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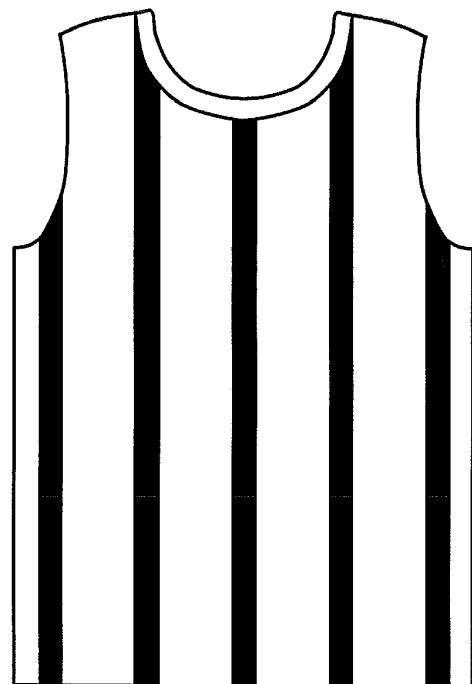
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(54) **A PLATING-KNITTING METHOD AND A FLAT KNITTING MACHINE FOR THE METHOD**

(57) Aligning and feeding two knitting yarns (24, 25) from a yarn feeder (10, 30a, 30b) to knitting needles (19) in a needle bed (4), and plating-knitting such that one of the two knitting yarns appears on the face of a knitted fabric as a face yarn and the other appears on the back of the knitted fabric as a back yarn. Changing the relation of the greater and smaller of tensions applied to the two knitting yarns (24, 25) by a tension control unit (15), making the knitting yarn with the greater tension take a lower position at the guide surface (22) and within the hook (18) of knitting needles (19) as the face yarn, making the other knitting yarn with the smaller tension take a higher position at the guide surface (22) and within the hook (18) of knitting needles (19) as the back yarn, and swapping the allocation of the face yarn and the back yarn to the two knitting yarns (24, 25).

F I G . 8



Description

Technical Field

[0001] The present invention relates to a plating-knitting method where the allocation for the face and back yarns may be swapped and also a flat knitting machine for the method.

Background Art

[0002] In plating-knitting, for example, two knitting yarns are aligned and fed to knitting needles to form stitches comprising the two knitting yarns. The two knitting yarns are fed from separate yarn feeders, and in the knitting direction, one yarn feeder leads the other. Then, the knitting yarn fed from the leading yarn feeder appears as the face yarn on the face of the knitted fabric, and the knitting yarn fed from the following yarn feeder appears as the back yarn on the back of the knitted fabric. According to this method, the relation of the face and back yarns is determined according to the leading and following relation of the yarn feeders. Since knitting machines usually do not have a mechanism for swapping the relation of leading and following yarn feeders during knitting, it is difficult to swap the relation of the face and back yarns during knitting.

[0003] Patent Document 1 (Japanese Utility Model Sho52-51444A) describes to provide two yarn feeders in a single carrier and to make one of the yarn feeders capable of rocking in the direction of carrier movement. When the moving direction of the carriage is reversed, it is necessary for keeping the relation of face and back yarns the same as the previous course to exchange the leading and following relation between the two yarn feeders. Therefore, according to Patent Document 1, the rockable yarn feeder is rocked backward when the carriage reverses so that the face and back relation of the yarns is kept the same as the previous course.

[0004] Patent Document 2 (JP2016-176159A) describes a method on a flat knitting machine with movable sinkers using the combination of trajectories of sinkers and knitting needles for swapping the order of the face and back yarns. In this method, the trajectory of sinkers is kept constant, and the trajectory of knitting needles are changed from usual trajectory to another trajectory for swapping the order of the face and back yarns.

Prior Art List

[0005]

Patent Document 1: Japanese Utility Model Sho52-51444A

Patent Document 2: JP2016-176159A

Summary of the Invention

Object of the Invention

[0006] The object of the invention is to swap the relation of face and back yarns in plating-knitting during knitting by a novel means.

Means for Solving the Problem

[0007] The plating-knitting method according to the invention uses a knitting machine, aligns and feeds at least two knitting yarns from at least a yarn feeder of at least a carrier to knitting needles in at least a needle bed, such that one of said at least two knitting yarns appears on the face of a knitted fabric as a face yarn and the other of said at least two knitting yarns appears on the back of the knitted fabric as a back yarn.

