces the deflection of the yarns along the transverse direction during the arrangement process. Furthermore, due to the relative movement between the respectively selected yarn layer and the collector comb, the yarn arranging machine is able to provide larger offsets as compared to arranging meth-

ods using leasing machines. In particular, a movable collector comb allows not to depend on the spacing between the yarns in the respective layer before the releasing.

[0008] Each layer comprises a plurality of yarns extending lengthwise parallel to each other along a machining direction of the yarn arranging machine before the yarns of each layer are deflected by the yarn releasing device to be arranged in the collector comb. When each yarn of the layer extends in the machining direction, it passes through the collector comb of the yarn arranging machine, the collector comb being in its working position.

[0009] Typically, each layer may comprise yarns of a specific color, thickness, material and/or shape which are to be arranged according to the desired yarn arrangement for forming e.g. a warp. The yarn arranging machine is preferably used to handle all kind of yarns, in particular all kind of yarns used for shirting. As a further advantage of the present invention, there is no limit in handling as much layers as required to form the desired yarn arrangement because the plurality of yarn layers are selectively suppliable to the yarn releasing device. The plurality of layers are layered in parallel next to each other, in particular on top of each other, separated from each other by e.g. dividing rods or cords.

[0010] The yarn arranging machine may be used in different setups for weaving beam preparation. For example, the yarn arranging may be positioned between a dividing field and a beaming unit used for winding a weaving beam. The plurality of yarn layers are provided by warper's beams, each warper's beam carrying one layer of yarns extending lengthwise parallel to each other reeled-up thereon. From there, the layers may pass through a sizing and drying device and are subsequently being spaced apart from each other in the dividing field, e.g. by dividing rods or cords. The dividing rods may be hold e.g. in corresponding supports of the dividing field. From the dividing field, the different layers may then pass through the yarn arranging machine toward the beaming unit. As a consequence, the layers are fixed and tensioned in between the beaming unit and the respective warper's beam by tensioning means of the sizing machine. Of course, the yarn arranging machine may also be used at different places or in other setups for weaving beam preparation. For example, at a sizing machine, the yarn arranging machine may be placed between the bobbin creel or warper's beams and a sizing device, or between a sizing and drying device and a dividing field. The yarn arranging machine may also be used at a parallel line to the sizing machine: the warp yarn arrangement is done from the warper's beams into an open collector comb and is then fixed by tape to be available during the next sizing process. The yarn arranging machine may also be used at a re-beaming machine, between warper's beams and the beaming unit without a sizing device therebetween. In particular, the entire yarn arranging machine may be transferrable to different places, e.g. by being mounted onto a transport frame comprising wheels.

[0011] In terms of the present invention, "selected yarn layer" or "respectively selected yarn layer" refers to that layer of the plurality of yarn layers that is currently supplied to the support member of the yarn releasing device, whereas the other layers of the plurality of yarn layers are either already arranged in the collector comb or are still to be supplied to and processed by the support member one after the other as soon as the release process of the current "selected yarn layer" is finished. Therefore, as soon as the release process of a respectively selected yarn layer is finished, another layer will be supplied to and processed by the support member which consequently corresponds the new/next selected yarn layer".

[0012] In terms of the present invention, a movement relative to the respectively selected yarn layer refers to a movement in the transverse, preferably perpendicular, direction with respect to the length extension of yarns of the selected layer that are supported by the support member. A movement relative to the respectively selected yarn layer across the width of this layer refers to a movement in the transverse, preferably perpendicular, direction with respect to the length extension of yarns and transverse, preferably perpendicular, to the normal of the respectively selected yarn layer.

[0013] In a first preferred embodiment, the longitudinal axis of the collector comb extends along the layer width and perpendicular to the machining direction as well as perpendicular to the parallel orientation of the yarns. Preferably, the direction of the relative movement between the collector comb and the respectively selected yarn layer is also perpendicular to the machining direction as well as perpendicular to the parallel orientation of the yarns.

[0014] In another preferred embodiment, the collector driving means is configured to cause the relative movement between the collector comb and the selected yarn layer at least in the transverse direction by moving at least the collector comb at least in the transverse direction. The respectively selected layer may either be static in the transverse direction (, i.e. is not moved by the collector driving means) or movable in the transverse direction, either by the collector driving means for moving the collector comb or by further collector driving means. This configuration of the movable collector comb helps to limit deviation of the yarns of the selected layer in the transverse direction. Preferably, the yarn collector comb is movable relative to the respectively selected yarn layer over at least 20 cm, in particular over at least 30 cm, preferably over at least 40 cm allowing for offsets of the same order. In addition, the length of the collector comb may be preferably larger than the full width of the selected yarn layer and/or may be as large as or even larger than the length of the weaving beam. Typically, the collector comb may have a length of 2200 mm which corresponds to the maximum width of typical weaving beams, though the length portion of the weaving beam carrying the yarns reeled-up thereon may be smaller.

[0015] In another preferred embodiment, the collector

driving means is configured to move only the collector comb in the transverse direction.

[0016] In another preferred embodiment, the yarn arranging machine may further comprise a frame to which the yarn releasing device and the collector comb are movably attached to, wherein the collector driving means move the collector comb relative to the frame in the transverse direction and the releasing driving means move the free end relative to the frame in the transverse direction.

[0017] In a further embodiment, the collector comb may be part of a yarn collector device that preferably also comprises the collector drive means, such as a step motor, and guiding means for moving the collector comb and the respectively selected yarn layer relative to one another at least in the transverse direction.

[0018] The collector comb may comprise rod-like or plate-like or needle-like teeth. Furthermore, the teeth density may be larger than 50 teeth/dm, in particular 60 teeth/dm or larger. In order to facilitate receiving yarns released from the releasing device, the inter-teeth space may be larger than the largest diameter of any yarn to be arranged in the yarn collector comb. The teeth length may be more than 3 cm, in particular more than 5 cm, preferably 10 cm or longer.

[0019] In another preferred embodiment, the support member is configured to deflect the supported yarns of the selected yarn layer out of the collector comb. Hence, the yarns, when being deflected by the support member, are deviated from the machining direction in a direction perpendicular to the transverse direction and to the machining direction. The deflected yarns form a triangular space volume through which the open end of the collector comb extends. The yarns to be released move into the collector comb due to their deflection and pre-tension as soon as the passage toward the collector comb is freed. The yarn releasing device may be arranged above the collector comb such that the releasing path from the releasing device toward the collector comb has some vertical component.

[0020] Most preferably, the support member comprises at least one releasing rod having a free end movable transverse to the machining direction across the full width of the respectively selected yarn layer, preferably parallel to the relative movement between the collector comb and the respectively selected yarn layer, such as to release the yarns of the respectively selected yarn layer at the moving free end.

[0021] The releasing rod is preferably flexible and/or windable such that the releasing rod is windable at the opposite side of the free end, e.g. onto a winder. The winder may be driven by a winder motor, e.g. a step motor. The releasing rod may be windable around an axis perpendicular to the transverse direction. Such a flexible and windable releasing rod furthermore allows to keep the size of the yarn arranging machine as small as possible such that the arranging machine may be adapted to a sizing machine or other warp preparing machines

for weaving processes. In addition, the releasing rod may be of any cross-sectional shape, e.g. rectangular, square, triangular, round or oval. In a particular embodiment, the releasing rod may be made of steel with a constant round cross-section having a diameter of about 2 mm. The free end extends substantially perpendicular to the length direction of the releasing rod. The support surface of the releasing rod supporting the selected yarn layer directly passes on to the free end, i.e. the support surface and the surface forming the free end intersect each other.

[0022] Due to the free end of the releasing rod that is shifted relative to some pre-tensioned supported yarns of selected yarn layer, the yarn releasing process into the collector comb is automatic, i.e. no manual operation or gripper means to transfer the yarns of the selected yarn layer from the support member into the collector comb is necessary. This is a particular benefit of the present invention as the layered arrangement of the plurality of layers does only allow limited access to a specific layer for the operator. In addition, the releasing rod with its free end is compatible with all types of yarns without modifications. A further advantage of the releasing rod is that it only has to be moved along one axis which does not need much technical effort.

[0023] In order to guide and support the releasing rod when it is fully withdrawn, the yarn releasing device may further comprise a guiding member, e.g. a closed conduit or channel or a semi shell-like conduit or channel, through or on which the releasing rod is guided and supported along its moving direction.

[0024] Instead of a flexible and windable rod, the support member may be a threaded rod with a free end that is rotatable by a motor drive around the rod axis in order to be moved back- and forward along the rod axis. In particular, this allows for a high stroke precision due to the given pitch of the threaded rod.

[0025] Alternatively, the support member may be a rigid rod with a free end that is moved along its rod axis in order to release the yarns supported thereon. In particular, each layer may be individually supported by a corresponding releasing rod, wherein the respective rods may be coupled one after the other to a drive motor in order to be moved along their rod axes for releasing the yarns supported thereon. Preferably, the releasing rods are used to separate the layer from each other and substitute any dividing rods.

[0026] According to another embodiment of the present invention, the yarn arranging machine further comprises position detection means for detecting the position of the collector comb relative to the free end of the support member along the transverse direction.

[0027] According to another embodiment of the invention, the yarn arranging machine may further comprise a controller unit for controlling the releasing driving means and the collector driving means and yarn detection means in operative communication with the controller unit for detecting the yarns of the selected yarn layer

while being in the freed passage toward the collector comb. Preferably, the yarn detection means may be optical yarn detection means such as a camera, e.g. CCD camera, or a photoelectric barrier. In particular, the yarn detection means may comprise an optical detection beam, e.g. a laser beam, and a corresponding beam detector, e.g. a photodetector. For this, the optical detection beam may pass from the beam source toward the beam detector across the full width of the selected yarn layer between the collector comb and the support member such as to be crossed by each yarn being released from the releasing device into the collector comb. Alternatively, the optical detection beam is emitted at the free end of the releasing rod from an optical fiber housed within the releasing rod along the rod axis to monitor the passage freed by the moving free end.

[0028] The controller unit may comprise calculation means that automatically calculate the arranging sequence for each layer according to the desired yarn arrangement for the warp, i.e. the determined length portion of the collector comb that each yarn of the respective layer shall occupy along the length of the collector comb according to the desired yarn arrangement, which simplifies the operator's work. To synchronize the movement of the collector comb and the yarn release of the yarn releasing device, i.e. the movement of the releasing rod, according to the pre-determined arranging sequence, the controller unit may further comprise specific synchronization means.

[0029] The detection of the yarns being released in a specific time frame allows the controller unit, in particular the synchronization means, to adjust in real time the relative transverse movement between the releasing rod and the collector comb to make the yarn arrangement as close as possible to the desired yarn arrangement.

[0030] Furthermore, the controller unit may comprise a yarn counter and/or a layer counter counting the number of yarns and layers being released from the releasing device into the collector comb, thereby ensuring that all yarns have been processed and helping to detect and avoid possible faults in the yarn arrangement.

