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(71) Applicant: **MECCANOTECNICA S.p.A.**
I-24025 Gazzaniga - Bergamo (IT)

(72) Inventors:
- **Andreoni, Giuseppe**
  24052, Azzano san Paolo (BG) (IT)
- **Adobati, Germano**
  24027, Nembro (BG) (IT)

(74) Representative: **Pezzoli, Ennio et al**
Maccalli & Pezzoli S.r.l.
Via Settembrini 40
20124 Milano (IT)

(54) A sewing station with retractable needles for a book binding machine

(57) A sewing station (130) for a bookbinding machine (100) is proposed. The sewing station includes a plurality of sewing elements (210,215) for sewing stacks of signatures (505) by means of corresponding continuous threads (510a-510c), and driving means (205,230,235) for driving the sewing elements with a reciprocating motion towards a signature (105a,105b) to be sewn; the sewing station of the invention further includes biasing means (435,315) for biasing at least part of the sewing elements individually to an operative position or to a non-operative position, each sewing element in the operative position acting on the signature and each sewing element in the non-operative position not reaching the signature when the sewing element is moved towards the signature.

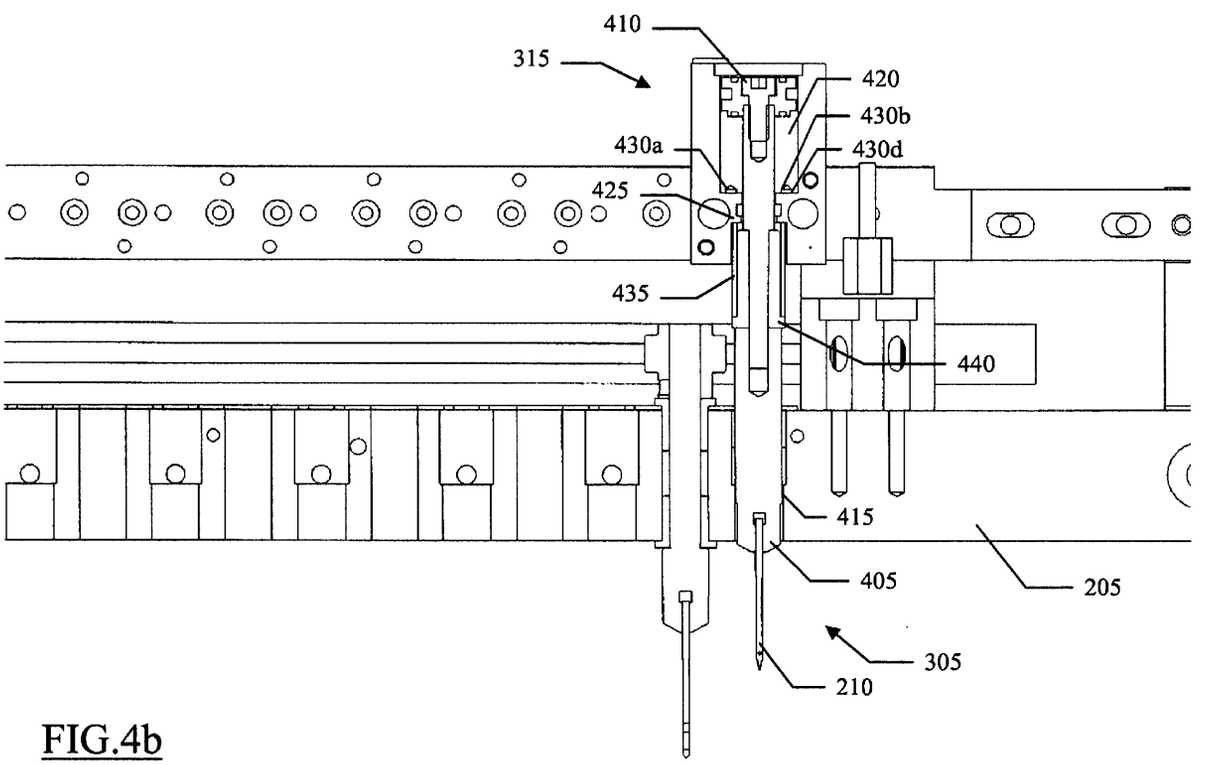

FIG.4b

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Description

[0001] The present invention relates to the bookbinding field, and more specifically to a sewing station for a bookbinding machine.

[0002] Bookbinding machines are commonly used for making sewn books. A sewn book consists of a stack of signatures that are sewn together in a corresponding station of the bookbinding machine. The sewing station includes a series of needles and hook needles (or crochets), which cooperate to sew the signatures by means of continuous threads. The sewing stations known in the art, although generally satisfactory, suffer a number of drawbacks in some specific operative conditions.

[0003] Particularly, a problem is experienced when the sewing station uses a stagger stitch sewing technique. In the stagger stitch sewing technique each needle alternately cooperates with the following hook needle (on its right) and with the preceding hook needle (on its left) during each sewing cycle. The stagger stitch sewing technique allows producing books that are more compact, since the thickness of the threads is better distributed; the advantage is clearly perceived in books with a high number of signatures and/or very thin signatures. This technique differs from the normal stitch sewing technique, wherein each needle always cooperates with the same adjacent hook needle (on its right).

[0004] In the stagger stitch sewing technique, the threads that have been drawn inside the signature by the needles must be conveyed one time to the following hook needles and the other time to the preceding hook needles, respectively. For this purpose, a thread carrier (with a rightwards hook and a leftwards hook) is associated with each needle; the thread carrier alternately moves to the right and to the left, so as to pull the thread to the desired hook needle. Alternatively, the thread carriers are replaced with nozzles (actuated through respective valves); each nozzle provides an air jet, which pushes the thread in the desired direction.

[0005] In the above-described technique, the sewing of the signatures must start and end with a needle in order to close each sewing stitch correctly. Therefore, it is necessary to avoid conveying the threads to the left of the first needle and to the right of the last needle (since the corresponding hook needles are outside the signatures).

[0006] A commonplace solution is that of updating the thread carriers associated with the ending (first and last) needles; particularly, the thread carrier for the first needle has the rightwards hook only whereas the thread carrier for the last needle has the leftwards hook only. In this way, when the thread carrier of the first needle moves to the left or the thread carrier of the last needle moves to the right they are unable to catch the corresponding threads. Alternatively, the hook needle immediately preceding and the hook needle immediately following the signatures are removed. Therefore, no stitches are closed even if the threads are conveyed outside the signatures by the thread carriers. Conversely, in the sewing stations using the air jets in place of the thread carriers it is enough to disable the nozzles associated with the ending needles when necessary.

[0007] However, the above-described solutions based on the thread carriers require a series of manual operations on the sewing station for replacing the thread carriers or removing the hook needles. These operations are very time consuming, so that the resulting non-working period of the sewing station strongly reduces its yield.

[0008] In any case, the major problem of all the solutions known in the art (based on either the thread carriers or the air jets) is due to the loosening of the threads. Indeed, each thread conveyed inside the signature by the needle is unwound from a corresponding bobbin. Therefore, if the stitch is not closed (using one of the above-described techniques) the thread is not tight any longer when the needle is extracted from the signature (being the distance between the needle and the bobbin shorter). This problem involves a number of drawbacks; for example, the thread can twist around the needle, or a false error signal can be generated (as if the thread was broken). Moreover, the resulting sewing is loose, thereby impairing the quality of the book. The above-described drawbacks are more acute in the sewing stations based on the air jets, since this structure requires that the threads should be drawn deeper inside the signature by the needles.

[0009] A solution commonly used in an attempt to solve the problem is that of providing the sewing station with a thread recovery system. The recovery system consists of a series of pivoting arms or sliding pegs, each one associated with a corresponding thread; those elements lengthen or shorten a path of the threads so as to maintain their correct tension.

[0010] However, the mechanisms of the recovery system are quite complex; indeed, the recovery system must alternately act on the thread associated with the first needle and on the thread associated with the last needle during each sewing cycle. Moreover, operation of the recovery system is critical, since it must not interfere with the sewing operations of the ending needles or with the other needles. In any case, the configuration of the bookbinding machine requires a manual intervention for updating the path of the threads associated with the ending needles (with a corresponding waste of time and yield reduction).

[0011] A different problem arises, irrespective of the sewing technique, when one or more sewing elements (needles or hook needles) acting on the signature are not used. A typical example is that of multiple signatures including two or more pages; in this case, any sewing element between adjacent pages is not involved in the sewing. The same situation can arise when unpaired needles or hook needles are arranged along the signature (close to the ends of each

page). The unused sewing elements pierce the signature; the resulting holes allow the glue typically used for completing the book to slip between adjacent pages, thereby causing their sticking.

[0012] A solution known in the art for solving this problem consists of manually removing the sewing elements that are not needed (with the drawbacks that have been pointed out above).

[0013] It is an object of the present invention to provide an improved sewing station.

[0014] It is another object of the present invention to allow disabling at least part of the sewing elements individually.

[0015] It is yet another object of the present invention to facilitate the configuration of the sewing station.

[0016] Particularly, it is an object of the present invention to avoid most of the configuration problems that are experienced when using the stagger stitch sewing technique or multiple signatures.

[0017] The accomplishment of these and other related objects is achieved by a sewing station as set out in the first claim.

