



(11) **EP 2 025 785 A1**

(12) **EUROPEAN PATENT APPLICATION**  
published in accordance with Art. 153(4) EPC

(43) Date of publication:  
**18.02.2009 Bulletin 2009/08**

(51) Int Cl.:  
**D04B 7/26 (2006.01) D04B 15/36 (2006.01)**

(21) Application number: **07737164.9**

(86) International application number:  
**PCT/JP2007/000508**

(22) Date of filing: **11.05.2007**

(87) International publication number:  
**WO 2007/132559 (22.11.2007 Gazette 2007/47)**

(84) Designated Contracting States:  
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR**  
Designated Extension States:  
**AL BA HR MK RS**

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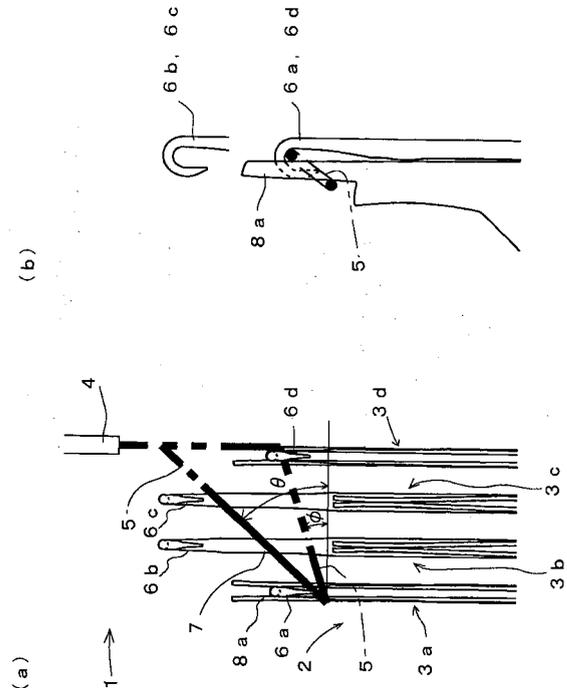
(30) Priority: **17.05.2006 JP 2006137760**

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(54) **KNITTING METHOD OF INTERSIA PATTERN FABRIC AND WEFT KNITTING MACHINE**

(57) A knitting method of an intersia pattern fabric and a weft knitting machine in which the condition of yarn catch can be improved. As shown at (a), when a knitting yarn (5) is kept hooked from the knitting needle (3a) of high tuck on the starting side of a section to the knitting needle (3d) of high tuck on the ending side, inclination angle of the knitting yarn (5) becomes  $\theta$ . Drawing-in of the knitting needle (3d) on the ending side is preceded. As a result of preceded drawing-in, inclination angle of the knitting yarn (5) decreases to  $f$  and the timing at which the knitting yarn (5) is hooked to the hook (6b) can be delayed. Because of this timing lag, yarn catch at the knitting needle (3b) begins after knock over is started at the knitting needle (3a) on the starting side.; Knock over started at the knitting needle (3a) can decrease a level difference of the knitting yarn (5) at an adjoining knitting needle (3b) and the condition of yarn catch can be improved.

Fig. 1



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**Description****Technical Field**

5 **[0001]** The present invention relates to a knitting method and a flat knitting machine that can knit intarsia patterns by feeding a knitting yarn that serves as a warp yarn simultaneously in a plurality of sections.

**Background Art**

10 **[0002]** Conventionally, a knitting yarn feeding apparatus that can feed a knitting yarn that serves as a warp yarn is used to knit fabrics similar to warp knit structures in a flat knitting machine that basically knits fabrics of weft knit structures (for example, see Patent Document 1). This knitting yarn feeding apparatus is equipped with lace bars, each lace bar has a plurality of mounted feeder tubes capable to feed knitting yarns simultaneously to a plurality of sections, and is able to knit structures similar to warp knit structures in which knitting yarns that form knitted loops run in the wale direction  
15 by lapping action in which the lace bars shuttles in the longitudinal direction of the needle bed and by swing action in which the lace bars oscillates between the front and the back of the needle bed. It is also possible to knit intarsia pattern knit fabrics by combining the lapping and swing actions of the lace bars (for example, see Patent Document 2).