[0031] For controlling the different movements of the yarn releasing device and the yarn collector device, the controller unit may be operatively connected to any drives of the yarn releasing device and the yarn collector device, in particular of the support member, i.e. of the releasing rod, and of the yarn collector comb. In addition, the controller unit may comprise a user interface, such as a touch screen, to allow for data input and output as well as for manual process control. In particular, data about the collector comb and/or the releasing comb may be provided to the controller unit, such as teeth density, inter-teeth spacing, or the like.

[0032] According to yet another embodiment, the yarn releasing device may further comprise a releasing comb formed by adjacent open-ended teeth through which at least the yarns of the selected yarn layer extend, the support member being movable relative to the releasing

comb in the transverse direction. The releasing comb facilitates to limit concomitant yarn displacements when the releasing rod moves relative to the supported yarns and, thus, to ensure movement of the releasing rod causes the release of the desired number of yarn(s).

[0033] Preferably, the releasing comb has a fixed position relative to the frame in the transverse direction and extends across the full width of the selected yarn layer. In particular, the releasing comb may comprise rod-like or plate-like or needle-like teeth. The teeth density of the releasing comb may similar to the teeth density of the collector comb, in particular may be larger than 50 teeth/dm, preferably 60 teeth/dm or larger. In particular, with a teeth density similar to the collector comb, the releasing comb may receive one yarn of each layer at the most between two of its teeth which will help to individually release the yarns into the collector comb. Furthermore, the releasing comb may have a length of 2200 mm which corresponds to the maximum width of typical weaving beams for shirting.

[0034] Preferably, the releasing rod cooperates with the releasing comb to withhold the yarns supported on the moving releasing rod. For this, the releasing comb may comprise at least one support opening in each tooth for the movable support member to pass through. In order to make the yarn detection as accurate and as fast as possible, the releasing comb may further comprise at least one detection opening in each tooth for the optical detection beam to pass through.

[0035] In order to increase the yarn offset to be achievable in the desired yarn arrangement, the releasing comb may also be movable by collector driving means along its longitudinal extension with respect to the collector comb and the frame.

[0036] In a further embodiment of the invention, the yarn arranging machine may comprise fore and/or aft guiding means, e.g. guiding rods or guiding rollers, positioned fore and aft the yarn releasing support member with respect to the machining direction for guiding and/or pre-tensioning the plurality of layers. The fore and/or aft guiding means - being in touch with the yarn layers - may further be movable transverse to the plane of the layers such as to provide additional yarn length, e.g. to limit tension in the yarns when being deflected by the releasing support member and to allow yarns already sorted into the collector comb to follow the transverse movement of the collector comb.

[0037] In addition, the yarn arranging machine may also comprise fore and/or aft deflecting means, e.g. deflecting rods or deflecting rollers, being positioned or detachably arrangeable fore and aft the support member of the yarn releasing with respect to the machining direction for guiding and/or pre-tensioning the respectively selected yarn layer supplied to the releasing device. In particular, the fore deflecting means, the aft deflecting means and the yarn releasing support member may encompass - in a particular working configuration of the yarn arranging machine - a triangular space volume

transverse to the machining direction, the collector comb open end extending therethrough. In particular, such deflecting rods may ensure enough and constant yarn deflection causing an accurate and reproducible release of the respectively yarns supported by the yarn releasing support member. The fore and/or aft deflecting means may further be movable transverse to the plane of the selected layer in order to adjust the deflection and tensioning of the selected layer.

[0038] According to yet another embodiment, the yarn releasing device and/or the collector comb are movable relative to the frame in a direction transverse to the machining direction and the transverse direction, in particular the yarn releasing device and the collector comb are movable relative to one another in a direction transverse to the machining direction and the transverse direction, preferably in the vertical direction. In particular, the yarn releasing device and the collector comb may be movable toward each other between a close working configuration, in which maximum distance between the releasing comb and the collector comb is 5 mm, and a spaced non-working configuration, in which minimum distance between the releasing comb and the collector comb is 100 mm. These options allow for arranging the yarn releasing device and/or the collector comb in different configurations, e.g. for feeding the plurality of yarn layers to be arranged into the yarn arranging machine or for sizing the yarn layers without obstacle with the yarn releasing device and with the collector comb.

[0039] The yarn arranging machine may further comprise driving means, such as moving cylinders, spindle drives or the like, for moving the yarn releasing device and/or the yarn collector device with respect to the frame. In particular, the yarn releasing device may be attached to a crossbeam that is movably attached to the frame and that also may support the winder carrying the releasing rod as well as the winder motor. In a similar way, the yarn collector device may comprise a crossbeam that is movably attached to the frame and carries the driving means and guiding means for the collector comb as well as the collector comb itself.

[0040] Furthermore, the yarn arranging machine may comprise selecting means for selecting and separating a respective yarn layer to be supplied to the support member from the other layers still to be selected and processed. Selecting means are interposed between a respective selected layer and other layers to be selected (not yet released) and between other layers to be selected and the open collector comb. In this way, layers to be selected are kept at a certain distance from the open collector comb in order to not interfere with yarns already arranged in the open collector comb. For example, dividing rods of a dividing field being placed in front of the yarn arranging machine in the machining direction may be used as selecting means. These dividing rods already separate the plurality of layers from each other and may be easily introduced/inserted into the yarn arranging machine. In particular, the yarn releasing device may com-

prise supports to detachably support the selecting means, e.g. the dividing rods. In the preferred embodiment, these supports may have inclined recesses to receive and hold a dividing rod. Alternatively, separating cords may be used as selecting means for selecting and separating a respective yarn layer to be supplied to the releasing support member.

[0041] The invention further relates a sizing machine including a creel, a sizing device, a beaming unit and a yarn arranging device according to the invention. The yarn arranging device is placed between the creel and the beaming unit.

[0042] The invention further relates to a method for preparing a warp with a desired yarn arrangement from a plurality of separated yarn layers overlapping each other across the width of the plurality of yarn layers, the method comprising the steps;

- a. Determining an arranging sequence for the yarns of each layer to be arranged into a yarn collector comb according to the desired yarn arrangement;
- b. Selecting and separating one yarn layer out of the plurality of yarn layers and interposing a support member between the collector comb and the selected yarn layer;
- c. Positioning a determined length portion of the collector comb to be occupied by a first yarn or first set of yarns of the respectively selected yarn layer relative to the support member according to the arranging sequence of the selected yarn layer;
- d. Releasing the first yarn or the first set of yarns from the support member into the respective length portion of the collector comb;
- e. Consecutively perform steps c. and d. for all further yarns or set of yarns of the selected yarn layer to be sorted into a respective length portion of the collector comb according to the desired yarn arrangement;
- f. Consecutively perform steps b. to e. for all further yarn layers of the plurality of yarn layers,

[0043] According to a preferred embodiment of the method, the method further includes the detection of the yarns while being released from the support member into the respective length portion of the collector comb.

[0044] The invention will now be further described by way of example only with reference to the accompanying drawings in which:

Fig. 1 shows a perspective view of a specific embodiment of the yarn arranging machine according to the present invention;

Fig. 2 shows the detail perspective view of the

- yarn Releasing device of the yarn arranging machine according to Fig. 1;
- Fig. 3 shows a perspective view of the yarn arranging machine according to Fig. 1 without the yarn releasing device and the controller unit;
- Fig. 4 shows a schematic illustration of the release process of the yarn arranging machine according to Fig. 1;
- Fig. 5 shows a side view of a sizing machine for forming a weaving beam with a warp yarn arrangement using the yarn arranging machine according to Fig. 1; and
- Figs. 6a-6f illustrate, from a side view of the yarn arranging machine, the method for preparing a warp with a desired yarn arrangement using the yarn arranging machine according to Fig. 1.

[0045] Fig. 1 to 3 show a preferred embodiment of a yarn arranging machine 1 according to the present invention. The yarn arranging machine 1 comprises a yarn releasing device 20 to which a plurality of separated yarn layers 100, 200, 300, 400 are selectively suppliable as depicted in Figs. 4, 5 and 6a to 6f.

[0046] Referring to Fig. 4 as well as to Fig. 5, each of the layers 100, 200, 300, 400 comprises a plurality of yarns 101, 201, 301, 401 extending parallel to each other lengthwise along a machining direction D of the yarn arranging machine 1 before being arranged. The yarns 101, 201, 301, 401 of a respective layer 100, 200, 300, 400 may comprise yarns e.g. of a specific color, thickness, material and/or shape which are to be arranged according to the desired yarn arrangement for forming a warp on a weaving beam 2.

[0047] As exemplarily illustrated in Fig. 5, the sizing machine comprises a creel 8, a sizing and drying device 3, a dividing field 4, a yarn arranging device 1 and a beaming unit 6. The plurality of yarn layers 100, 200, 300, 400 are typically provided by respective warper's beams 102, 202, 302, 402 of the creel, each warper's beam having the plurality of yarns 101, 201, 301, 401 of a specific color, thickness, material and/or shape reeled-up thereon in parallel. From there, the plurality of yarn layers 100, 200, 300, 400 may run to the sizing and drying device 3 and subsequently through the dividing field 4. There, the different yarn layers 100, 200, 300, 400 may be physically separated from each other by separating rods 7, rollers or cords placed in between along the width direction of the layers with respect to the lengthwise extensions of the yarns 101, 201, 301, 401. From there, the plurality of separated yarn layers 100, 200, 300, 400 are supplied to the yarn arranging machine 1 for preparing the warp according to desired yarn arrangement that is afterwards

reeled-up onto the weaving beam 2 in a beaming unit 6. Furthermore, an expansion comb 5 may be arranged between the yarn arranging machine 1 and the weaving beam 2.

[0048] "Fore", "entrance", "front" relate to the side of the yarn arranging device along the machining direction that is turned toward the separated layers. "Aft" and "exit" relate to the opposite side of the yarn arranging device along the machining direction D. The transverse direction is transverse to the machining direction and to the lengthwise extension of the yarns and is preferably parallel to the width direction of the yarn layers.

[0049] The layers 100, 200, 300, 400 are prepared next to each other in layers overlapping each other across the width of the plurality of yarn layers when extending through the yarn arranging machine.

[0050] According to the invention, the yarn arranging machine 1 is configured such that the plurality of separated yarn layers 100, 200, 300, 400 are selectively suppliable to the yarn releasing device 20. The yarn releasing device 20 itself is configured to release the yarns of a respectively selected yarn layer supplied thereto into a collector comb 50 which will be described in more detail below.

[0051] In the preferred embodiment according to Fig. 1 to 3, the yarn arranging machine 1 comprises a frame 10 to which the yarn releasing device 20 and the collector comb 50 are movably attached to. The releasing device 20 comprises a crossbeam 21 that is movable relative to the frame 10 in a direction transverse to the machining direction and transverse to the width of the yarn layers 100, 200, 300, 400. In the present embodiment, the machining direction D extends horizontally and the horizontal crossbeam 21 is movable along the vertical direction between a high and low position, e.g. by using a spindle drive or a lifting cylinder 29. The yarn releasing device 20 further comprises a support member 22 supporting the respectively selected yarn layer supplied to the yarn releasing device 20. The support member 22 is interposed between the selected yarn layer and the collector comb 50 and is configured to deflect the yarns of the selected yarn layer out of the collector comb 50 and to free a passage for the supported deflected yarns toward the collector comb 50, thereby releasing the yarns of the respectively selected yarn layer therefrom into the collector comb 50.