[0018] Briefly, an aspect of the present invention provides a sewing station for a bookbinding machine including a plurality of sewing elements for sewing stacks of signatures by means of corresponding continuous threads, and driving means for driving the sewing elements with a reciprocating motion towards a signature to be sewn, wherein the sewing station further includes biasing means for biasing at least part of the sewing elements individually to an operative position or to a non-operative position, each sewing element in the operative position acting on the signature and each sewing element in the non-operative position not reaching the signature when the sewing element is moved towards the signature.

[0019] The present invention also provides a bookbinding machine including the sewing station. Moreover, a corresponding sewing method is also encompassed.

[0020] Further features and the advantages of the solution according to the present invention will be made clear by the following description of a preferred embodiment thereof, given purely by way of a non-restrictive indication, with reference to the attached figures, in which:

Figure 1 is a pictorial representation of a bookbinding machine in which the sewing station of the invention can be used;
Figure 2 is a perspective view of the sewing station;
Figure 3 shows a detail of the sewing station;
Figures 4a and 4b illustrate the different operative positions of each needle of the sewing station; and
Figures 5a-5g show the sequence of operations relating to a sewing process based on the stagger stitch sewing technique.

[0021] With reference in particular to Figure 1, a bookbinding machine 100 is shown. The machine 100 is used to sew together stacks of signatures 105, in order to produce corresponding books. Each signature 105 consists of a large printed sheet, which is folded one or more times so as to form several layers. A last fold of the signature 105 defines a back, whereas an edge opposite the back defines a lip (or front); the back is connected to the lip by means of an upper edge (head) and a lower edge (foot). The signature 105 may be either a single one (wherein only one page is printed on each layer) or a multiple one (wherein two or more pages are printed on each layer); the multiple signature is commonly referred to as a two-up signature, a three-up signature, and so on (according to the number of pages printed on the layer).

[0022] The signatures 105 are loaded into a hopper 110. Pliers 115 extract the signatures 105 from the hopper 110 and feed them in succession to an opening station 120 (including a series of upper and lower opening heads). The signatures 105 are opened in the middle and placed astride a fixed saddle 125; the fixed saddle 125 is provided with a longitudinal slit for a chain with pushing pegs (not shown in the figure), which chain conveys the signatures 105 to a sewing station 130.

[0023] Particularly, each signature 105 passes through a shaping station 135. When the signature 105 is close to the sewing station 130, a throwing wheel 140 accelerates the signature 105; as a consequence, the signature 105 is separated from the preceding ones and it is thrown onto a movable saddle 145 of the sewing station 130 (which is open in a lowered position, so as to be aligned with the fixed saddle 125).

[0024] The movable saddle 145 is then closed (to a raised position). The signature 105 loaded on the movable saddle 145 is sewn to a previous signature by means of continuous threads. Once a last signature of a current stack 150 has been sewn, the threads are cut. The stacks of signatures 150 being sewn are then placed onto a holder, which is provided with a pair of conveying guides 155. The stacks of signatures 150 are then supplied to further machines (not shown in the figure) for completing the production of the book. Operation of the bookbinding machine 100 is managed by means of a programmable logic controller (PLC) 160.

[0025] Similar considerations apply if the bookbinding machine has a different structure or includes other units (such as a series of trays for pre-loading the signatures), if the PLC is replaced with equivalent logic means (for example, a Personal Computer), and the like.

[0026] Considering now Figure 2, the sewing station 130 includes a support bar 205 for a series of sewing elements (for example, 20-30). The sewing elements are formed by a sequence of alternate needles 210 and hook needles 215. Each needle 210 consists of a slender element with an eye at its pointed end for inserting a thread (typically supplied by a bobbin, not shown in the figure); each hook needle 215 consists of a similar slender element but with a hook at its pointed end for catching the thread of an adjacent needle 210.

[0027] The signature to be sewn is stopped at the desired position along the movable saddle 145 by a square register 220; moreover, a pressure insert 225 is used to hold down the signature on the movable saddle 145. A punching device (not shown in the figure) is arranged inside the movable saddle 145; the device includes a series of punches (each one for a corresponding sewing element 210,215), which punches are pushed against the signature to cause its piercing.

[0028] The needles 210 and the hook needles 215 cooperate to sew the signature put astride the movable saddle 145. For this purpose, the bar 205 drives the needles 210 and the hook needles 215 with a reciprocating motion towards the movable saddle 145 (which features a longitudinal slit along its corner for allowing their passage). A thread carrier (not shown in the figure) is associated with each needle 210 inside the movable saddle 145; the thread carrier conveys the respective thread to an adjacent hook needle 215. The sewing station 130 can use either a normal stitch sewing technique or a stagger stitch sewing technique. In the normal stitch sewing technique each needle 210 co-operates only with the following hook needle 215 on its right; therefore, the thread carriers always convey the threads from the left to the right. Conversely, in the stagger stitch sewing technique each needle 210 alternately co-operates with the adjacent hook needles 215 on its right and on its left; in this case, the thread carriers convey the threads one time from the left to the right and the other time from the right to the left.

[0029] A transmission shaft 230 drives the different moving members of the sewing station 130. For this purpose, a tie rod mechanism 235 couples the moving members to the shaft 230, so as to implement the above-described operations during each sewing cycle (defined by a complete rotation of the shaft 230). The shaft 230 is further provided with a cam 240, which causes the thread carriers to be moved alternately to the right or to the left (during each sewing cycle) when the sewing station 130 uses the stagger stitch sewing technique. An inductive proximity sensor 245 detects a state of the sewing station 135 at the beginning of a sewing process. Particularly, the sensor 245 checks the position of a marker mounted on the shaft 230; in this way, it is possible to determine whether the cam 240 is in a position to drive the thread carriers to the right or to the left during a first sewing cycle.

[0030] Similar considerations apply if the sewing station has an equivalent structure, if a different number of needles and hook needles are provided, or if each needle cooperates with the hook needle on its left in the normal stitch sewing technique. Alternatively, other mechanisms are used to drive the moving members of the sewing station (and particularly the thread carriers when the stagger stitch sewing technique is used), the sensor is placed elsewhere (for example, close to the thread carriers) or is replaced with an equivalent element (such as a photocell), and the like.

[0031] As shown in Figure 3, the needles 210 and the hook needles 215 project downwards from the bar 205. Each needle 210 is fastened to a piston 305 by means of a sprig 310. The piston 305 can slide along its longitudinal axis (transversally to the bar 205). A pneumatic block 315 controls the position of the piston 305 (and then also of the needle 210). For this purpose, all the pneumatic blocks 315 can be coupled with a compressor (not shown in the figure) that supplies pressurized air (for example, at 6 bar).

[0032] Particularly, two small retracting tubes 320a, 320b and a small disabling tube 320d (running along the bar 205) are used to connect the pneumatic blocks 315 to the compressor through corresponding valves. The retracting valves associated with the tubes 320a and 320b are alternately opened at each sewing cycle, while the disabling valve associated with the tube 320d is always open. Each pneumatic block 315 is provided with three configuration screws 325a, 325b and 325d, which allow opening or closing corresponding valves coupling the pneumatic block 315 with the first retracting tube 320a, the second retracting tube 320b and the disabling tube 320d, respectively.

[0033] Each hook needle 215 is likewise fastened to a small shaft 330 by means of a sprig 335. The shaft 330 can rotate around its longitudinal axis (extending transversally to the bar 205). The shaft 330 is provided with a pinion 340 at its upper end (opposite the hook needle 215). A rack 345 is coupled with all the pinions 340, so as to rotate the hook needles 215 alternately clockwise and counterclockwise during each sewing cycle.

[0034] Similar considerations apply if the needles and the hook needles are mounted on the bar in a different way, or if the bar is replaced with an equivalent support element. Alternatively, another structure is used to couple the pneumatic blocks to the compressor, or the configuration screws are replaced with similar elements for controlling the corresponding valves. In any case, the concepts of the present invention are also applicable when different actuators are used for biasing the needles to the desired position (for example, of the electric, oil-pressure, or magnetic type).

[0035] Moreover, the structure described above for the needles can be applied to the hook needles as well. In this case, each piston must slide inside the corresponding pinion (for example, being coupled by means of a key or a splined shaft). However, this implementation requires that the pneumatic blocks should be miniaturized, since the space of the adjacent sewing elements cannot be exploited any longer.

[0036] The structure of a generic pneumatic block 315 is illustrated in detail in Figures 4a and 4b. Considering in

particular Figure 4a, the piston 305 consists of a stem 405 ending with a head 410 at its upper end (opposite the needle 210). The piston 305 is housed inside a cylinder 415 having a chamber 420 (defined by a shoulder 425) for the head 410. Three ports 430a, 430b and 430d (at the bottom of the chamber 420) define corresponding inlets for the pressurized air supplied by the first retracting tube, the second retracting tube and the disabling tube, respectively. The chamber 420 is further provided with a series of vent-holes for the air on its top wall. A spring 435 is arranged around the stem 405; particularly, the spring 435 is restrained (inside the cylinder 415) between the shoulder 425 and a collar 440 provided halfway down the stem 405.

[0037] When no pressurized air is supplied to the chamber 420, the spring 435 pushes the collar 440 downwards until the head 410 abuts against the shoulder 425; the piston 305 is then kept extracted from the bar 205 (in an operative position).