[0008] The method is characterized by:

guiding said at least two knitting yarns by a guide surface provided on sinkers in the needle bed and feeding to the knitting needles;

changing a tension applied to at least one of said at least two knitting yarns by a tension control unit during movement of the carrier;

making the knitting yarn with a greater tension take a lower position at the guide surface and within the hook of knitting needles as the face yarn, and making the knitting yarn with a smaller tension take a higher position at the guide surface and within the hook of knitting needles as the back yarn;

and thereby,

swapping the allocation of the face yarn and the back yarn to said at least two knitting yarns.

[0009] The flat knitting machine according to the invention comprises at least a needle bed provided with knitting needles and sinkers arranged along the longitudinal direction of the needle bed; and at least a carrier having a yarn feeder for feeding at least two knitting yarns to the knitting needles in an aligned state, wherein said sinkers have guide surfaces for guiding said at least two knitting yarns. The flat knitting machine is characterized by a tension control unit for controlling a tension applied to at least one of said at least two knitting yarns; and by said tension control unit being configured to swap an allocation of said at least two knitting yarns to a face yarn and a back yarn during movement of the carrier by changing said tension applied to said at least one yarn such that a yarn allocated to the face yarn has a greater tension than the other yarn allocated to the back yarn.

[0010] According to the invention, the aligned knitting yarns are guided by the guide surface of sinkers; namely, their positions are regulated by contact with the guide surface, and are fed to the hooks of knitting needles. Further, regarding the up-down relation between the relevant parts, the yarn feeder is at the higher position, the

hooks are at the lower position, and the knitting yarns contact the guide surfaces at the intermediate height. At this instance, the knitting yarn with the greater tension takes the shortest path from the yarn feeder to the hook and therefore is made to take the lower position on the guide surface under the knitting yarn with the smaller tension. Therefore, the knitting yarn with the greater tension (the face yarn) takes the lower position within the hook, the knitting yarn with the smaller tension (the back yarn) takes the higher position within the hook, and thus, the knitting yarn with the greater tension becomes the face yarn, and the knitting yarn with the smaller tension becomes the back yarn.

[0011] When swapping the allocation of the greater and the smaller tensions to the knitting yarns, then, the knitting yarn with the greater tension moves towards the lower portion of the guide surface, the knitting yarn with the smaller tension moves towards the upper portion of the guide surface, and the relation between the face and back yarns is reversed. The inventor confirmed these facts with observing how the two aligned knitting yarns move by swapping the tensions. Namely, the knitting yarn with the greater tension moved downwards on the guide surface, the knitting yarn with the smaller tension moved upwards on the guide surface, and as a result, the relation of the face and back yarns was reversed. According to the invention, with the guide by the guide surface and by swapping the tensions, the relation of the face and back yarns may be changed during knitting. As a result, the yarn appearing on the face of the knitted fabric may be swapped, and so, desired patterns may be formed on plating-knitted fabrics. Here, the setting about which yarn is made the face and which yarn is made the back is called the allocation of knitting yarns to the face and back yarns. Continuous tension controls are not necessary; it is enough that the tensions are controlled at least when the allocation to the face and back yarns is changed. Namely, when the same tension is applied to respective yarns, the allocation to the face and back yarns does not change. Therefore, the tensions may be changed only when the allocation is changed, and a common tension may usually be applied to respective knitting yarns. While the both tensions of yarns may be controlled, the tension to only one knitting yarn may be controlled and the tension to the other may be kept constant.

[0012] Preferably, pattern data in knitting data which expresses a pattern to be realized according to the allocation of the face and the back yarns is retrieved by a controller of the knitting machine; and the tension applied to at least one of said at least two knitting yarns is changed by the tension control unit according to the retrieved pattern data. Thus, the pattern according to the knitting data is realized by the tension swapping during plating-knitting.

[0013] Preferably, said at least two knitting yarns are separately fed from a pair of yarn feeders provided at a lower end of a common carrier. Since the yarns are fed via the common carrier, the control is simpler than a case

where the yarns are fed from two or more yarn feeders, and a smaller number of yarn feeders are necessary. Further, the yarns are fed separately from the pair of yarn feeders without mutual contact in the yarn feeders.

Therefore, the decrease in the tension difference due to the mutual contact of knitting yarns is suppressed, and thus, the relation of the face and back yarns is correctly kept.