[0052] In the present embodiment, the support member 22 comprises a releasing rod 23 that is a flexible steel wire with a diameter of about 2 mm and that has a free end 24 being movable relative to the respectively selected yarn layer and to the frame 10 transverse to the machining direction D and transverse to the extending direction of the yarns such as to release the yarns of the selected yarn layer therefrom at the moving free end 24. At the opposite side of the free end 24, the releasing rod 23 is windable onto a winder 25 driven by releasing driving means 26, which may comprise a winder motor as in the present embodiment. Both, the winder 25 carrying

the releasing rod 23 as well as the releasing driving means 26 are attached to the crossbeam 21. The releasing driving means 26 may comprise step motor. In the present embodiment, the axis of the winder is oriented vertically, but may alternatively be oriented parallel to the machining direction D, for example. A capacitive sensor 46 detects a reference position of the free end 24 relative to the frame 10 in the transverse direction T.

[0053] The yarn releasing device 20 further comprises a releasing comb 30 extending across at least the full width of the yarn layers 100, 200, 300, 400. Preferably, the length of the releasing comb 30 may be up to 2200 mm. In the present embodiment, the releasing comb 30 is a vertically open comb formed by a row of plate-like teeth 31 that are fixed to the crossbeam 21 at one end, i.e. the releasing comb has a fixed position relative to the frame 10 in the transverse direction T, and open at the other end as shown in Fig. 2. The teeth density of the releasing comb 30 may be 60 teeth/dm. The yarns of the yarn layers 100, 200, 300, 400 may extend through the releasing comb 30 without significant deflection in the transverse direction as the releasing comb 30 extends across the full width of the yarn layers 100, 200, 300, 400. Each plate-like tooth 31 has two holes, namely, a support opening 32 through which the releasing rod 23 may pass through, and a detection opening 33 through which an optical detection beam, such as a laser beam, may pass.

[0054] Referring to Fig. 4, it is shown the situation where the third lowest yarn layer 300 is currently supported by the releasing rod 23 while the yarns 101, 201 of the lowest and second lowest yarn layer 100, 200 as well as some yarns 301 of the third lowest yarn layer 300 are already arranged in the collector comb 50. When the releasing rod 23 moves relative to the supported yarns 301 of the respectively selected yarn layer 300 in the transverse direction T, the yarns 301 slide on the circumferential support surface 23a of the releasing rod 23. During this sliding movement, the releasing comb 30 helps to avoid that the yarns 301 are dragged along by the moving releasing rod 23 which otherwise would cause them to lay on top of each other or would cause the supported yarn layer 300 to be pulled together, respectively. When the free end 24 of the releasing rod 23 reaches the respective yarn 301 at the very edge of those yarns 301 still supported by the releasing rod 23 and then further moves over a distance equal to the respective yarn thickness, a vertical passage for the respective yarn 301 toward the collector comb 50 is freed and the respective yarn 301 drops down into the collector comb 50 due to its pre-tension. Pre-tensioning of the respectively selected yarn layer 300 is done to facilitate the drop-down of the yarns 301 into the collector comb 50.

[0055] Alternatively, the yarn releasing machine 1 may be arranged such that the machining direction D is mainly along the vertical, the transverse direction T being unchanged (horizontal) whereas the teeth of the collector comb 50 extend along the horizontal direction. In that

case, the yarns of the respectively selected yarn layer have to be deflected out of the collector comb 50 in the horizontal direction.

[0056] The length of the releasing rod 23 is configured such that the support surface 23a extends over the full width of the yarn layers 100, 200, 300, 400 such as the free end 24 is movable over at least the full width of the yarn layers 100, 200, 300, 400. When the releasing rod 23 is fully withdrawn or pulled back, it is supported by a guiding member 27 that is placed in the transverse direction T between the releasing comb 30 and the winder 25. The guiding member 27 may be for example a closed conduit or channel or a semi shell-like conduit or channel through or on which the releasing rod 23 is guided and supported along its moving direction.

[0057] When the flexible releasing rod 23 is extended over at least a part or the full width of the yarn layers 100, 200, 300, 400, it is additionally supported by the support openings 32 of the releasing comb 30 that are distributed along the transverse direction T. The support openings 32 enable a guided movement of the support member 22 when it moves in the transverse direction T through the support openings 32. Instead of using the guiding member 27, the releasing rod 23 may only be pulled back such that it is still engaged with at least some of the blade-like teeth 31 of the releasing comb 30. In order to facilitate a smooth and free movement of the releasing rod 23, the support openings 32 in the plate-like teeth 30 of the releasing comb 30 may have rounded or beveled edges.

[0058] Referring to Fig. 1 to 3, the collector comb 50 is part of a yarn collector device 40 comprising a crossbeam 41 that is movable relative to the frame 10 in a direction transverse to the machining direction D and transverse to the width of the yarn layers 100, 200, 300, 400. In the present embodiment, the horizontal crossbeam 41 is movable along the vertical direction between a high and a low position, e.g. by using a spindle drive or a lifting cylinder 47. The collector comb 50 is detachable secured by clamps onto a linear translation stage 42 which in turn is attached to the crossbeam 41. The translation stage 42 allows to move the collector comb 50 relative to the crossbeam 41, to the frame 10 and to the respectively selected yarn layer 100 supplied to the yarn releasing device 20 along the transverse direction T, in particular parallel to the moving direction of the free end 24. For this, the linear translation stage 42 comprises collector drive means 43 - such as a stepping motor -, two movable supports 48 provided with the clamps, one being driven by the collector drive means 43 and guiding means 44. The collector comb 50 is preferably movable along the transverse direction around a centered position over at least 20 cm, in particular over at least 40 cm, allowing for a large yarn offset.

[0059] The purpose of the yarn collector device 40, in particular of the collector comb 50, is to receive the yarns released from the releasing device 20 and to maintain the prepared yarn arrangement along the warp width due to the teeth of the comb 50. In the present embodiment

as illustrated in Fig. 3, the collector comb 50 is a vertically open-ended comb formed by a row of rod-like teeth 51 that are fixed at one end to a longitudinal support base whereas the opposite end is open, i.e. the inter-teeth space 52 between two adjacent teeth 51 are open to the outside at the level of the open end. The teeth density of the collector comb 50 is approximately the same as the teeth density of the releasing comb 30, the present embodiment on the order of 50 teeth/dm. Of course, the inter-teeth space 52 is larger than the maximum diameter of the yarns to be released therein. As shown in Fig. 4, the width of the inter-teeth space 52 may even be such as to receive more than one yarn next to each other, depending on the specific diameter of the yarns. The same may apply to the inter-teeth space 34 of the releasing comb 30. In order to facilitate receiving yarns in the inter-teeth space 51 of the collector comb 50, the open end of the teeth 51 may be tapered or sharpened.

[0060] The yarn collector device 40 further comprises a detection device 45 for detecting a transverse position of the collector comb 50 relative to the frame 10 along its moving direction. For this, the detection device 45 may for example comprise one or a plurality of inductive sensors fixed on the crossbeam 41 along the transverse moving direction of the collector comb 50. At least one inductive sensor 45 detects the centered position of the collector comb 50 along the transverse direction T by sensing a centered position of one movable support 48. Both, the capacitive sensor 46 detecting a reference position of the free end 24 relative to the frame 10 and the detection device 45 may serve as position detection means 45, 46 in operative communication with a controller unit 60 (described below) for detecting the position of the collector comb 50 relative to the free end 24 of the support member 22. In particular, a reference position of the collector comb 50 relative to the free end 24 is detected at the beginning of the arranging process.

[0061] As may be seen from Fig. 2 and 4, the yarn arranging machine 1 further comprises yarn detection means 80 for detecting yarns while being in the passage freed by the releasing rod 23 toward the collector comb 50, i.e. while being released from the releasing device 20 toward the collector comb 50. In the present embodiment as shown in particular in Fig. 4, the yarn detection means 80 include a detection beam source 81, such as diode laser, that is attached at one lateral side of the releasing comb 13, the lateral direction being defined along the transverse direction T, to the crossbeam 21 of the yarn releasing device 20. The detection beam source 81 emits an optical detection beam 82, e.g. a laser beam, passing across the full width of the selected yarn layer 300 between the collector comb 50 and the support member 22 toward a beam detector 83 such that the optical detection beam 82 is crossed by each yarn 301 being released from the releasing rod 23 into the collector comb 50. In the present embodiment, the detection beam 82 travels through all the detection openings 33 in the plate-like teeth 31 of the releasing comb 30. At the opposite

lateral side of the releasing comb 30, detection beam 82 hits onto the beam detector 83, such as a photodiode, that is attached to the crossbeam 21. Each time one or more yarns 301 are released from the releasing rod 23, the detection beam 82 is interrupted causing a signal in the beam detector 83 indicative of the number of respective yarns being released from the releasing rod 23 into the collector comb 50. Hence, the yarn detection means 80 allows to detect and count the number of yarns being released during a specific time period. Alternatively, the yarn detection means 80 may only allow to detect that yarns fall without counting the number of yarns being released.

[0062] According to the invention, the yarn arranging machine 1 further comprises a controller unit 60 for controlling and synchronizing the yarn release of the releasing device 20 as well as the relative movement between the collector comb 50 and the free end 24 in the transverse direction T such that the released yarns of the respectively selected yarn layer are arranged in the collector comb 50 according to the desired yarn arrangement. In the preferred embodiment, the controller unit 60 may comprise a layer counter 61 that is initialized at the beginning of the arranging process and incremented when the layer has been selected and is supported on the releasing rod 23. The controller unit 60 may further comprise a yarn counter 62 that is also initialized for each layer to be arranged and incremented in accordance with the detection results of the yarn detection means 80 that are operatively coupled to the controller unit 60. Furthermore, the controller unit 60 may comprise security means to ensure that all parts of the arranging device are in working position before starting the arranging process. The controller unit 60 is also connected to the drives, i.e. motors, of the winder 25 of the releasing rod 23 and of the collector drive means 43 of the yarn collector comb 50 and is in operative communication with the position detection means 45, 46. In addition, the controller unit 60 may comprise a user interface, such as a touch screen, to allow for data input and output as well as for manual process control.

[0063] In order to control the yarn release of the releasing device 20 and the relative transverse movement between the collector comb 50 and the free end 24, the controller unit 60 preferably comprises synchronization means 63 that control the respective drive means 26, 43 for the releasing rod 23 and the collector comb 50. For this, the synchronization means 63 determine the arranging sequence for each layer and the transverse movement of the releasing rod 23 and the transverse movement of the collector comb 50 for each yarn of the respectively selected yarn layer in order to achieve the arranging sequence of the respectively selected layer 100 in the yarn collector comb 50 according to the desired yarn arrangement.