[0038] Moving now to Figure 4b, when pressurized air is supplied to the chamber 420 (through one of the ports 430a, 430b or 430d), the pressure exerted by the air pushes the head 410 upwards to its end of stroke (with the spring 435 that is compressed between the shoulder 425 and the collar 440). As a consequence, the piston 305 is retracted inside the bar 205 (to a non-operative position).

[0039] Each pneumatic block 315 can be set with all the configuration valves that are closed, with only the configuration valve associated with the disabling tube that is open, or with one of the two configuration valves associated with the retracting tubes that is open. In the first case, the corresponding needle 210 is always extracted from the bar 205 (see Figure 4a). Conversely, when the pneumatic block is coupled with the disabling tube the needle 210 is always retracted (see Figure 4b). In the third configuration, the needle 210 is alternately retracted and extracted during each sewing cycle (when the corresponding retracting valve is opened and closed, respectively).

[0040] Similar considerations apply if the pneumatic block has a different structure or includes equivalent elements. Alternatively, other solutions are used to keep the sewing elements extracted from the bar (for example, by means of equivalent resilient means or magnetic elements).

[0041] The sequence of operations relating to the sewing process based on the stagger stitch sewing technique is illustrated schematically in Figures 5a-5g. Considering in particular Figure 5a, three needles (denoted with 210a, 210b and 210c) and two hook needles (denoted with 215a and 215b) are associated with a stack of signatures 505. Particularly, the first needle 210a cooperates with the following hook needle 215a when the corresponding thread (denoted with 510a) is conveyed to the right and must be excluded when the thread 510a is conveyed to the left; conversely, the last needle 210c cooperates with the preceding hook needle 215b when the corresponding thread (denoted with 510c) is conveyed to the left and must be excluded when the thread 510c is conveyed to the right. The intermediate needle 210b alternately cooperates with the following hook needle 215b when the corresponding thread (denoted with 510b) is conveyed to the right and with the preceding hook needle 215a when the thread 510b is conveyed to the left.

[0042] In this way, the threads 510a-510c form interlocked stitches, each one bridging between two adjacent signatures of the stack 505; particularly, a row of plain stitches is formed by the needles 210a-210c and a row of looped stitches is formed by the hook needles 215a-215b. In the condition shown in the figure, the threads 510a-510c pass through the eyes of the needles 210a-210c (between the bobbin and the plain stitches). The hooks of the hook needles 215a-215b face forwards and hold a loop that has been freshly formed. A new signature (denoted with 105a) is fed to the stack 505 (by means of the movable saddle); at the same time, the signature 105a is pierced using the punchers arranged inside the movable saddle.

[0043] In the example at issue, the sewing station is configured opening the valve for the first retracting tube that is associated with the needle 210a and the valve for the second retracting tube that is associated with the needle 210c (while all the other configuration valves are closed).

[0044] Moving now to Figure 5b, the bar supporting the needles and the hook needles (not shown in the figure) is lowered, after rotating the hook needles 215a-215b by 180°. Assuming that during the first sewing cycle the threads 510a-510c will be conveyed to the right, the second retracting valve is opened (while the first retracting valve is closed). In this way, the last needle 210c moves to the non-operative position so that it does not reach the signature 105a; therefore, the corresponding thread 510c slides in the eye of the needle 210c without being unwound from the bobbin.

[0045] The other needles 210a,210b and the hook needles 215a-215b cross the back of the signature 105a (through the corresponding holes). In this way, the threads 510a-510b are conveyed inside the signature 105a by the needles 210a-210b, while the loops remain wound around the hook needles 215a-215b (outside the signature 105a). The bar is then slightly retracted, in order to form a bend in the double-stranded threads 510a-510b inside the signature 105a.

[0046] With reference to Figure 5c, the thread carriers associated with all the needles 210a, 210b and 210c (denoted with 515a, 515b and 515c, respectively) move to the right. Therefore, the thread carriers 515a,515b catch the threads 510a,510b at those bends, and pull them past the hook needles 215a,215b; conversely, the thread carrier 515c moves idly (being the corresponding thread 510c outside the signature 105a). The thread carriers 515a-515c then pivots to have the threads 505a-505b contact the hook needles 215a-215b above their hooks.

[0047] The bar is raised thereby extracting the needles 210a-210b and the hook needles 215a-215b from the signature 105a. During this movement, the second retracting valve is closed and the first retracting valve is opened; in

this way, the last needle 210c returns to the operative position and the first needle 210a moves to the non-operative position. At the same time, the thread carriers 515a-515c go back to their starting position (close to the needles 210a-210c).

[0048] In this way, as shown in Figure 5d, the hooks of the hook needles 215a-215b pick up the threads 510a-510b; as a consequence, the threads 510a-510b are pulled out the signature 105a and form a new loop that is concatenated with the previous one. The hook needles 215a-215b then rotate by 180° so as to return to their starting position. At the same time, the double-stranded threads 510a-510b between the needles 210a-210b and the hook needles 211a-215b are tightened against an inner edge of the back of the signature 105a.

[0049] Considering now Figure 5e, the stack of signature 505 moves forward and a further signature (denoted with 105b) is fed. The same operations described above are then repeated. However, in this case the first needle 210a is retracted so that is does not reach the signature 105b (while the threads 510b-510c are conveyed inside the signature 105b by the needles 210b-210c).

[0050] With reference to Figure 5f, all the thread carriers 515a-515c move to the left. Therefore, the thread carriers 515b,515c catch and pull the threads 510b,510c past the hook needles 215a,215b (while the thread carrier 515a moves idly). The thread carriers 515a-515c then pivots to have the threads 505b-505c contact the hook needles 215a-215b above their hooks.

[0051] Therefore, as shown in Figure 5g, when the bar is raised the hooks of the hook needles 215a-215b pick up and pull the threads 510b-510c out the signature 105a (so as to form a new loop that is concatenated with the previous one). The same operations described above are then continually repeated at every sewing cycle.

[0052] Similar considerations apply if the sewing process includes equivalent or additional operations (for example, a blind stitch at the end of the sewing for improving the closing of the stitches), and the like.

[0053] Moreover, the proposed structure can also be used to disable any needle (or hook needle) acting on the signature that is not used (for example, sewing elements between adjacent pages of a multiple signature, and unpaired needles or hook needles being arranged along the signature, close to the ends of each page). In this case, the sewing station is configured opening the valve for the disabling tube associated with each unused needle. Therefore, the needle is always in the non-operative position, so that is does not reach the signature when the bar is lowered.

[0054] The above-described sewing station is also suitable to be configured automatically (under the control of the PLC). In this case, each sewing element is associated with three electro-valves (for the two retracting tubes and the disabling tube), which electro-valves can be actuated remotely. The PLC runs a program for controlling operation of the sewing station. For this purpose, the control program accesses a repository that stores configuration information for most of the formats of signatures that are supported by the sewing station. For example, the configuration information specifies the opening heads to be actuated for opening the signatures (according to their type, generally defined by the number of folds and the mutual direction thereof). An additional repository stores control information for different heights of the signatures (measured between the head and the foot) . For example, the control information provides a preferred position of the square register, and then of the signatures, on the movable saddle for different combinations (number of pages)-(sewing technique). The preferred position is defined so as to centre the signatures along the sewing elements. At the same time, the preferred position ensures a minimum margin (for example, 10 mm) between the sewing elements acting on the signatures and their free ends; moreover, the signatures are positioned so as to be associated with an even number of needles and hook needles (if the normal stitch sewing technique is employed) or with an odd number of needles and hook needles (if the stagger stitch sewing technique is employed), always starting from a needle.

[0055] Whenever the format of the signatures or the sewing technique is changed, the control program prompts an operator to set a series of configuration parameters for the new job; for example, the operator selects the mode of operation of the control program (automatic or manual), the number of signatures forming each book, the possible use of a blind stitch, the sewing technique (normal stitch or stagger stitch) used by the bookbinding machine, the number of pages printed on each layer of the signatures, and the like.

[0056] If the bookbinding machine has been set to the automatic mode of operation, the PLC displays a graphical representation of the different types of signatures being supported, so as to enable the operator to select the desired one. A signature production process, which involves the setting of a number of operative parameters of the bookbinding machine, is then performed. During this process, a first signature is extracted from the hopper, and its length (measured transversally to the back) is detected; the signature is then opened, placed astride the fixed saddle, and conveyed towards the sewing station (being stopped before reaching the movable saddle); while the signature moves along the fixed saddle, its height (H) is detected. The preferred position of the square register on the movable saddle is extracted from the corresponding repository (according to the height of the signature, the number of pages and the sewing technique).

[0057] Conversely, when the bookbinding machine has been set to the manual mode of operation, the operator selects the heads to be actuated for opening the signatures. The operator is then prompted to input the length and the height of the signatures, and the position of the square register on the movable saddle.

[0058] In both cases, a loop is then executed a number of times equal to the number of pages PG printed on each layer of the signatures (with PG=1 if the signatures are simple). In detail, the j-th iteration of the loop (with j=1...PG) starts calculating the number of the first sewing element (Sf_j) being active on the signature; denoting with DP the distance of a first sewing element from a starting reference and with PTH the distance between two adjacent sewing elements (for example, 19 mm), the number of the first sewing element Sf_j is given by the formula:

$$Sf_j = INT\left[\frac{CUR\_POS + (j-1)\cdot\frac{H}{PG} - DP + PTH}{PTH}\right]$$

If the first sewing element is a hook needle (i.e., Sf_j is odd), the number of the first sewing element is increased ($Sf_j=Sf_j+1$).