Brief Description of the Drawings

[0014]

Fig. 1: A front view of flat knitting machine according to the embodiment

Fig. 2: A schematic view of the feeding path of knitting yarns to the knitting needles via the sinkers according to the embodiment

Fig. 3: A schematic view showing the states before swapping of the face and back yarns according to the embodiment

Fig. 4: A schematic view showing the states after swapping of the face and back yarns according to the embodiment

Fig. 5: A flowchart showing the algorithm for swapping the face and back yarns according to the embodiment

Fig. 6: A diagram showing the tension control for swapping the face and back yarns according to the embodiment

Fig. 7: A side view of a carrier provided with plural yarn feeders

Fig. 8: A schematic view of plating-knitted fabric knitted according to the embodiment

Detailed Description of the Preferred Embodiment

[0015] Fig. 1 to Fig. 8 show the best embodiment for carrying out the invention and its modifications.

Embodiment

[0016] Fig. 1 shows a flat knitting machine 2 used in the embodiment. Indicated by 4 is a needle bed, and the flat knitting machine 2 is provided with, for example, a pair of front and a back needle beds or four needle beds of front upper and front lower, and back upper and back lower. Indicated by 6 is a carriage that manipulates the knitting needles in the needle beds 4. However, when each knitting needle is provided with a linear motor, the carriage 6 is not necessary. The carriage 6 reciprocates along the longitudinal direction of the needle beds 4 (the left and right direction in Fig. 1), and an entraining unit 8 integral with the carriage 6 entrains carriers 11 provided with a yarn feeder 10 along rails 12.

[0017] Yarn feeding portion 13, for example, provided on an upper non-center portion of the flat knitting machine 2, supplies knitting yarns to yarn feeders 10, and then,

they are aligned and fed to knitting needles in the needle beds 4. Yarn sources such as cones 14 in the yarn feeding portion 13 supply the knitting yarns to a tension control unit 15 that applies desired tensions to respective knitting yarns. Servo-motors in the tension control unit 15 control the rotation speeds of rollers for supplying the yarns and control the tensions of the yarns with the rollers. Alternatively, the knitting yarns are supplied through small holes in arms and variable biasing forces are applied to the arms. The changes in the biasing forces to the arms change the tensions to the knitting yarns.

[0018] The tension control unit 15 may be provided with additional elements such as rotary encoders for measuring the supplied lengths of the knitting yarns. Further, the switching mechanism for the tensions is arbitrary. In Fig. 1, knitting yarns are supplied from the upper portion of the flat knitting machine 2; though they may be supplied from a side portion of the flat knitting machine. In the following example, two aligned knitting yarns are supplied; while three or more yarns may be supplied. However, when three or more knitting yarns are aligned and supplied, it is necessary to apply an enough greater tension to the face yarn and smaller tensions to the back yarns, and it is difficult to provide a tension difference between the back yarns. Therefore, the plural back yarns might appear uncontrollably on the back face of the knitted fabric, and the color of the back face might be mixed.

[0019] Fig. 2 shows the supply of, for example, two knitting yarns 24, 25 from a yarn feeder 10 to hooks 18 of the knitting needles. The knitting direction (the course direction) is from the right to the left in Fig. 2, and the knitting yarns fed from the yarn feeder 10 at a higher position are guided by a guide surface 22 at the tip of sinkers and are fed to the hooks 18. Further, the two knitting yarns 24, 25 are aligned and fed from, for example, one or two yarn feeders 10. Then, at positions just before the hooks 18, the knitting yarn with the greater tension appears at the lower position, and the knitting yarn with the smaller tension appears at the higher position. In Fig. 1, one yarn feeder 10 supplies the knitting yarns 24, 25; however, separate two yarn feeders may supply the knitting yarns 24, 25 respectively.

[0020] In Fig. 2, a hook 18a has already returned in the needle bed 4 after forming a new stitch, and hooks 18b, 18c are returning in the needle bed in sequence after advancing to the trick gap. Further, the respective guide surfaces of the sinkers for guiding the knitting yarns to the hooks 18a, 18b, 18c are denoted by 22a, 22b, 22c respectively.