[0064] To determine the movement of the releasing rod 23, the synchronization means 63 may calculate for each layer - based on the yarn density for each layer

known from the respective layer width and the total number of yarns in the respective layer, which may be inputs by the operator before starting the arranging process - a releasing stroke of the releasing rod 23 that is equal to the theoretical distance from one yarn of the layer to the adjacent yarn of the layer. Theoretically, when the releasing rod free end 24 is placed at the very edge of those yarns supported by the releasing rod 23, by moving the releasing rod 23 with the releasing stroke, the releasing rod 23 moves relative to the supported yarns of a respectively selected yarn layer from a position, in which the releasing rod 23 is interposed between the supported yarns and the collector comb 50, into a position, in which the releasing rod 23 is shifted from the yarn of the respectively selected yarn layer - that is at the very edge of those yarns supported by the releasing rod 23 and that is to be released - and has freed a passage toward the collector comb 50 for this yarn to be released. The freed passage is bordered by the free end 24 on one side in the transverse direction T and extends between the initial position of a respective yarn at the level of the support surface 23a and a determined length portion of the collector comb 50 facing the respective yarn at the same transverse position. In practice, the releasing rod 23 may have to move slightly more or less than the theoretical releasing stroke.

[0065] The synchronization means 63 further determine the movement of the collector comb 50 relative to the frame 10, thus relative to the respectively selected yarn layer supported by the releasing rod 23, respectively, to ensure that the free end 24 of the releasing rod 23 - when moving by the determined releasing stroke - will release the yarn 101 directly facing the determined length portion of the collector comb 50 that the released yarn 101 shall occupy. For example, when several yarns of the same layer shall be released on a continuous portion of the collector comb 50, both, the releasing rod 23 and the collector comb 50 move with the same constant velocity. When the next yarn of the respectively selected yarn layer shall be released in another length portion of the collector comb 50, the releasing rod 23 is stopped and the collector comb 50 first moves with a predetermined stroke relative to the respectively selected yarn layer supported by the releasing rod 23 such that the determined length portion is facing the free end 24 of the releasing rod 23 at the same transverse position when it will move with the releasing stroke in order to release the next yarn to be arranged in this determined length portion of the collector comb 50. In addition, the synchronization means 63 may adjust the positioning of the collector comb 50 relative to the free end 24 in real time based on the results of the yarn detection means 80.

[0066] The controller unit 60 may also comprise calculating means 64 determining which position along the collector comb length should be occupied by each yarn of each layer according to the desired yarn arrangement for the warp. For this, the calculating means 64 first calculate the yarn density in the collector comb 50 based

on the total number of yarns to be arranged on the warp formed with all the layers and the width of the warp. In this embodiment, the width of the warp is equal to the width of the weaving beam 2, which may be an input given by the operator to the controller unit 60 as well as the number of layers to be processed for forming the warp. The calculating means then calculate for each layer - based on the given color repeat information which may also be an input given to the controller 60 by the operator - the position of each yarn along the width of the collector Comb 50. This corresponds to the arranging sequence. Based on the determined length portion of the collector comb 50 for each yarn, the calculating means may further determine the maximum expected offset, i.e. the maximum shift by which the collector comb has to move relative to the center position relative to the frame 10 such that the respective yarn occupies the determined length portion. This maximum expected offset may be compared to the given maximum offset that the collector comb 50 may move by the translation stage 42. If the expected offset is less than the given maximum offset, the desired arrangement is validated. Otherwise, the controller unit 60 informs the operator that an automatic arrangement is not possible.

[0067] As illustrated in Fig. 1 and 6c to 6f, the yarn arranging machine 1 may further comprise fore and aft layer guiding means 70, 71 for guiding and pre-tensioning the plurality of layers 100, 200, 300, 400. The fore layer guiding means 70 are provided at the entrance side of the yarn arranging machine 1 and may comprise guiding rods or guiding rollers. The fore layer guiding means 70 are movable between at least 2 positions, high and low, and suitable to be latched in each of these at least two position. In the high position, i.e. the non-working position, there is no interaction between the fore guiding means 70 and the yarns 101, 201, 301, 401 of the plurality of yarn layers 100, 200, 300, 400. In the low position, i.e. the working position, the fore guiding means 70 are in contact with all the yarns 101, 201, 301, 401 of the plurality of yarn layers 100, 200, 300, 400 and control the deflection of all yarn layers in the releasing comb 50 during the arrangement process.

[0068] The aft guiding means 71 are arranged at the exit of the yarn arranging machine 1 facing toward the weaving beam 2. The aft guiding means 71 are mainly provided to enable enough supply of yarn length in the yarn arranging machine 1 and may also comprise guiding rods or guiding rollers. In the present embodiment, the aft guiding means are movable in the vertical direction between three positions, i.e. a high, an intermediate and a low position, and are suitable to be latched in each of these three positions. In the high position, i.e. the non-working position, the aft guiding means do not interact with the yarns. In the low position, the aft guiding means 71 deviate all yarns from the normal path and provide enough length of supply for each layer to be released. In the intermediate position, the aft guiding means 1 control the deviation of all yarn layers in the releasing comb 50

during the arrangement process.

[0069] The yarn arranging machine 1 may further comprise fore and/or aft deflecting means 72, 73, e.g. deflecting rods or deflecting rollers. The fore and aft deflecting means 72, 73 extend across the full width of the yarn layers 100, 200, 300, 400. As illustrated in Fig. 1 and 6d to 6f, the fore and deflecting means 72, 73 may be detachably supported in inclined recess-like fore and aft holding means 74, 75 attached to the frame 10. The fore and aft deflecting means 72, 73 may be brought into the holding means 74, 75, such that they are only in contact with the respectively selected yarn layer supported by the releasing rod 23 in a respective fore and aft position relative to the releasing rod 23 in the machining direction D (see Fig. 6e). As the respectively selected yarn layer is already deflected by the yarn releasing support member 22 in a direction perpendicular to the transverse direction, between the fore and aft layer guiding means 70 and 71, the fore and aft deflecting means 72, 73 allow for an additional deflection and therefore for additional tension of the yarns of the respectively selected yarn layer. Preferably, the open end of the collector comb 50 is placed in the triangular space delimited by the fore and aft deflecting means 72, 73 and the support member 22 before starting the release of yarns of the selected layer such as to ensure that a yarn released from the yarn releasing device 20 will necessarily enter into a teeth gap of the collector comb 50.

[0070] The full width of each layer refers to the width of this layer at the entrance of the yarn arranging machine, when the yarns of the respective layer do not yet cooperate with the releasing comb 30 and the collector comb 50. For example, the full width of the selected layer can be considered at the level of the contact of the selected layer with the fore deflecting means 72.

[0071] Referring to Figs. 6a to 6f, an exemplary yarn arranging process using the yarn arranging machine 1 integrated into a set up according to Fig. 5, will now be described in detail.

[0072] The yarn arranging machine 1 is introduced between a dividing field 4 positioned behind a sizing and drying machine 3 and before the beaming unit 6 for winding the weaving beam 2. The collector comb 50 is clamped to the translation stage 42 in its centered transverse position such that the open end of the collector comb 50 faces the open end of the releasing comb 30. The plurality of yarn layers 100, 200, 300, 400 coming from a warper's beams 102, 202, 302, 402 and passing through the sizing and drying device 3 are spaced apart from each other in the dividing field 4 by dividing rods 7. The different layers are displayed with a strong line even if they may be hidden by parts of the yarn arranging machine 1. Typically, each layer 100, 200, 300, 400 comprises a plurality of yarns 101, 201, 301, 401 of one specific color, shape, material and/or thickness. The dividing rods 7 are placed in corresponding supports of the dividing field 4. From there, the different layers pass through the yarn arranging machine 1 at a normal non-deflected

path level toward the beaming unit 6.

[0073] At the beginning of the yarn arranging process (step 1, see Fig. 6a), the operator may input data needed for the arranging process into the controller unit 60 that determines the arranging sequence for each layer. The releasing device 20 and the collector comb 50 are spaced apart from each other in the vertical direction such that the releasing device 20 is in a high position and the yarn collector device 40 with the collector comb 50 is in the low position. Thus, there is no interference between yarns running from the sizing and drying device 3 unit into the beaming unit 6 and the yarn arranging machine 1.

[0074] The releasing device 20 is then lowered into the working position (step 2, see Fig. 6b). The releasing rod (not visible in Fig. 6b) is withdrawn from the releasing comb 30 such that the releasing comb 30 is opened in the vertical direction to allow the yarns of each layer 100, 200, 300, 400 to be introduced into the releasing comb 30. As a consequence, the yarns are distributed in a uniform way over the inter-teeth space between the plate-like teeth of the releasing comb 30. Then, a separating means 90, e.g. a separating rod, is introduced into inclined recesses 28a of supports 28 arranged at the cross-beam 21 at both sides of the releasing comb 30 (see Fig. 1), such that the lowest layer 100 and of course all other layers 200, 300, 400 above are supported thereon.

[0075] Afterwards (step 3, see Fig. 6c), the fore guiding means 70 is arranged into its lower working position to get into contact with the yarn layers 100, 200, 300, 400 at the entrance side of the arranging machine. At the same time, the aft guiding means 71 also is arranged into its lowest position thereby deviating the yarn layers 100, 200, 300, 400 downwards at the exit side of the arranging machine in order to provide enough yarn length for the arrangement process.

[0076] Then (step 4, see Fig. 6d), the yarn releasing device 20 and the aft guiding means 71 are continuously raised in the vertical direction into the high position or intermediate position, respectively. Due to the separating means 90, all yarn layers 100, 200, 300, 400 are also lifted and deflected. Alternatively, instead of the separating means 90, the releasing rod 23 may be introduced through the support openings 32 along the full width of the releasing comb 30 in order to support all layers 100, 200, 300, 400 thereon and to lift them together with the yarn releasing device 20.

[0077] At the same time, the yarn collector device 40 with the collector comb 50 is raised in the vertical direction into its working position. As can be seen on Fig. 6d, if the yarn collector device 40 is raised into its working position before the yarns of the layers 100, 200, 300, 400 are deflected by the yarn releasing device 20, each yarn 101, 201, 301, 401 extending in the machining direction D (the extension of the yarns is shown in dotted line) passes through the collector comb 50. When the yarns of each of the layers 100, 200, 300, 400 are deflected by the yarn releasing device 20, the yarns are deviated out of the collector comb 50 (the extension of the deflected yarns

is shown in solid line), All yarns of each of the layers 100, 200, 300, 400 are tensioned between the beams 102, 202, 302, 402 and the beaming unit 6. The layer counter 61 is put to $l=0$.