[0059] The number of a last sewing element (Sl_j) associated with the current page is likewise calculated applying the formula:

$$Sl_j = INT\left[\frac{CUR\_POS + j\cdot\frac{H}{PG} - DP}{PTH}\right]$$

If the number of the last sewing element Sl_j is even (for the normal stitch sewing technique) or odd (for the stagger stitch sewing technique), the number of the last sewing element Sl_j is decreased ($Sl_j=Sl_j-1$).

[0060] The control program verifies whether the first sewing element and the last sewing element ensure a minimum margin (for example, 5 mm) from the respective free ends of the page (with this margin given by the formulas

$$Sf_j \cdot PTH - CUR\_POS-(j-1)\cdot\frac{H}{PG}+DP$$

and

$$CUR\_POS + j\cdot\frac{H}{PG} - DP - Sl_j \cdot PTH,$$

respectively). If not, the number of the first sewing element is incremented by 2 and/or the number of the last sewing element is decremented by 2. An enabling flag associated with each sewing element from the first one Sf_j to the last one Sl_j inclusive is asserted; moreover, a starting flag and an ending flag associated with the first sewing element Sf_j and with the last sewing element Sl_j, respectively, are further asserted.

[0061] The movable saddle is now opened. The first signature is placed onto the movable saddle; the movable saddle is then raised approaching the closed position wherein the operator can check the position of the signature with respect to the needles and the hook needles. The operator may change the position of the square register and/or the needles or hook needles that are active on the signature. For example, the configuration of the sewing station is updated to take into account printing scraps on the signatures; alternatively, the position of the signatures on the movable saddle is moved towards the fixed saddle to make easier their throwing onto the movable saddle (for example, when the signatures feature a high number of open layers or are made with very light paper).

[0062] Once the operator confirms the configuration of the sewing station, the electro-valves are controlled accordingly. Particularly, the electro-valves for the disabling tube that are associated with the unused sewing elements (corresponding enabling flags deasserted) are closed. Moreover, when the sewing station uses the stagger stitch sewing technique, the electro-valves for the first retracting tube that are associated with each first needle of the pages (corresponding starting flags asserted) are opened; likewise, the electro-valves for the second retracting tube that are associated with each last needle of the pages (corresponding ending flags asserted) are opened.

[0063] Similar considerations apply if other information is stored, if equivalent memory structures are used, or if the PLC implements an equivalent algorithm (for example, supporting a single sewing technique).

[0064] More generally, an aspect of the present invention proposes a sewing station for a bookbinding machine. The sewing station includes a plurality of sewing elements, which are used to sew stacks of signatures by means of corresponding continuous threads. Driving means are provided for driving the sewing elements with a reciprocating motion towards a signature to be sewn. The sewing station of the invention further includes biasing means for biasing at least part of the sewing elements individually to an operative position or to a non-operative position; each sewing element in the operative position acts on the signature and each sewing element in the non-operative position does not reach the signature when the sewing element is moved towards the signature.

[0065] The devised solution strongly improves the operation of the sewing station.

[0066] Indeed, the structure of the invention allows disabling at least part of the sewing elements individually.

[0067] This solution dramatically facilitates the configuration of the sewing station.

[0068] Particularly, the invention avoids most of the configuration problems that are experienced when using the stagger stitch sewing technique and/or multiple signatures.

[0069] The preferred embodiment of the invention described above offers further advantages.

[0070] Particularly, the solution of the present invention is specifically designed for the stagger stitch sewing technique.

[0071] In this case, it is possible to avoid replacing the thread carriers or removing the hook needles. In any case, the proposed structure prevents the loosening of the threads (since they are drawn inside the signature only when it is necessary); therefore, no thread recovery system is required in the sewing station. The configuration of the sewing station is then very simple; particularly, the operation can be performed even without removing the threads from the eyes of the needles. As a consequence, the yield of the sewing station is strongly increased.

[0072] As a further enhancement, during the first sewing cycle the needles are controlled according to the starting state of the sewing station (which starting state is detected by the corresponding sensor).

[0073] This feature makes it possible to move the needles in the correct sequence automatically.

[0074] In addition or in alternative, the proposed solution is used for disabling the unused sewing elements.

[0075] Therefore, it is possible to avoid removing the needles and the hook needles that are not needed (for example, when working with multiple signatures). As a consequence, the configuration of the sewing station for different formats of the signatures is strongly simplified. The yield of the sewing station is then further increased.

[0076] However, the solution according to the present invention leads itself to be implemented even without any system for automatically detecting the starting state of the sewing station. Moreover, the use of the devised structure only for the stagger stitch sewing technique or only for disabling the unused sewing elements is not excluded.

[0077] A suggested choice for implementing the solution of the invention is that of keeping the sewing elements extracted from the corresponding bar; each sewing element can then be selectively coupled with means that are able to retract the sewing element into the bar.

[0078] This structure is very simple, but at the same time effective.

[0079] A way to further improve the solution is to use two retracting structures, which are alternately enabled during each sewing cycle.

[0080] The proposed feature strongly simplifies the implementation of the invention for the stagger stitch sewing technique (since only two retracting valves must be controlled alternately for all the sewing elements).

[0081] Moreover, each sewing element can also be selectively coupled with a disabling structure, which is always active.

[0082] This feature likewise simplifies the implementation of the invention for the unused sewing elements.

[0083] Alternatively, the disabling tube is removed, and the same functionality is provided coupling any desired pneumatic block to both the retracting tubes. However, the solution of the invention is also suitable to be implemented keeping the sewing elements retracted and selectively coupling each sewing element to a first extracting tube, a second extracting tube or an enabling tube. In any case, the use of an independent biasing structure for each sewing element is not excluded.

[0084] The sewing station of the invention is specifically designed for use in a bookbinding machine.

[0085] Advantageously, the bookbinding machine is provided with logic means that are used to control operation of the sewing station automatically (according to corresponding configuration information).

[0086] This feature further simplifies the configuration of the sewing station, strongly reducing any intervention of the operator.

[0087] However, the solution of the invention leads itself to be implemented in bookbinding machines wherein the sewing elements to be retracted and/or disabled must be selected by the operator directly, or even in bookbinding machines wherein the desired configuration of the sewing station is enforced acting on the relevant pneumatic blocks manually.

[0088] Naturally, in order to satisfy local and specific requirements, a person skilled in the art may apply to the solution described above many modifications and alterations all of which, however, are included within the scope of protection of the invention as defined by the following claims.

Claims

1. A sewing station (130) for a bookbinding machine (100) including a plurality of sewing elements (210,215) for sewing stacks of signatures (505) by means of corresponding continuous threads (510a-510c), and driving means (205,230,235) for driving the sewing elements with a reciprocating motion towards a signature (105a,105b) to be sewn,

   characterized in that the sewing station further includes biasing means (435,315) for biasing at least part of the sewing elements individually to an operative position or to a non-operative position, each sewing element in the operative position acting on the signature and each sewing element in the non-operative position not reaching the signature when the sewing element is moved towards the signature.

2. The sewing station (130) according to claim 1, wherein the sewing elements (210,215) consist of a plurality of alternate needles (210) and hook needles (215), the sewing station further including means (160) for configuring the sewing station to implement a stagger stitch sewing technique wherein each needle associated with the signature (105a,105b) alternately cooperates with a first adjacent hook needle during a first sewing cycle and with a second adjacent hook needle during a second sewing cycle, the needles associated with the signature including at least one first ending needle (210a) and at least one second ending needle (210c) along each page being printed on the signature, and further including control means (160) for controlling the biasing means (435,315) to bias the at least one first ending needle to one position and the at least one second ending needle to the other position alternately during each sewing cycle.

3. The sewing station (130) according to claim 2, further including means (245) for detecting a starting state of the sewing station wherein the needles (210) associated with the signature (105a,150b) are in a condition to cooperate with the first or the second adjacent hook needles (215) during a starting sewing cycle, the control means (160) controlling the biasing means (435,315) according to the starting state.

4. The sewing station (130) according to any claim from 1 to 3, wherein at least one of the sewing elements (210,215) associated with the signature (105a,105b) is unused, the sewing station further including means (160) for controlling the biasing means (435,315) to bias the at least one unused sewing element to the non-operative position during each sewing cycle.

5. The sewing station (130) according to any claim from 1 to 4, wherein the driving means (205,230,235) includes a support structure (205) carrying the sewing elements (210,215), and wherein the biasing means (435,315) includes means (435) for keeping the sewing elements extracted from the support structure in the operative position and means (315) for selectively retracting the sewing elements into the support structure in the non-operative position.

6. The sewing station (130) according to claim 5, wherein the means for selectively retracting (315) includes first retracting means (320a) for retracting the sewing elements during each first sewing cycle, second retracting means (320b) for retracting the sewing elements (210,215) during each second sewing cycle, and means (325a,325b) for selectively coupling each sewing element with the first retracting means or the second retracting means.

7. The sewing station (130) according to claim 5 or 6, wherein the means for selectively retracting (315) further includes disabling means (320d) for retracting the sewing elements (210,215) during each sewing cycle, and means (325d) for selectively coupling each sewing element with the disabling means.