[0021] Fig. 3 shows one unit of hook 18a, sinker 20a, and its guide surface 22a, and the hooks 18 and the sinkers 20 are provided on the needle beds at a predetermined pitch along the longitudinal direction of the beds. Denoted by 19 is a knitting needle having said hook 18a at the tip and it may be a latch needle, a compound needle, or the like. The sinker 20 is, for example, fixed on a needle bed, however, it may be a movable sinker manipulated by the carriage. The tip surface of the sinker 20

forms the guide surface 22 in a view from the needle bed, and the guide surface 22 may be vertical or tilted from a vertical surface 23 with a tilt angle θ . Fig. 3 shows an example where the tilt angle θ is 15° , however, the tilt direction may be reversed (with a negative tilt angle).

[0022] Fig. 3 shows the situations of the knitting yarns 24, 25 at the hook 18a and at the guide surface 22a just before changing the tensions to the knitting yarns 24, 25 or before the tension change influences them. The knitting yarn 25 with the greater tension is compelled to take the shortest path from the yarn feeder to the hook 18a and takes the lower position at the guide surface 22a, and the knitting yarn 24 with the smaller tension takes the higher position at the guide surface 22a. Within the hook 18a, the knitting yarn 25 with the greater tension takes the lower position and becomes the face yarn, and the knitting yarn 24 with the smaller tension takes the higher position and becomes the back yarn.

[0023] Fig. 4 shows the situation where the tensions have been switched so that the tension to the knitting yarn 24 becomes greater than that to the knitting yarn 25 and the tension change has influenced the knitting yarns at the hook 18c and the guide surface 22c. The up-down relation between the knitting yarns 24, 25 changes at the guide surface 22c and within the hook 18c so that the knitting yarn 24 with the greater tension takes the lower position than the knitting yarn 25 with the smaller tension, and within the hook 18c the knitting yarn 24 takes the lower position and becomes the face yarn, and the knitting yarn 25 takes the higher position and becomes the back yarn.

[0024] The ratio of tensions applied to the two knitting yarns (tension ratio at the tension control unit 15) is, for example, two or more, preferably, not less than two and not more than 15, for preventing the excessive tensions from breaking the knitting yarns, and in particular, not less than two and not more than 10. According to the embodiment, the greater tension was set to 40g/yarn, the smaller tension was 5g/yarn, and the ration of the tensions was 8. However, a knitting condition of the greater tension of 20g/yarn and the smaller tension of 5g/yarn allowed satisfactory knitting with correctly keeping the relation of the face and back yarns. By the way, g/yarn is a unit indicating the tension for one knitting yarn.

[0025] Since the contact of the two knitting yarns decreases the tension difference, for feeding from one single yarn feeder, the following is preferable. Namely, the yarn feeder has such a size that the two knitting yarns may pass it without mutual contact and has a shape of an ellipse, or the like, with the longer axis being perpendicular to the longitudinal direction of the needle beds. This configuration prevents the contact of the knitting yarns within the yarn feeder and also within the carrier.

[0026] Since the difference in tensions to the knitting yarns determines the relation of the face and back yarns, one tension applied to one knitting yarn is controlled to take either a greater value or a smaller value, and the tension applied to the other knitting yarn may be fixed at

the intermediate value. In this case, the tension to the other knitting yarn may be kept nearly constant by a tension spring or the like without the feedback control or the like.

[0027] After swapping the tensions at the tension control unit 15, the yarns need, for example, about from 1/5 inch to 1 inch, before the relation of face and back yarns really reverses. This length becomes longer when the distance between the tension control unit 15 and the yarn feeders 10 is longer and becomes shorter when the distance is shorter. Preferably, the controller in the knitting machine stores the lengths for various distances between them.

[0028] The difference in the tensions changes the up-down relation of the knitting yarns at the guide surface 22. While the same tensions are applied to the two knitting yarns, the up-down relation between the knitting yarns does not change. Therefore, the same tensions may usually be applied, the tension to the face yarn is made greater than that to the back yarn when the relation of the face and back yarns is to be changed, and the tensions to the two knitting yarns may be made equal after completely swapping the face and back yarns.

[0029] Fig. 5 and Fig. 6 show the tension control during plating-knitting. Fig. 5 shows the control in the flat knitting machine, and since the allocations for face and back yarns are described in the knitting data, the knitting machine retrieves this data. For the allocations, for example, the initial allocation for the face and back yarns is specified, and positions to change the allocation for the face and back yarns is specified for the subsequent knitting. Therefore, these allocations are retrieved and stored (Step 1).

[0030] The tension control unit controls the tensions so that the yarn allocated to the face yarn has the greater tension and the yarn allocated to the back yarn has the smaller tension, and the two knitting yarns are aligned and fed (Step 2).