[0078] In the next step (step 5, see Fig. 6e), the reference position of the releasing rod 23 is sensed by the capacitive sensor 46 and the releasing rod 23 is then introduced through the support openings 32 along the full width of the releasing comb 30 while all non-released yarn layers 100, 200, 300, 400 are still supported on the separating means 90 above the releasing rod 23. The releasing rod 23 and the movable collector comb 50 are placed one above the other in the vertical direction. The openings 32 are arranged in the triangular space defined by the non-released yarns contacting the fore and aft guiding means 70, 71 and the separating means 90 positioned in the inclined recess 28a of the supports 28. To select the first, i.e. the lowest, layer 100 to be arranged into the collector comb 50, the separating means 90 is removed and another separating means 90, which is interposed between the lowest layer 100 and the second lowest layer 200, is introduced into the supports 28, thereby separating the lowest layer 100 from the other layers 200, 300, 400 above. For this, the second lowest separating rod 7, separating the second lowest layer 200 from the lowest layer 100 in the dividing field 4, may be used as the other next separating means 90 as it can be easily transferred from the dividing field 4 into the recesses 28a of the supports 28. As a result, the lowest layer 100 is now placed between the releasing rod 23 and the separating means 90 and separated from the other layers 200, 300, 400 to be still selected and supported on the separating means 90. In the working position of the collector comb 50 and the yarn releasing device 20, the selected yarn layer 100 and the layers 200, 300, 400 to be selected are all deflected out of the collector comb 50. Furthermore, the selected lowest layer 100 is tensioned by manually introducing e.g. rods working as fore and aft deflecting means 72, 73 into the fore and aft holding means 74, 75. In this situation, the yarns 101 are in contact with the support surface 23a of the releasing rod 23 and deflected in the vertical direction while the open end of the collector comb 50 is arranged in the triangular space defined by the fore and aft deflecting means 72, 73 and the releasing rod 23. Layer counter is incremented: $1=1+1$. It is to be noted that Fig. 6e shows step 5 for the situation where the third lowest yarn layer 300 is currently supported by the releasing rod 23 while the yarns 101 and 201 of the lowest yarn layers 100 and 200 are already arranged in the collector comb 50.

[0079] Alternatively, depending on the type of yarns to be arranged, the yarn arranging machine may work without guiding means 70, 71, 72, 73 or with only some of them.

[0080] In the next step (step 6, not shown), the centered position of the collector comb 50 is controlled by the detection device 45. The yarn counter 62 is set to $i=0$. The synchronization means 63 of the controller unit

60 provide the movements of releasing rod 23 and of the collector comb 50 for layer l . Then, the releasing rod 23 starts being wound such that its free end 24 moves relative to the supported yarns 101 of the selected yarn layer 100 transverse to their length extension to the estimated length position of the first yarn of the layer 100. The estimation is based on the selected layer width. The releasing rod then starts the initializing movement and moves with the releasing stroke. At the same time, the collector comb 50 moves in the transverse direction relative to the selected layer 100 and follows the releasing rod 23 so as to ensure that the respective inter-teeth apace 52 that has to receive the first $n= (1 \text{ or } 2 \text{ or } 3 \text{ or } \dots)$ yarn(s) 101 of the selected yarn layer 100 is directly at the transverse position of the free end 24. The yarn detection means 80 detects if the first yarn(s) fall(s) during this initializing movement and if yes, stops initializing movement. If not, the releasing rod 23 is further withdrawn over a distance according to the required releasing stroke to free a passage toward the collector comb 50 for the first $n= (1 \text{ or } 2 \text{ or } 3 \text{ or } \dots)$ yarn(s) to be released. The yarn detection means 80 detect if the first yarn(s) fall(s) during this initializing movement and if yes, stops initializing movement. Otherwise, this procedure is repeated until the first detection event. Subsequently, the yarn counter is incremented with the $n= (1 \text{ or } 2 \text{ or } 3 \text{ or } \dots)$ yarns detected by the detection means: $i = i + n$.

[0081] Subsequently, all further yarns 101 of the selected layer are released one after the other into the pre-determined length portion of the movable collector comb 50 in accordance with the arranging sequence calculated by the controller unit 60;

a. The collector comb 50 is moved such that the pre-determined length portion of the collector comb 50 that has to receive the next $n= (1 \text{ or } 2 \text{ or } 3 \text{ or } \dots)$ yarn(s) 101 of the selected yarn layer 100 is directly positioned at the transverse position of the free end 24 of the releasing rod 23 when it moves with the releasing stroke.

b. Subsequently, the releasing rod 23 is further moved by the pre-determined releasing stroke for layer 1 to free a passage toward the collector comb 50 for the next yarn(s) supported by the releasing rod 23.

c. The yarn detection means 80 detects when the next yarn(s) to be released fall(s) and the detection result is sent to the controller in real time:

- If detection result is "n", i.e. the detection means has detected n yarns falling during movement of the releasing rod in step b.: the controller immediately stops the releasing rod movement (even if the releasing stroke is not reached) and the yarn counter is incremented ($i = i + n$) and the process continues at step a. for the next

yarns of the respectively selected yarn layer 100 to be sorted into the collector comb 50.

- If detection result is "no yarn fell down", the process continues at step b. until the total movement of the releasing rod 23 reaches a predefined value, e.g. 10 mm, without detecting any yarns. In this case, the arranging machine is stopped and some information is displayed by the controller unit 60 on its user interface. The operator may then decide if the respectively selected yarn layer 100 is finished or if the machine should proceed with any of the above steps.

[0082] When yarn counter 62 is equal to the total number of yarns 101 of the selected layer 100, or when the operator's input is "layer is finished", the information "layer is finished" may be displayed by the controller unit 60 via its user interface. The operator may check if there are still non-released yarns supported by the releasing rod 23, which - if so - have to be removed manually. The fore and aft deflecting means 72, 73 are also removed.

[0083] Subsequently (step 7), steps 5 and 6 are repeated for the other yarn layers 200, 300, 400 starting with the next lowest one of these layers.

[0084] Fig 6e shows a configuration of arrangement of the selected layer 300, while layers 100 and 200 are already arranged in the collector comb 50 and the layer 400 to be selected are supported by separating means 90 out of the collector comb 50.

[0085] Fig. 4 schematically shows the arranging process of a respectively selected yarn layer 300 supplied to the releasing device 20 in the configuration of Fig. 6e. Yarns 101 and 201 of the lowest layers have been already arranged in the collector comb 50 and some yarns 301 of the selected layer 300 have been already arranged whereas some yarns 301 supported by the releasing rod 23 are still to be arranged.

[0086] Arranging process is finished when all layers are arranged in the collector comb 50 and form a warp according to the desired yarn arrangement at the exit of the yarn arranging machine (see Fig 6f). At the end of the arranging process, some information concerning the accomplished arrangement are output by the controller unit 60, e.g. yarns missing, mistakes in the arrangement that have been detected by the yarn detection means 80 and/or that have to be corrected by hand, color repeat information, etc..

[0087] Finally, the fore and aft guiding means 70, 71 are raised away from the yarns (step 8, not shown).

[0088] During step 6, the free end 24 of the releasing rod 23 travels along the full width of the selected layer. During releasing of the yarns into the comb (steps 5 to 7), the only movements of the collector comb 50 and of the releasing free end 24 are movements in the transverse direction.

[0089] An expansion comb 5 may be introduced into the yarn path between the collector comb 50 and the

beaming unit 6 for winding the yarn arrangement onto the weaving beam 2. Or the collector comb 50 with the arranged yarns may be separated from the yarn arranging machine and brought closer of the beaming unit 6.

- 5 The collector comb 50 may be an expansion comb. During the sizing and winding process taking place after the yarn arranging process, the yarn collector device 40 (with or without comb 50) may be lowered in its low non-working position and the releasing device 20 may be raised in its high position.

10 **[0090]** In the present embodiment described above, the releasing free end 24 and yarn collector comb 50 move along the same (transverse) direction. However, the movement directions may also be slightly deviated from one another (up to 45°).

15 **[0091]** It has been described that all layers 100, 200, 300, 400 extend through the yarn arranging machine 1 during all arrangement processes. However, it may also be possible that the first layer 100 is installed through the yarn arranging machine 1 whereas the other layers 200, 20 300, 400 to be selected are still wound on their warper's beam and selectively unwound above the preceding arranged layers when they have to be selected.

25 **[0092]** The release from the support member 22 into the collector comb 50 may also include some additional means if the yarns are not enough deflected and tensioned by the support member.

30 Claims

1. A yarn arranging machine (1) for forming a warp with a desired yarn arrangement from a plurality of yarn layers (100, 200, 300, 400), each layer comprising a plurality of yarns (101, 201, 301, 401) extending parallel to each other lengthwise along a machining direction (D) of the yarn arranging machine (1), said yarn arranging machine (1) comprising:

- 35 - an open collector comb (50) for receiving the plurality of yarns (101, 201, 301, 401) according to the desired yarn arrangement, the collector comb extending lengthwise along a transverse direction (T) across the width of the plurality of yarn layers (100, 200, 300, 400) transverse to the machining direction (D);
- 40 - a yarn releasing device (20) comprising at least one support member (22) for supporting the yarns (101, 301) of a respective yarn layer (100, 300) selected from the plurality of yarn layers, said support member (22) having a free end (24) and being interposable between the yarns (101, 301) of the selected yarn layer (100, 300) and the collector comb (50);
- 45 - releasing driving means (26) configured to move the free end (24) of the support member (22) in the transverse direction (T) relative to the respectively selected yarn layer (100, 300) to
- 50
- 55