8. A bookbinding machine (100) including the sewing station (130) according to any claim from 1 to 7.

9. The bookbinding machine (100) according to claim 8, further including means (160) for providing configuration information indicative of a format of the signature, and logic means (160) for controlling the biasing means (435,315) according to the configuration information.

10. A sewing method for a bookbinding machine including a plurality of sewing elements for sewing stacks of signatures by means of corresponding continuous threads, the method including the steps of:

    driving the sewing elements with a reciprocating motion towards a signature to be sewn,

    characterized by the step of

biasing at least part of the sewing elements individually to an operative position or to a non-operative position, each sewing element in the operative position acting on the signature and each sewing element in the non-operative position not reaching the signature when the sewing element is moved towards the signature.

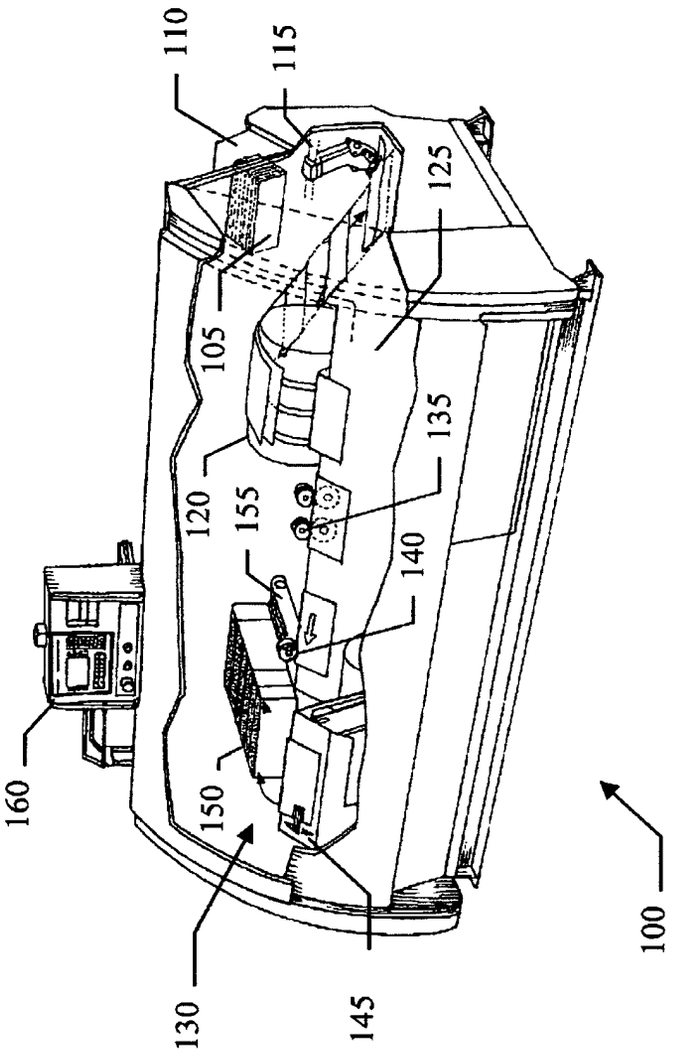

FIG.1

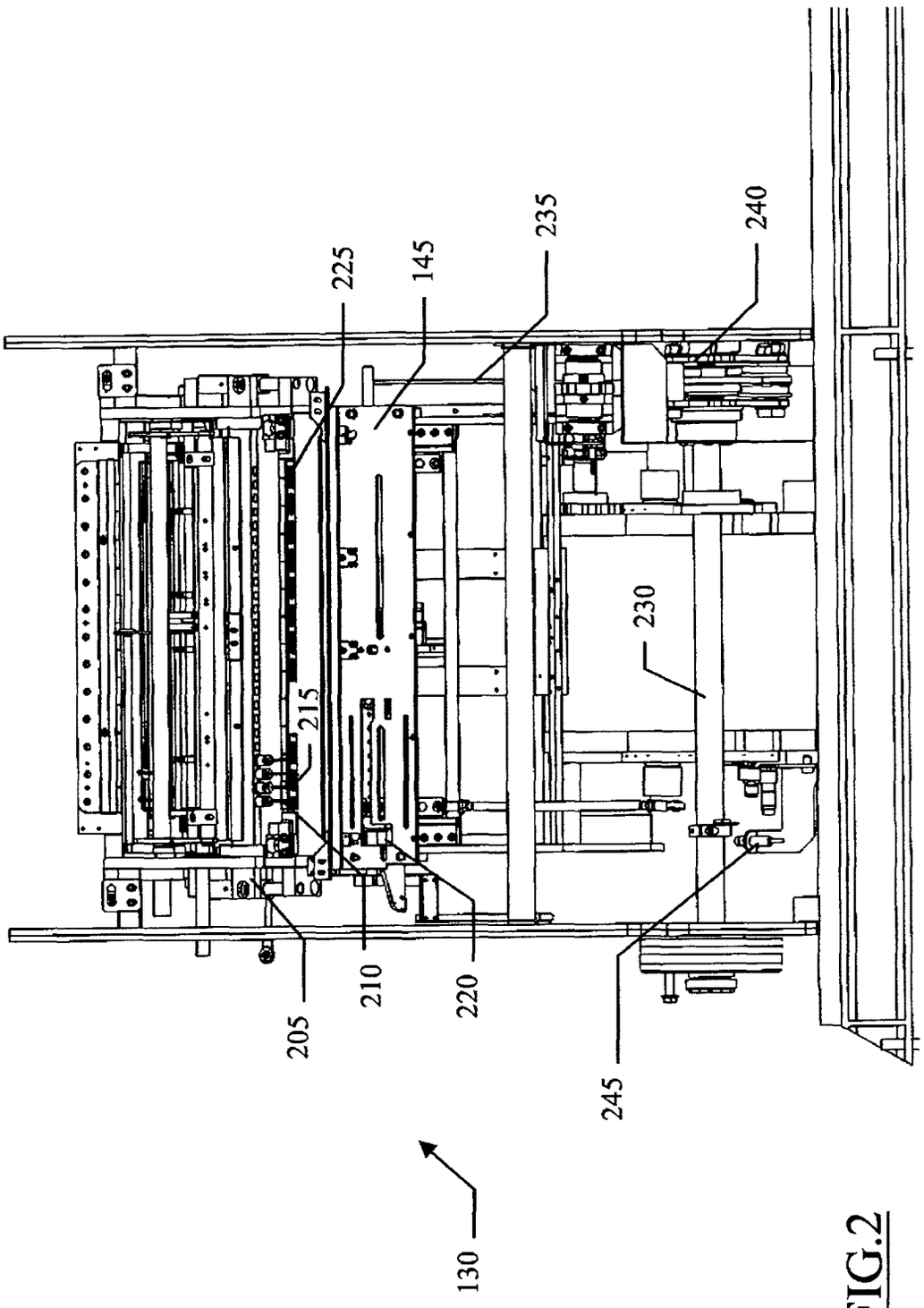

FIG.2

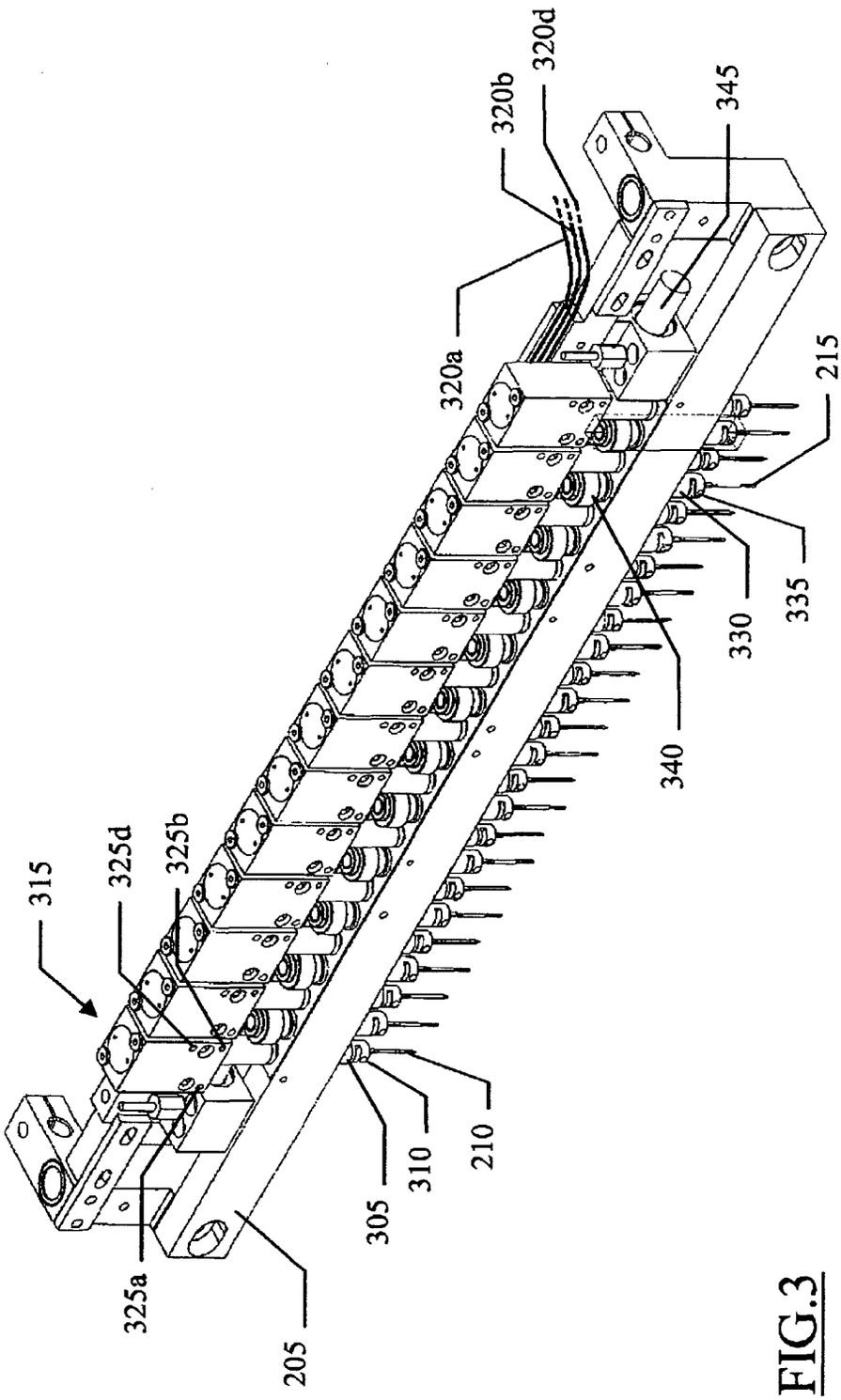
320d
320b
345
320a
215
335
330
340
315
325d
325b
325a
205
305
310
210