[0031] Then, the greater and smaller relation between the tensions is switched at an upstream position from a position to change the face and the back relation of the yarns by the number of needles necessary till the relation actually changes after the tension change (Steps 3, 4), and then the process returns to Step 2.

[0032] Fig. 6 schematically shows swapping the tensions to the two knitting yarns and swapping the relation of the face and back yarns.

[0033] The allocation for the face and back yarns may be changed not for forming patterns according to the knitting data but for changing the allocation of the face and the back yarns randomly and independently of the knitting data. Then, knitted fabrics having random color changes and so on are knitted.

[0034] Fig. 7 shows a carrier 11 having a pair of yarn feeders 30a, 30b at the tip. The carrier 11 moves along the rail 12, has the pair of the yarn feeders 30a, 30b at the same position along the longitudinal direction of the needle beds and between a pair of front and back support

members 31, 31 along the direction. Through a pair of eyelets 32a, 32b, the knitting yarns 24, 25 are fed to the yarn feeders 30a, 30b and are aligned and fed to knitting needles without mutual contact in the vicinity of the carrier 11.

[0035] Preferably, the eyelets 32a, 32b are provided in a plane perpendicular to the longitudinal direction of the rail 12 (the longitudinal direction of the needle beds 4), and the contact between the knitting yarns 24, 25 between the tension control unit 15 and the yarn feeders 30a, 30b is prevented.

[0036] Fig. 8 shows schematically a plating-knitted fabric 80 to be knitted according to the embodiment, and the allocation for the face and back yarns is swapped according to the data specifying the color pattern (pattern data) in the knitting data. The timing for changing the tensions is determined based upon the data regarding carriage positions, the needle selection data indicative of the needles to be selected, or the like.

[0037] It is not needed to keep the greater side tension and the smaller side tension constant. For example, the greater side tension may usually be kept between 5g/yarn and 20g/yarn, and also the smaller side tension may usually be kept between 5g/yarn and 20g/yarn. When swapping the allocation for the face and back yarns, the greater side tension may be increased to, for example, 30g/yarn and the smaller side tension may be decreased to, for example, 3g/yarn so that the allocation of knitting yarns may be easily swapped. Namely, the difference in the tensions between the face and back yarns may usually be made smaller than that for the allocation change, and, in an extreme example, the tensions to the face and back yarns may usually be the same. Further, the tension for one yarn may be controlled, for example, between 5g/yarn and 30g/yarn or the like, and the tension for the other yarn may be kept constant at 15g/yarn, for example.

Description of Symbols

[0038]

2	flat knitting machine
4	needle beds
6	carriage
8	entraining unit
10	yarn feeder
11	carrier
12	rails
13	yarn feeding portion
14	cones
15	tension control unit
16	controller
18	hooks
19	knitting needles
20	sinkers
22	guide surfaces
23	vertical surface
24, 25	knitting yarns

30a,b yarn feeders
 31 support members
 32a,b eyelets
 80 plating-knitted fabric

Claims

1. A plating-knitting method using a knitting machine (2), aligning and feeding at least two knitting yarns (24, 25) from at least a yarn feeder (10, 30a, 30b) of a carrier (11) to knitting needles (19) in at least a needle bed (4), such that one of said at least two knitting yarns appears on the face of a knitted fabric as a face yarn and the other of said at least two knitting yarns appears on the back of the knitted fabric as a back yarn, **characterized by:**

guiding said at least two knitting yarns (24, 25) by a guide surface (22) provided on sinkers (20) in the needle bed (4) and feeding to the knitting needles (19);

changing a tension applied to at least one of said at least two knitting yarns (24, 25) by a tension control unit (15) during movement of the carrier (11);

making the knitting yarn (24, 25) with a greater tension take a lower position at the guide surface (22) and within the hook (18) of knitting needles (19) as the face yarn, and making the knitting yarn (24, 25) with a smaller tension take a higher position at the guide surface (22) and within the hook (18) of knitting needles (19) as the back yarn;

and thereby, swapping the allocation of the face yarn and the back yarn to said at least two knitting yarns (24, 25).

2. A plating-knitting method according to claim 1, **characterized by:**

retrieving pattern data in knitting data expressing a pattern to be realized according to the allocation of the face yarn and the back yarn by a controller (16) of the knitting machine (2); and changing the tension applied to at least one of said at least two knitting yarns (24, 25) by the tension control unit (15) according to the retrieved pattern data.