- free a passage for the supported yarns (101, 301) of the selected yarn layer (100, 300) toward the collector comb (50) ;
 - collector driving means (43) configured to cause a relative movement between the collector comb (50) and the respectively selected yarn layer (100, 300) at least in the transverse direction (T).
2. The yarn arranging machine (1) according to claim 1, wherein the collector driving means (43) is configured to move only the collector comb (50) in the transverse direction (T).
 3. The yarn arranging machine (1) according to claim 1 or claim 2, wherein the support member (22) is configured to deflect the supported yarns (101, 301) of the respectively selected yarn layer (100, 300) out of the collector comb (50).
 4. The yarn arranging machine (1) according to claim 3, further comprising deflecting means (72, 73), e.g. deflecting rods or deflecting rollers, positioned fore and/or aft the support member (22) with respect to the machining direction (D) and being in contact with the yarns (101, 301) of the respectively selected yarn layer (100, 300).
 5. The yarn arranging machine (1) according to any one of the preceding claims, further comprising a frame (10) to which the yarn releasing device (20) and the collector comb (50) are movably attached to, the collector driving means (43) moving the collector comb (50) relative to the frame (10) in the transverse direction (T) and the releasing driving means (26) moving the free end (24) of the support member (22) relative to the frame (10) in the transverse direction (T).
 6. The yarn arranging machine (1) according to any one of the preceding claims, wherein the yarn releasing device (20) further comprises a releasing comb (30) formed by adjacent open-ended teeth (31) through which at least the yarns (101, 301) of the selected yarn layer (100, 300) extend, the support member (22) being movable relative to the releasing comb (30) in the transverse direction (T).
 7. The yarn arranging machine according to claims 5 and 6, wherein the releasing comb (30) has a fixed position relative to the frame (10) in the transverse direction (T) and extends across the full width of the selected yarn layer (100, 300).
 8. The yarn arranging machine (1) according to claim 6 or 7, wherein the releasing comb (30) comprises support openings (32) for a guided movement of the support member (22) therethrough in the transverse direction (T).
 9. The yarn arranging machine (1) according to any one of the preceding claims, further comprising position detection means (45, 46) for detecting a position of the collector comb (50) relative to the free end (24) of the support member (22).
 10. The yarn arranging machine (1) according to any one of the preceding claims, wherein the support member (22) comprises a releasing rod (23) windable around an axis perpendicular to the transverse direction (T), and configured to extend across the full width of the selected yarn layer (100, 300).
 11. The yarn arranging machine (1) according to any one of the preceding claims, further comprising a controller unit (60), for controlling the collector driving means (43) and the releasing driving means (26), and yarn detection means (80), preferably optical yarn detection means, in operative communication with the controller unit (60) for detecting the yarns (101, 301) of the selected yarn layer (100, 300) while being in the freed passage toward the collector comb (50).
 12. The yarn arranging machine (1) according to claim 11, wherein the yarn detection means (80) comprise a detection beam source (81) and a beam detector (83) arranged at opposing lateral sides of the selected yarn layer (100, 300), wherein detection beam source (81) is configured to emit an optical detection beam (82) passing between the collector comb (50) and the support member (22) toward the beam detector (83).
 13. The yarn arranging machine (1) according to any one of the preceding claims, further comprising selecting means (90) being removably interposed between the selected yarn layer (100, 300) and other layers (200, 300; 400) to be still selected, and between the other layers (200, 300, 400) to be still selected and the collector comb (50).
 14. A sizing machine including a creel, a sizing device, a beaming unit and a yarn arranging device according to any one of claims 1 to 13.
 15. A method for preparing a warp with a desired yarn arrangement from a plurality of separated yarn layers (100, 200, 300, 400) overlapping each other across the width of the plurality of yarn layers (100, 200, 300, 400), the method comprising the steps:
 - a. Determining an arranging sequence for the yarns (101, 201, 301, 401) of each layer (100, 200, 300, 400) to be arranged into a yarn collector comb (50) according to the desired yarn

arrangement;

b. Selecting and separating one yarn layer (100) out of the plurality of yarn layers (100, 200, 300, 400) and interposing a support member (22) between the collector comb (50) and the selected yarn layer (100); 5

c. Positioning a determined length portion of the collector comb to be occupied by a first yarn (101) or first set of yarns (101) of the respectively selected yarn layer (100) relative to the support member (22) according to the arranging sequence of the selected yarn layer (100); 10

d. Releasing the first yarn (101) or the first set of yarns (101) from the support member (22) into the respective length portion of the collector comb (50); 15

e. Consecutively perform steps c. and d. for all further yarns (101) or set of yarns (101) of the selected yarn layer (100) to be sorted into a respective length portion of the collector comb (50) according to the desired yarn arrangement; 20

f. Consecutively perform steps b. to e. for all further yarn layers (200, 300, 400) of the plurality of yarn layers. 25

16. The method according to claim 15, further including the detection of the yarns (101, 201, 301, 401) while being released from the support member (22) into the respective length portion of the collector comb (50). 30

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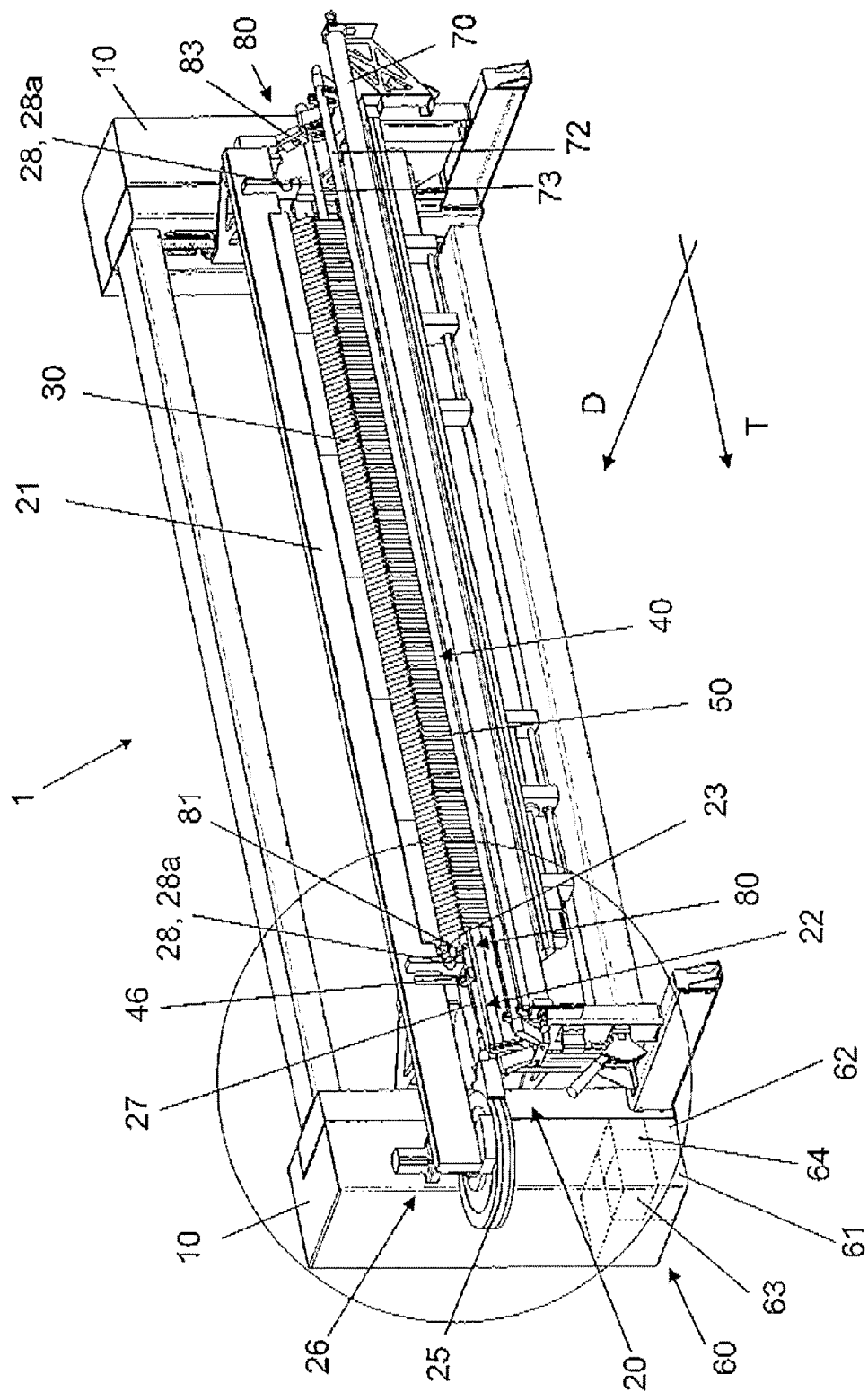