FIG.3

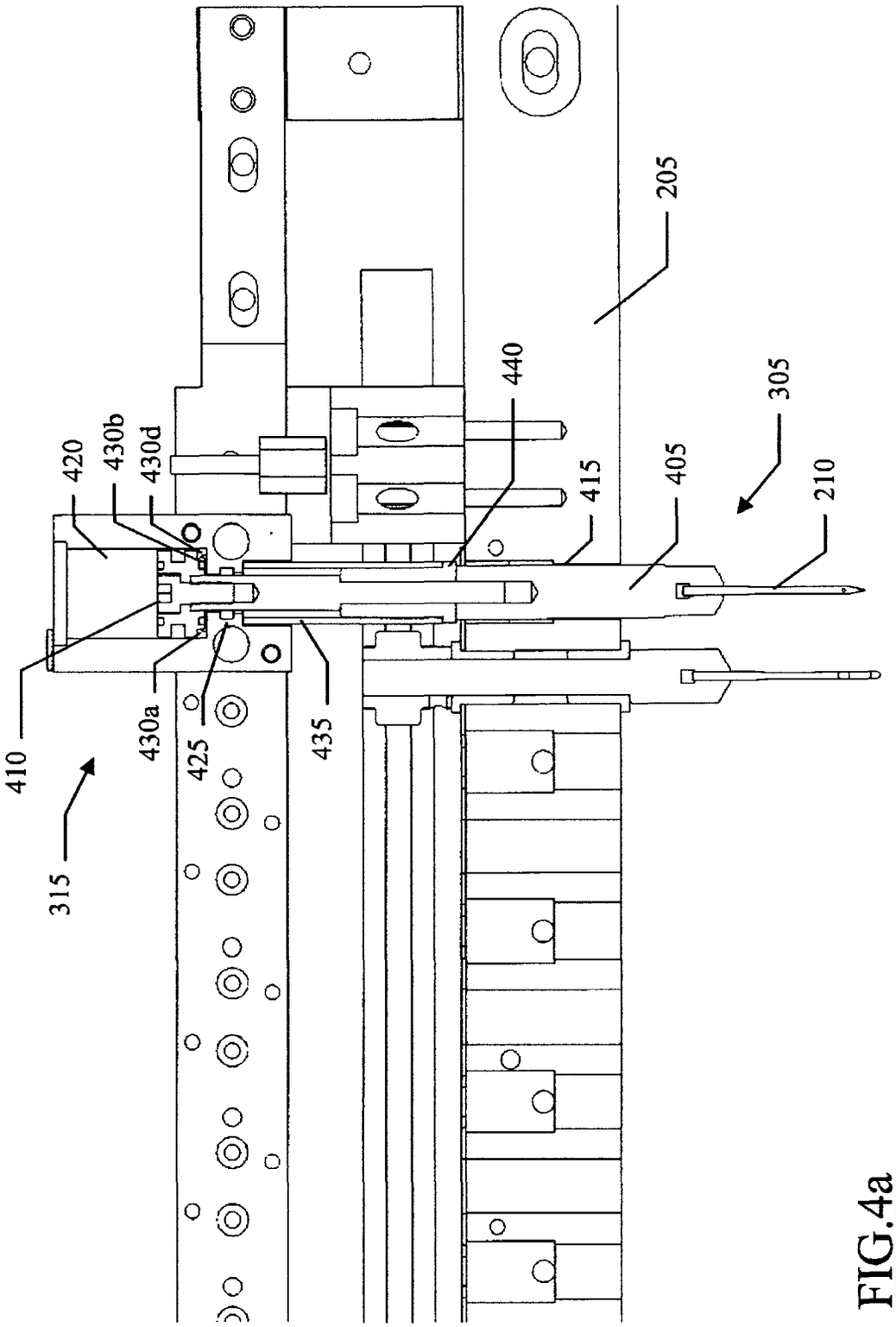

FIG.4a

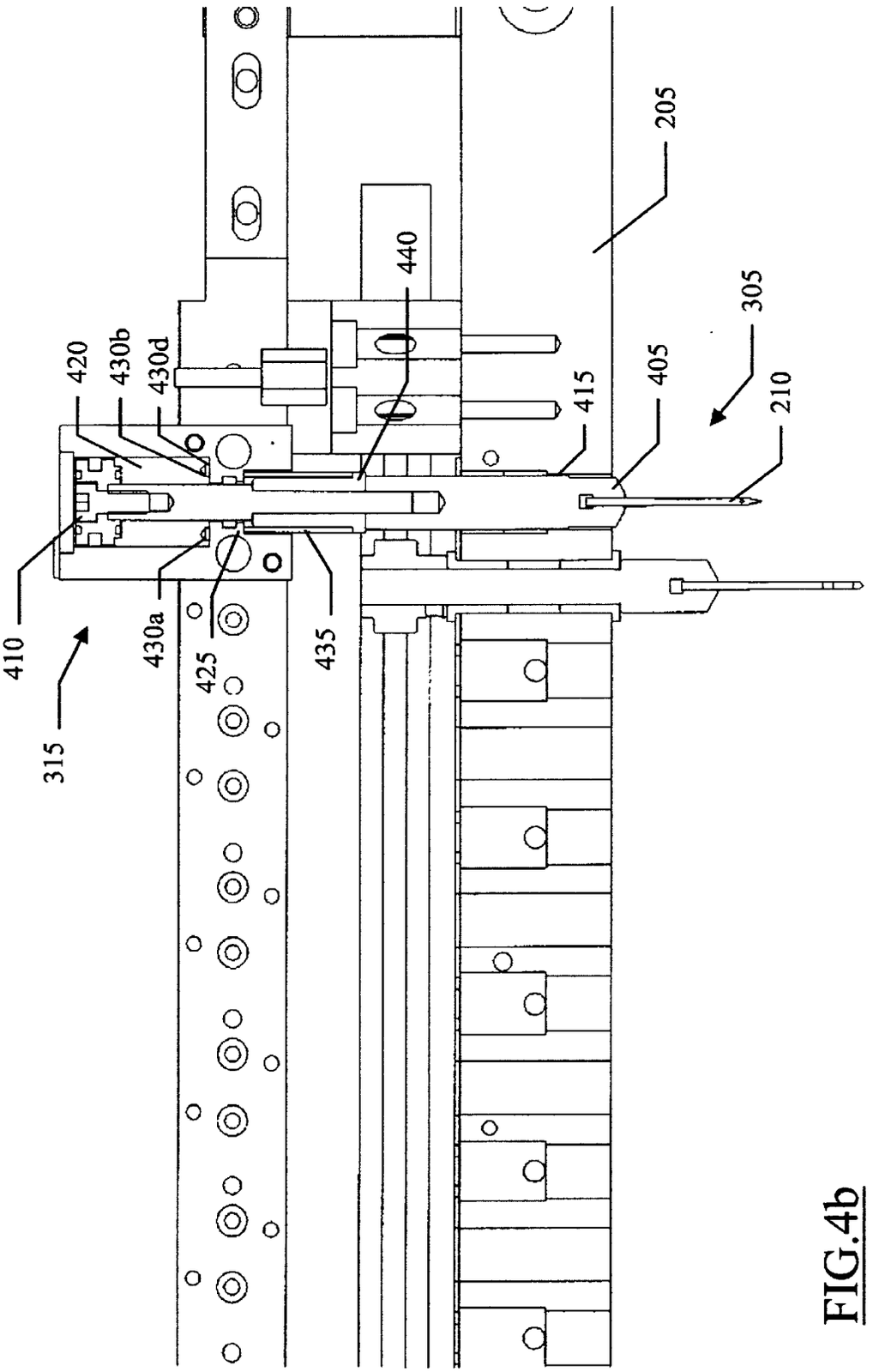

FIG.4b

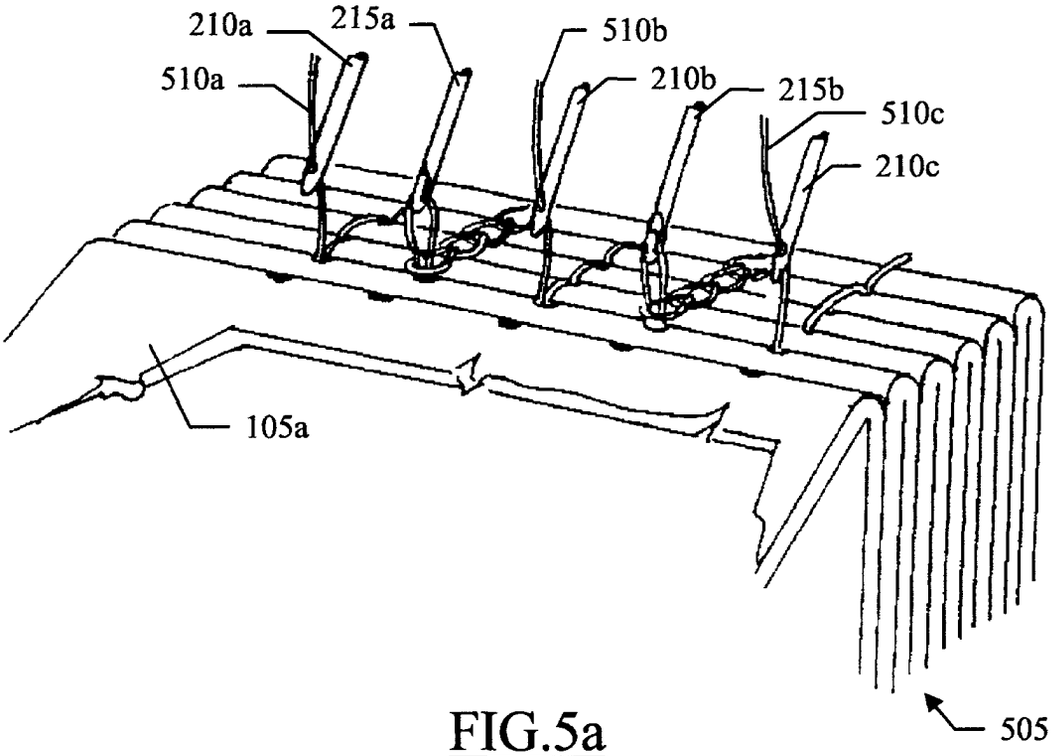
210a
215a
510b
510a
210b
215b
510c
210c
105a
505

FIG.5a

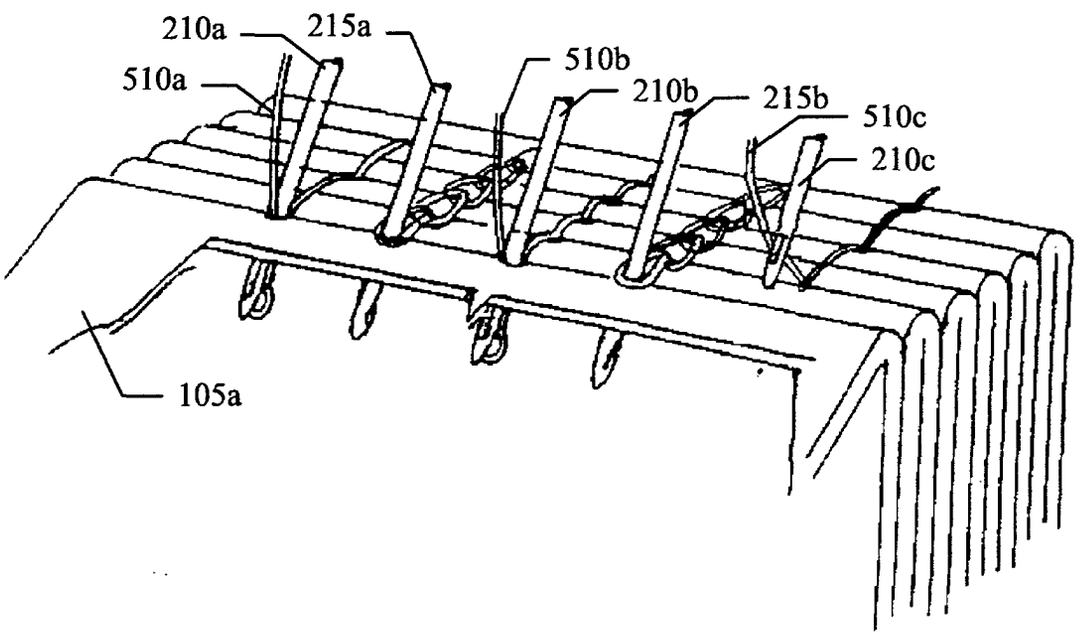