3. A plating-knitting method according to claim 1 or 2, **characterized in that** said at least two knitting yarns (24, 25) are separately fed from a pair of yarn feeders (30a, 30b) provided at a lower end of a common carrier (11).

4. A flat knitting machine (2) comprising at least a nee-

dle bed (4) provided with knitting needles (19) and sinkers (20) arranged along the longitudinal direction of the needle bed (4); and at least a carrier (11) having a yarn feeder (10, 30a, 30b) for feeding at least two knitting yarns to the knitting needles (19) in an aligned state, wherein said sinkers (20) have guide surfaces (22) for guiding said at least two knitting yarns, **characterized by**

a tension control unit (15) for controlling a tension applied to at least one of said at least two knitting yarns (24, 25) ;

and by said tension control unit (15) being configured to swap an allocation of said at least two knitting yarns to a face yarn and a back yarn during movement of the carrier (11) by changing said tension applied to said at least one yarn such that a yarn allocated to the face yarn has a greater tension than the other yarn allocated to the back yarn.

5. A flat knitting machine according to claim 4, **characterized by:**

a controller (16) retrieving pattern data in knitting data expressing a pattern to be realized according to the allocation of the face yarn and the back yarn; and

said tension control unit (15) being configured to change the tension applied to at least one of said at least two knitting yarns (24, 25) according to the retrieved pattern data.