Fig. 1

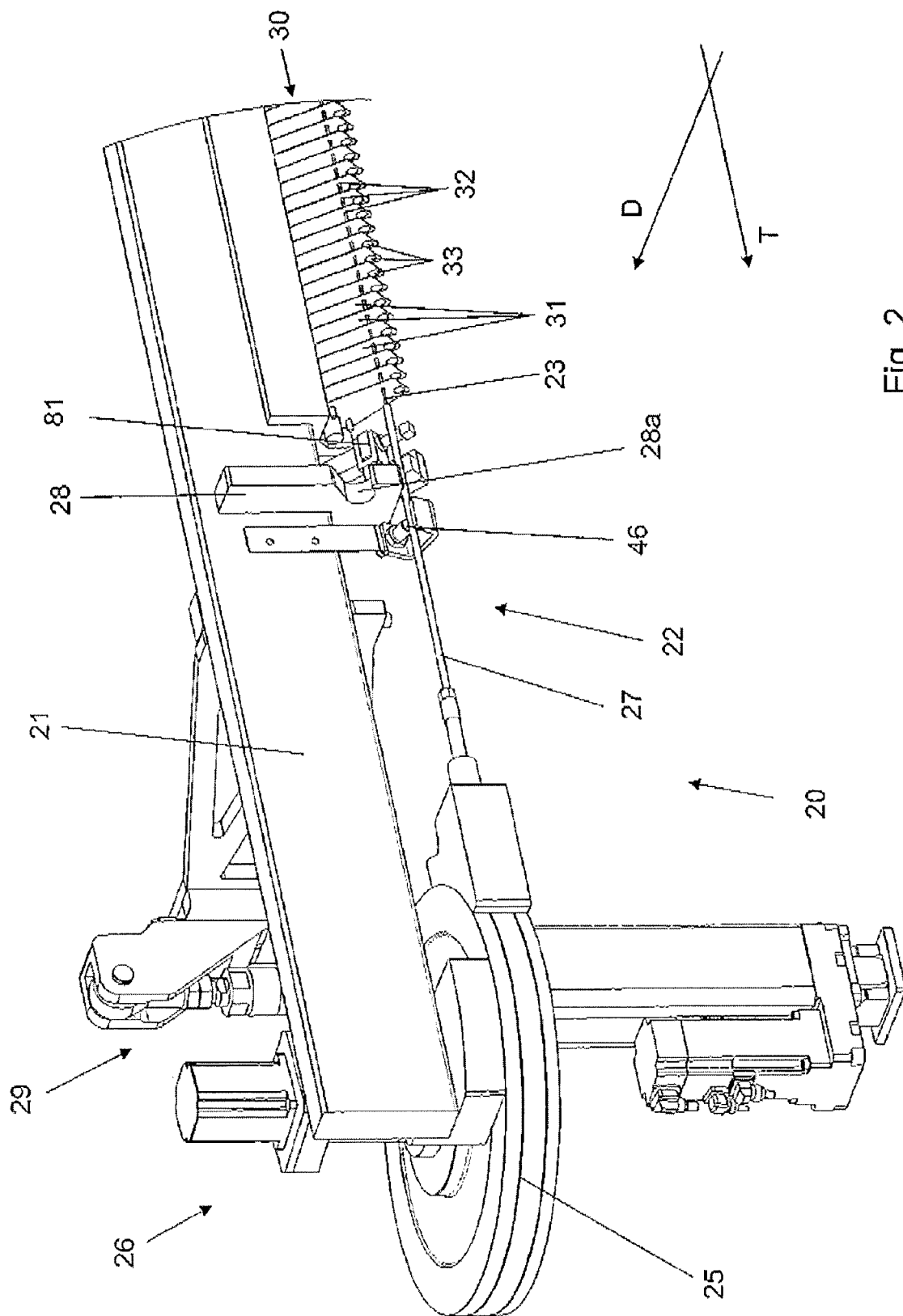
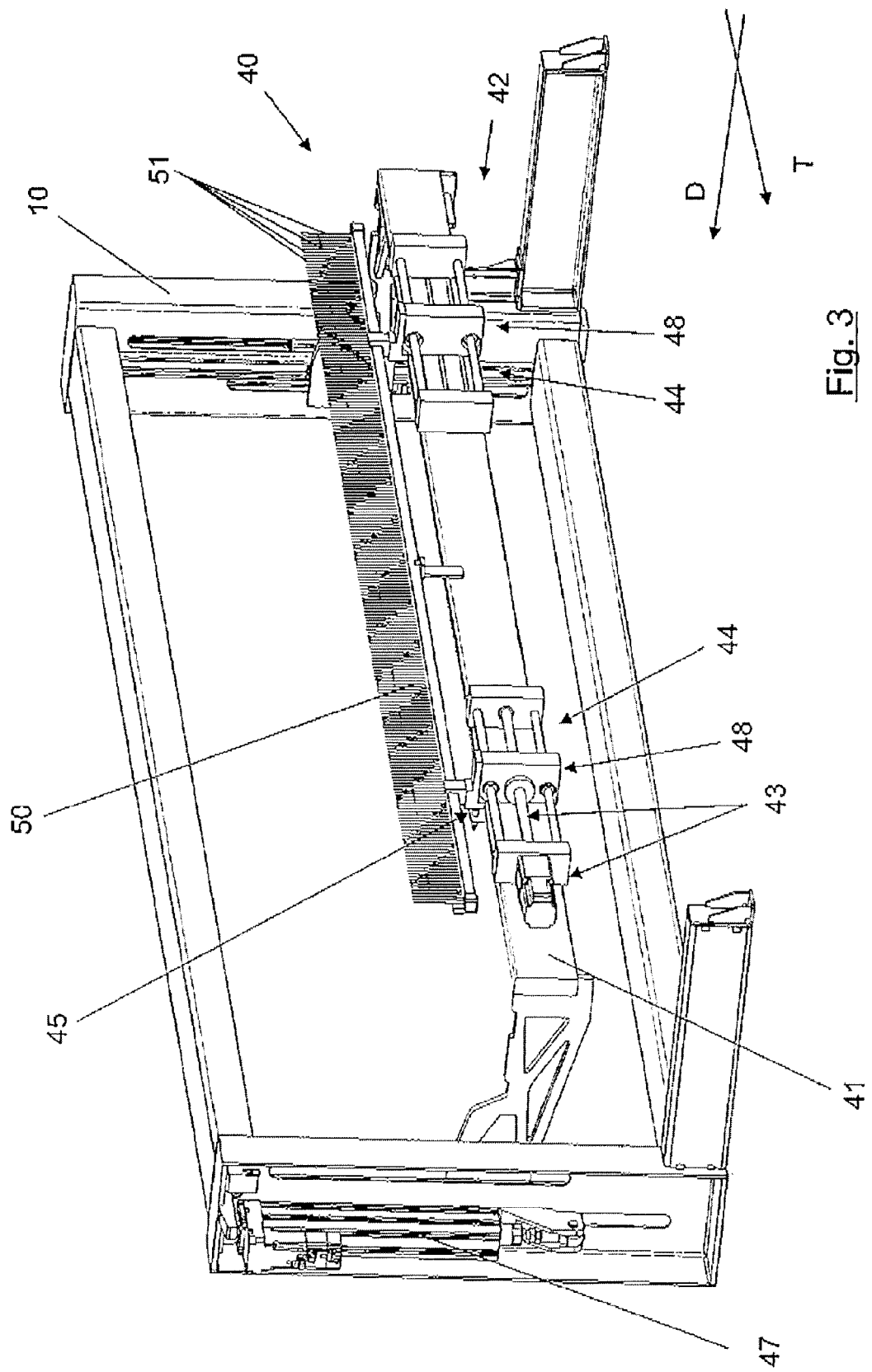