210a
215a
510b
510a
210b
215b
510c
210c
105a

FIG.5b

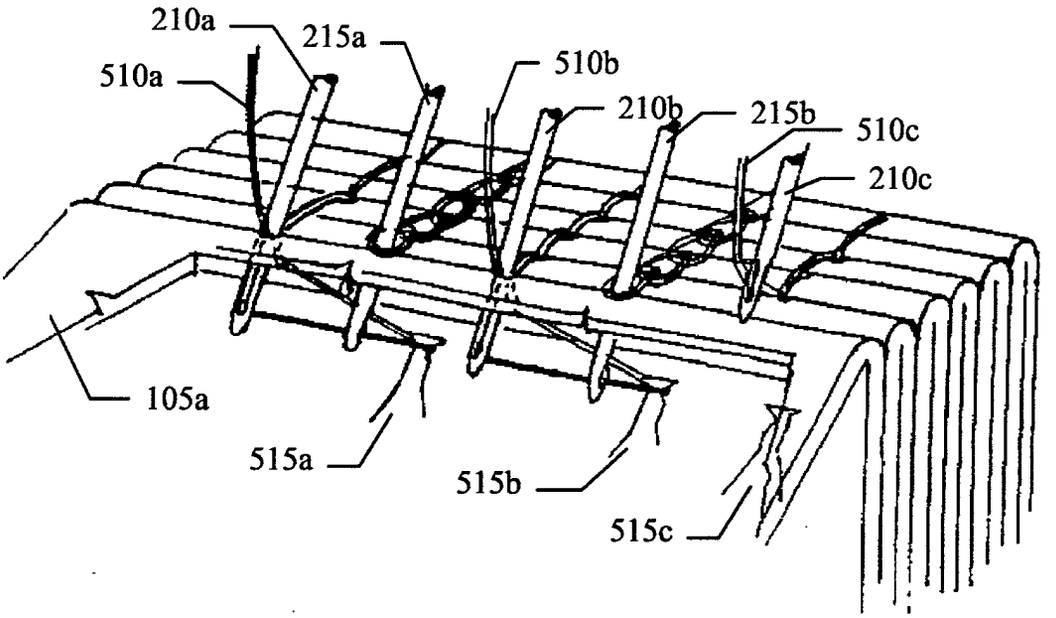
210a
215a
510a
510b
210b
215b
510c
210c
105a
515a
515b
515c

FIG.5c

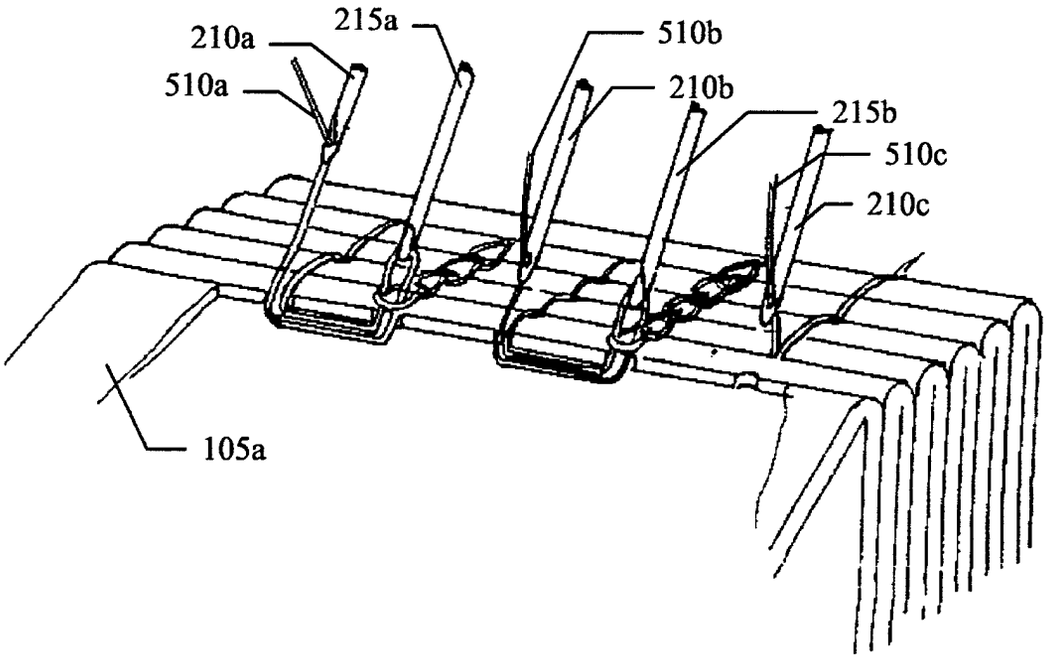
215a
210a
510b
510a
210b
215b
510c
210c
105a