FIG. 1

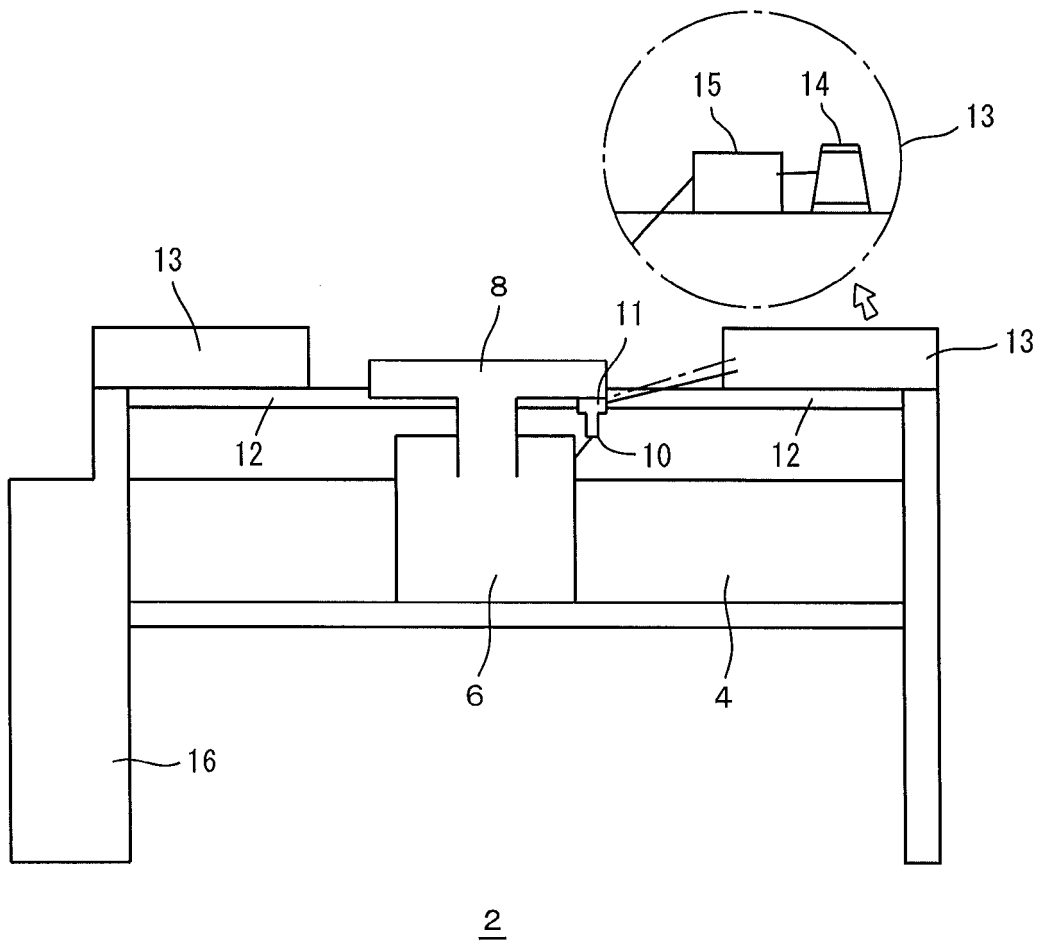


FIG. 2

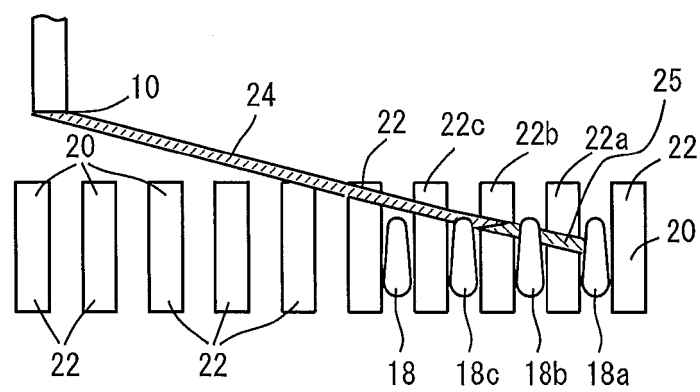


FIG. 3

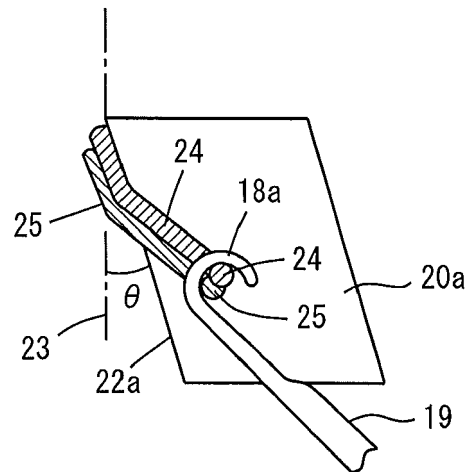


FIG. 4

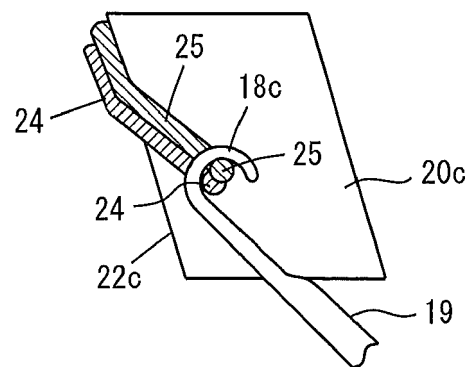


FIG. 5

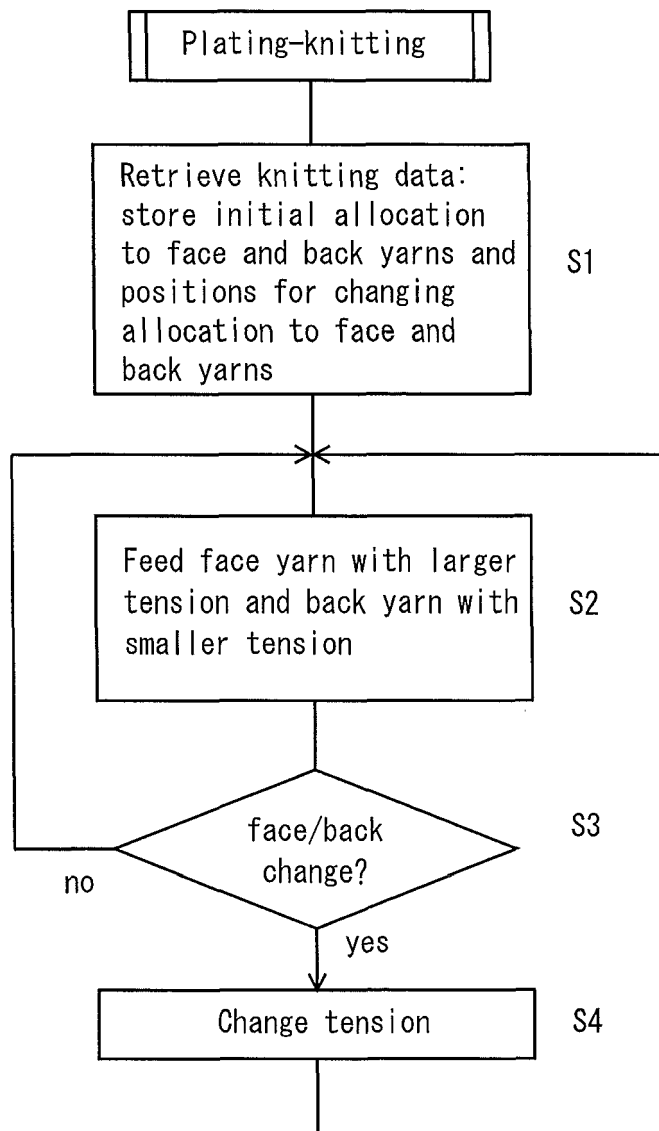


FIG. 6