Fig. 2



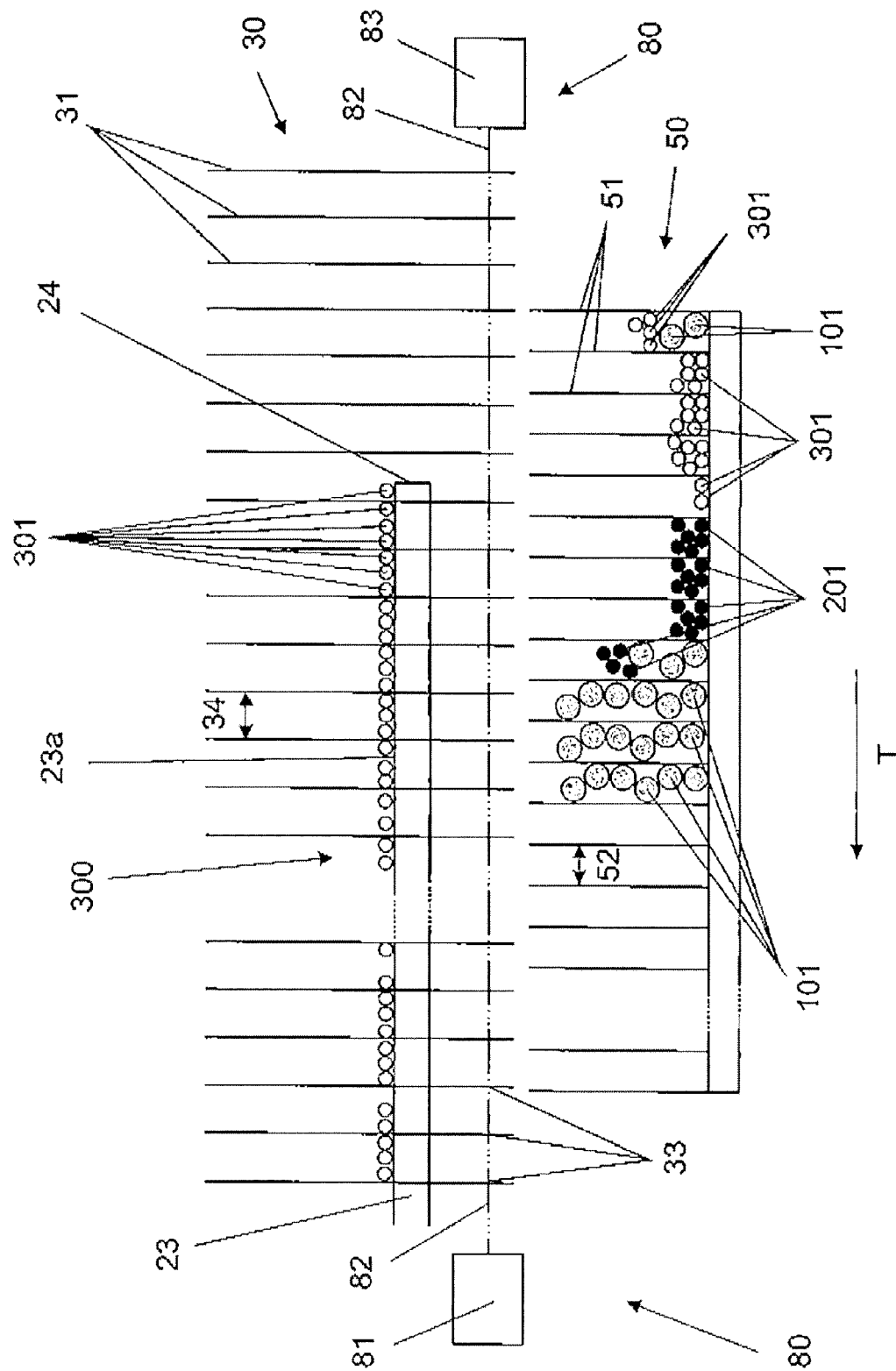


Fig. 4

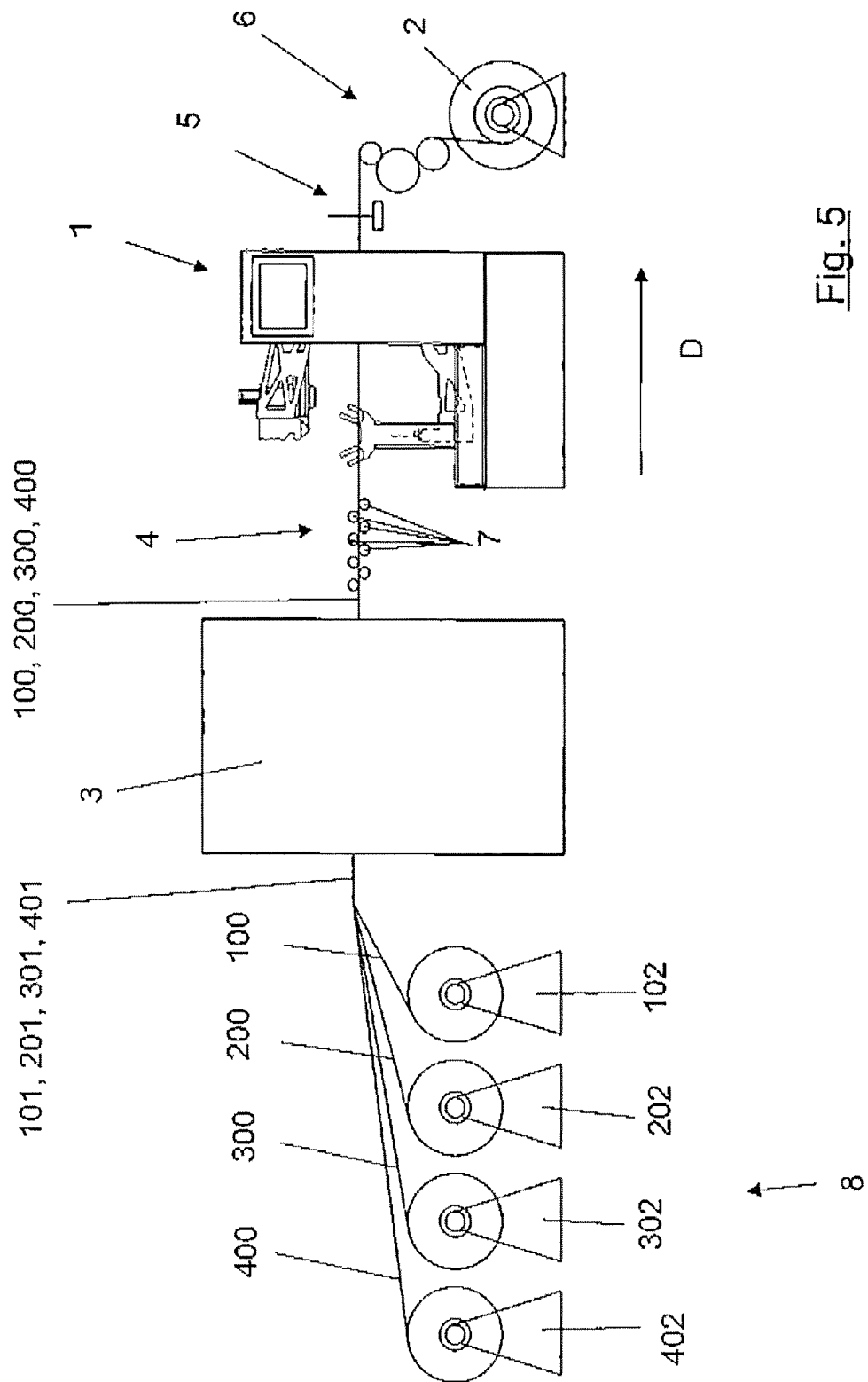
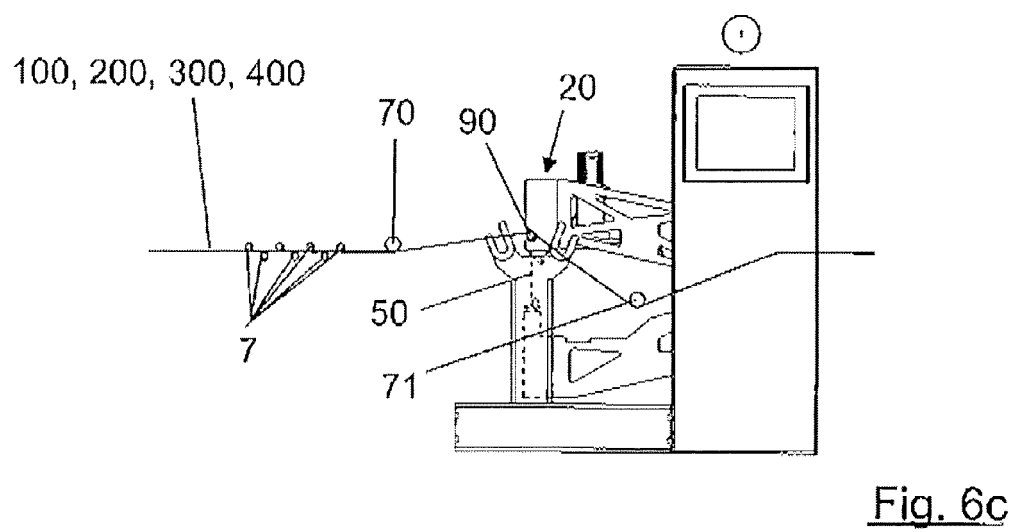
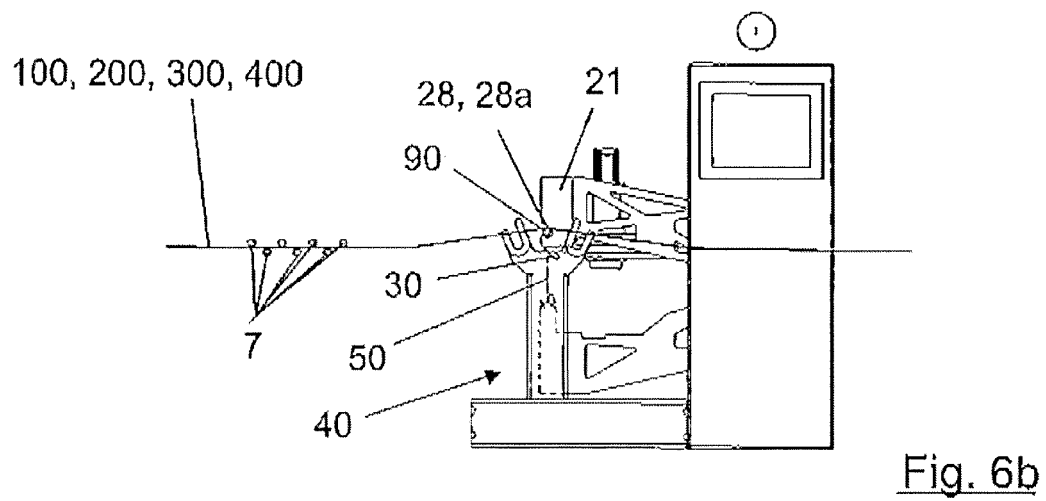
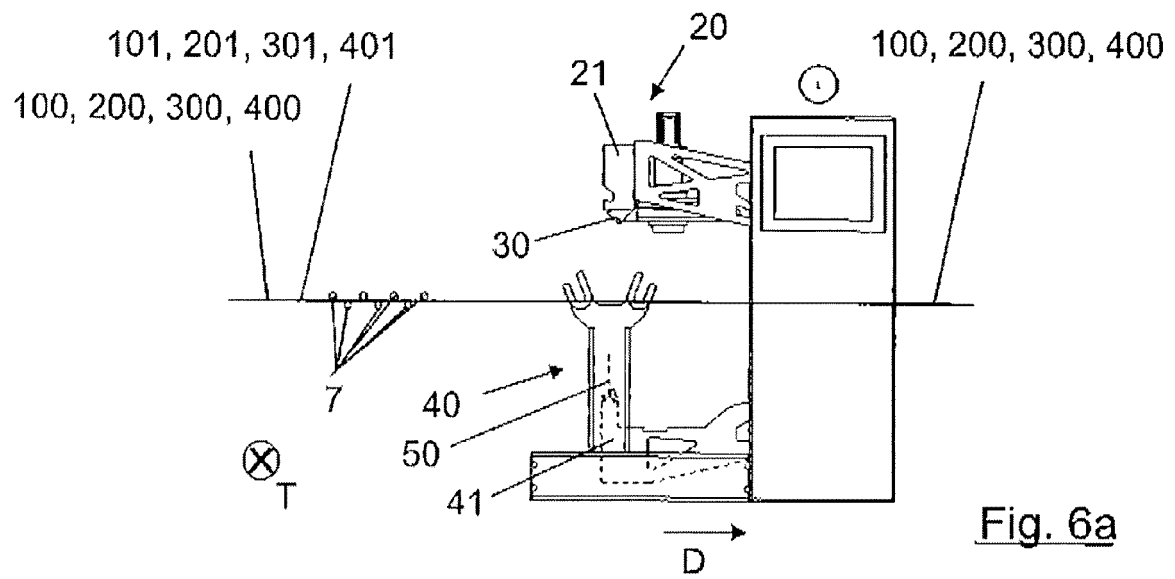


Fig. 5



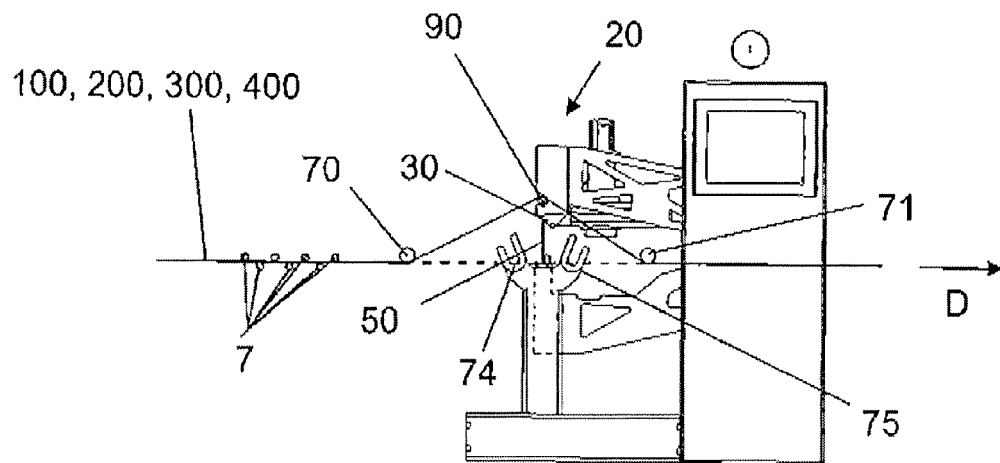


Fig. 6d

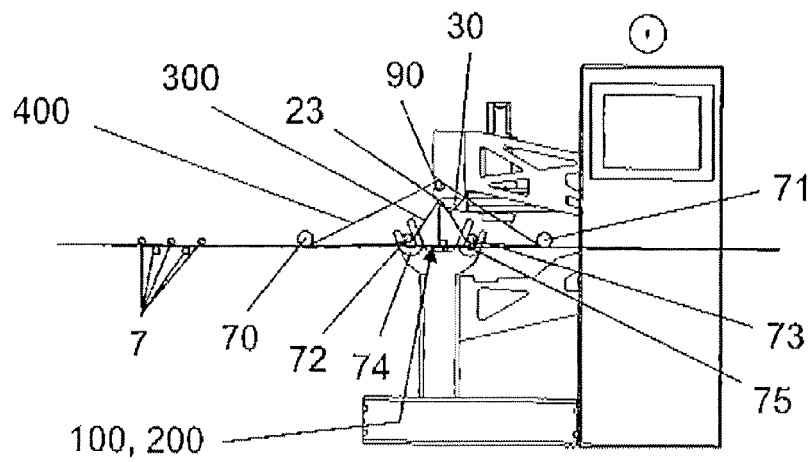


Fig. 6e

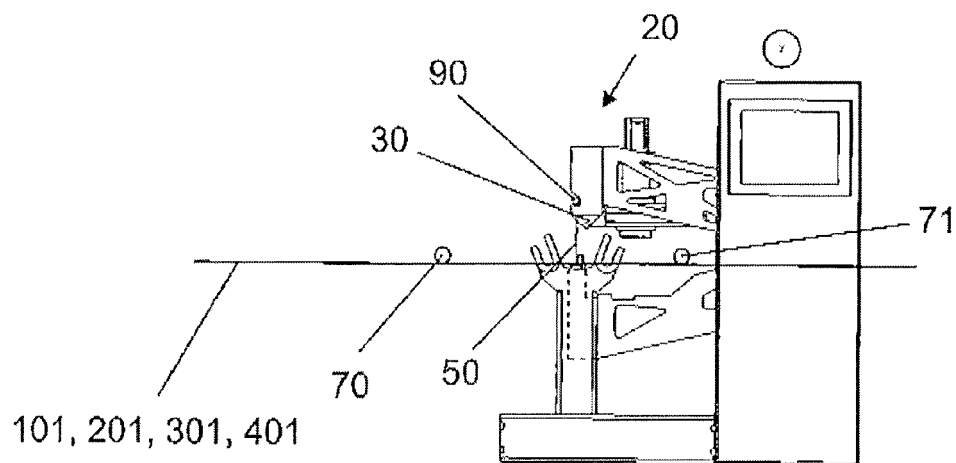


Fig. 6f



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A	EP 1 741 814 A2 (MURATA MACHINERY LTD [JP]; KATAYAMA CO LTD [JP]) 10 January 2007 (2007-01-10) * abstract; figures 1-3 *	1,15	
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			D02H D03J D06B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 8 February 2016	Examiner Pollet, Didier
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