FIG.5d

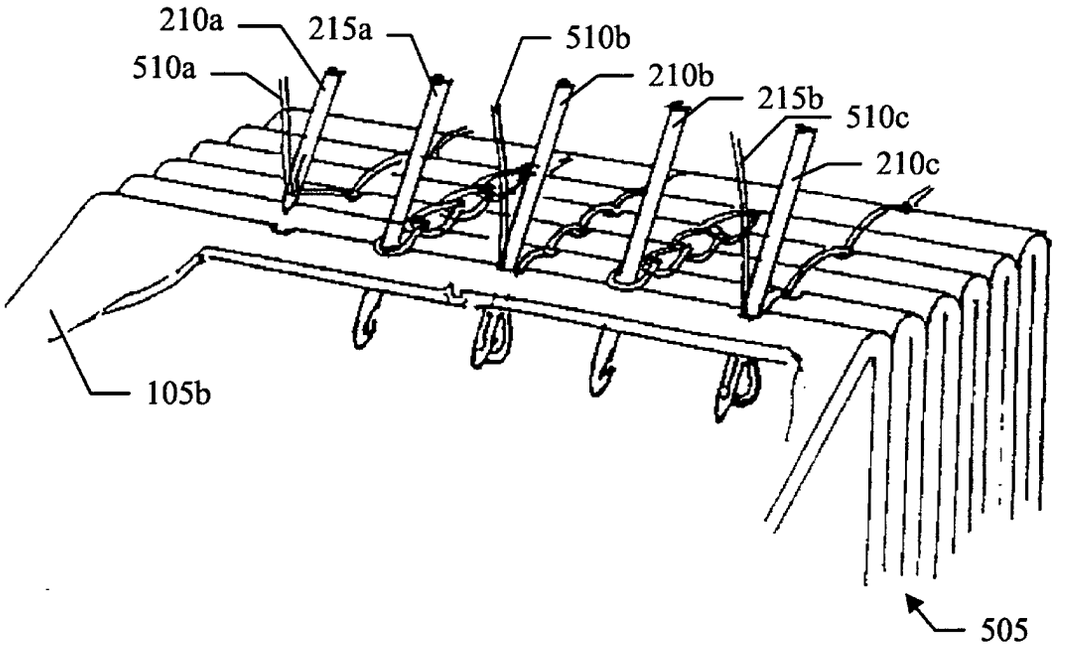
210a
215a
510b
510a
210b
215b
510c
210c
105b
505

FIG.5e

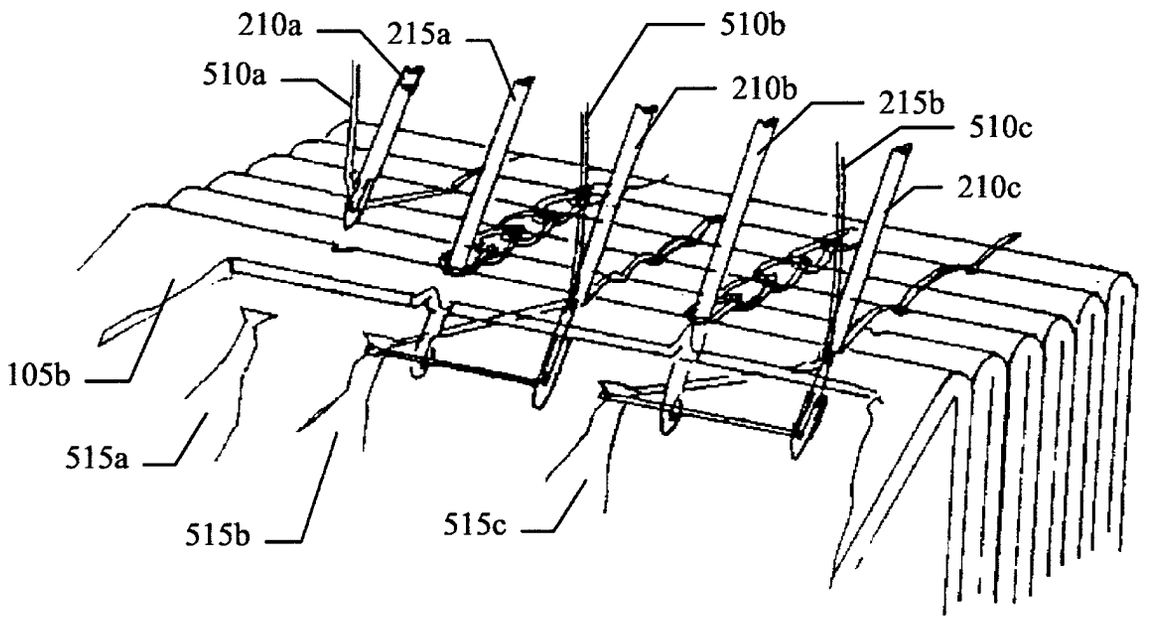
210a
215a
510b
510a
210b
215b
510c
210c
105b
515a
515b
515c

FIG.5f

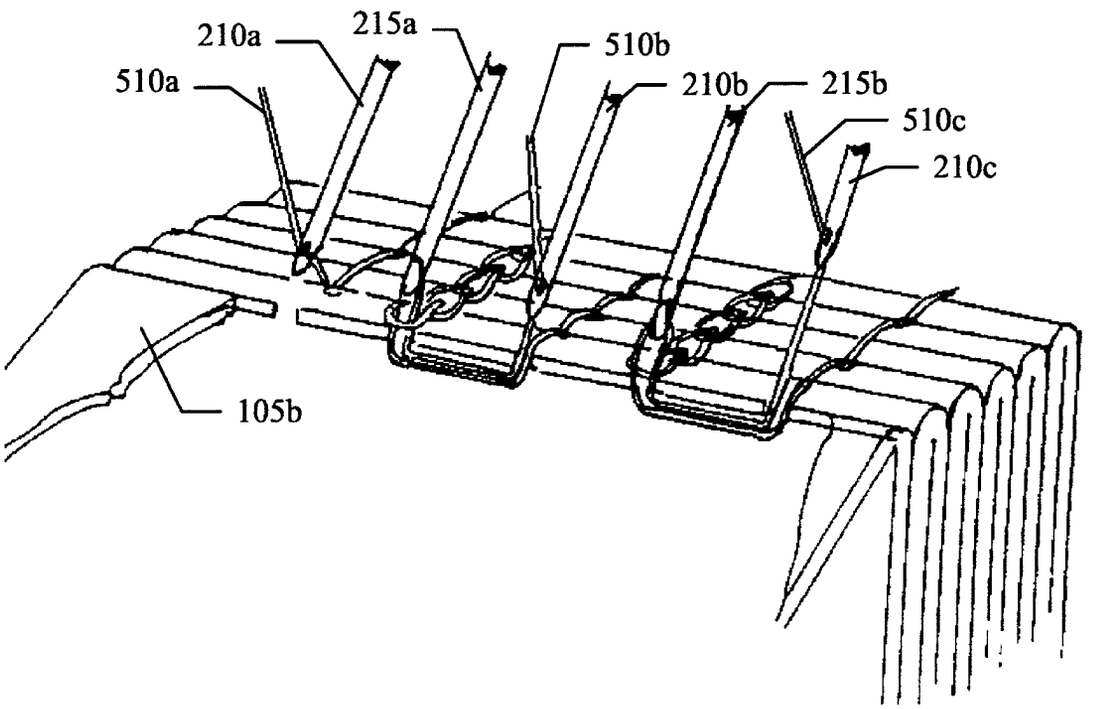

FIG.5g

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 10 0221

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 5 887 532 A (BOETSCHI HEINZ ET AL) 30 March 1999 (1999-03-30) * column 2, line 36 - column 3, line 46; figures 1A-1F *	1-10	B42B2/02
A	US 3 797 419 A (DEPETRIS L) 19 March 1974 (1974-03-19)		
A	GB 621 920 A (WILLIAM ARTHUR HOPKINSON AULD;JOHN THOMAS AULD) 22 April 1949 (1949-04-22)		

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B42B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	17 June 2004	Sartor, M

CATEGORY OF CITED DOCUMENTS

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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17-06-2004

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5887532 A	30-03-1999	AT 203210 T	15-08-2001
		DE 59704064 D1	23-08-2001
		EP 0832758 A2	01-04-1998
		ES 2161428 T3	01-12-2001
		JP 10129145 A	19-05-1998
US 3797419 A	19-03-1974	IT 964713 B	31-01-1974
		CA 984682 A1	02-03-1976
		CH 563885 A5	15-07-1975
		DD 107408 A5	05-08-1974
		DE 2335358 A1	31-01-1974
		GB 1425974 A	25-02-1976
		JP 895051 C	30-01-1978
		JP 49125121 A	29-11-1974
		JP 52022565 B	18-06-1977
		US RE29071 E	14-12-1976
GB 621920 A	22-04-1949	NONE	

EPO FORM P0459

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