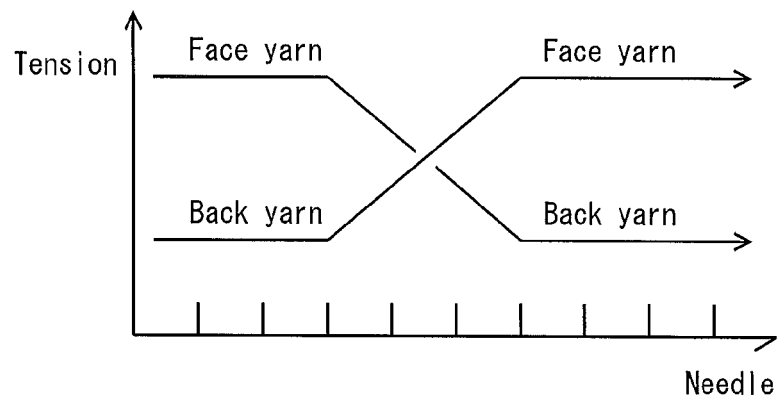
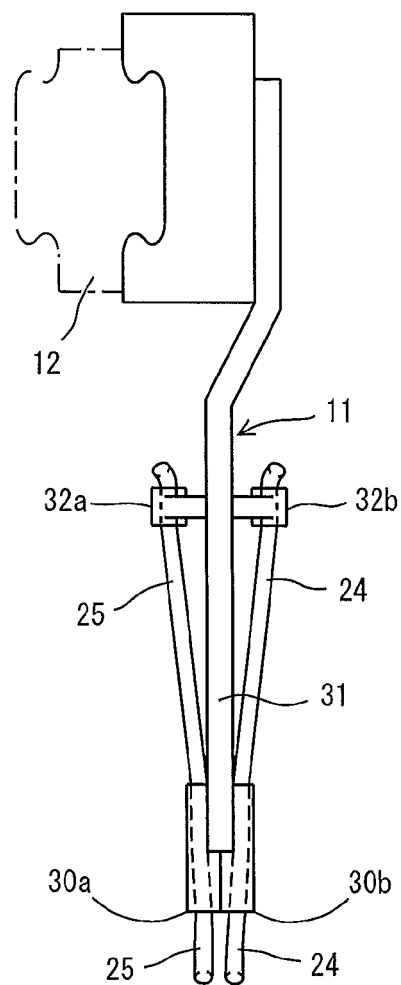
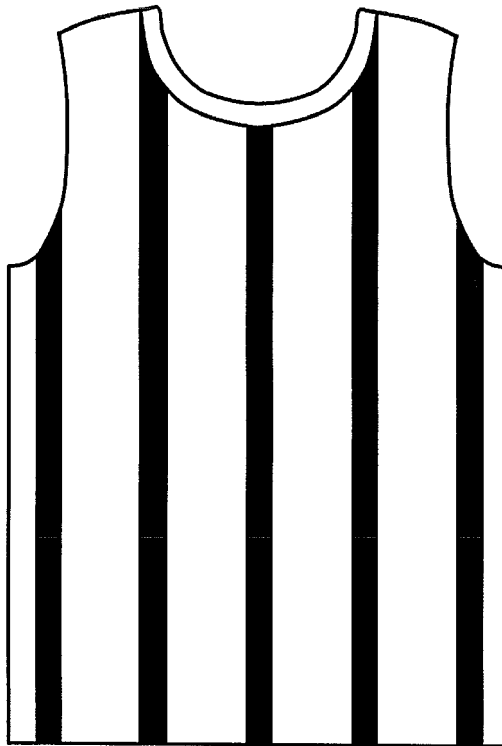


FIG. 7



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EUROPEAN SEARCH REPORT

 Application Number
 EP 17 19 9054

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