**[0003]** Fig. 6 shows the condition in which a knitting yarn 5 is hanged over from a feeder tube 4 mounted to a lace bar to a plurality of knitting needles 3 advanced from a needle bed 2 to a needle bed gap 1. As shown in Fig. 6(a), the feeder tube 4 hangs the knitting yarn 5 over each section by a swing action of the lace bar, a lapping action and a swing action. Incidentally, in this occasion, one section is formed by four knitting needles 3a, 3b, 3c, and 3d. On the start-end side of the section, the feed tube 4 oscillates from the rear side to the front side on the left side of the knitting needle 3a by a swing action to pull out the knitting yarn 5 from an old loop of the knit fabric kept by the rear side of the needle bed 2 to the front side of the needle bed 2. From the knitting needle 3a on the start-end side to the knitting needle 3d on the terminal-end side, the feeder tube 4 traverses by a wrapping action and feeds the knitting yarn 5 from the head end of the feeder tube 4 to each of knitting needles 3a, 3b, 3c, and 3d which belong to this section. On the terminal-end side of the section, on the right side of the knitting needle 3d, the feeder tube 4 oscillates from the front side of the needle bed 2 to the rear side by a swing action and pulls out the knitting yarn 5. The needle bed 2 is tilted so that the end confronting the needle bed gap 1 ascends. The knitting yarn feeding apparatus equipped with the lace bars is installed above the needle bed opposed to the needle bed 2 with the needle bed gap 1 in-between, and oscillates between the position where the head end of the feeder tube 4 is located on the front side and the position where the head end of the feeder tube 4 is located on the rear side with respect to the extension line of the needle bed 2; therefore, on the terminal-end side of each section, the knitting yarn 5 is pulled in the head end direction of the knitting needle 3 and is engaged to a hook 6. Consequently, the knitting yarn 5 that is hanged over is tilted at an angle  $\theta$  ( $0^\circ < \theta < 90^\circ$ ).  
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**[0004]** As described in paragraph 0046 of Patent Document 2, in tuck knit used for connection of intarsia boundaries of warp yarns, high tuck is able to be chosen, in which the knitting yarn 5 is tucked on the old loop side, which is knocked over by knitting action of the knitting needle 3. Hereinafter, in the event that the same kind of things are collectively shown such as knitting needles 3a, 3b, 3c, 3d, and the like, the figure "3" and the like only are described and English characters following the figure such as "a," etc. are omitted. In the high tuck, there is no pull-back by the hook 6, and fabrics of close texture are able to be obtained. The knitting needle 3 shown in Fig. 6 is a compound needle which has a needle body 7 with the hook 6 equipped at the head end and a slider 8 that opens and closes the hook 6. The slider 8 is formed with two plates and adopts a type that enables stitch transfer action and the like when it is advanced to the needle bed gap 1 side from the position where the hook 6 of the needle body 7 is closed. In the case of using a compound needle as the knitting needle 3 and hanging over the knitting yarn 5 with the start-end side and the terminal-end side of the section as the high-tuck state, the knitting yarn 5 on the start-end side is fed over the slider 8, and the knitting yarn 5 on the terminal-end side is fed into the hook 6 as shown in Fig. 6(b). Incidentally, knitting needles 3b and 3c at the middle of the section form stitches by catching the hanged-over knitting yarn 5 into the hook 6, and therefore, as in the case of using a plated stitch, plating knitting action is chosen.  
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**[0005]** Fig. 7 and Fig. 8 schematically show partial construction of a cam lock for warp yarn 10 that carries out drive for knitting action of the knitting needle 3 shown in Fig. 6. The cam lock for warp yarn 10 corresponds to one system of the three systems that are mounted to a carriage that reciprocates in the longitudinal direction of the needle bed 2 as is the case with Fig. 1 of Patent Document 2. On the left side of the drawing, a weft yarn cam lock is installed and the cam lock for warp yarn is further installed. The cam lock for warp yarn 10 shown in the drawing and the left side cam lock for warp yarn not shown carry out action to advance and retain the knitting needle 3 respectively chosen, to the needle bed gap 1 when the carriage traverses leftward and rightward. To the knitting needle 3 advanced and retained at the needle bed gap 1, the lace bar, equipped with the feed tube 4 shown in Fig. 6, carries out swing actions and lapping actions, and hangs over the knitting yarn 5. The warp-yarn cam lock 10 pulls in the knitting needle 3 with the knitting yarn 5 hanged over from the start-end side to the terminal-end side successively by a stitch cam 18 and forms a stitch when  
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the carriage traverses rightward. Similarly, the left side cam lock for warp yarn, not shown, forms a stitch when the carriage traverses leftward.

**[0006]** The cam lock for warp yarn 10 includes a cam lock for needle body 11 that guides a butt for driving the needle body 7, a cam lock for slider 12 that guides a butt for driving the slider 8, and A presser 13, H presser 14, and B presser 15. Each knitting needle 3 is chosen in such a manner that a select jack is located at either one of A position, H position, or B position by the action of a needle selection mechanism installed on the left side of the figure at a space remaining to the weft yarn cam lock. The A presser 13 is a movable type presser that can change over between operation or non-operation, and is installed in a route where the butt protruding from the select jack with chosen A position passes. The H presser 14 has two movable H pressers 14a and 14b that can change over individually between operation and non-operation, and is installed in a route where the butt of the select jack with H position chosen passes. The B presser 15 is a fixed presser that constantly operates and is installed in a route where the butt of the select jack with B position chosen passes.

**[0007]** The cam lock for needle body 11 includes a needle raising cam 16 that has inclined cam surfaces 16a and 16b for guiding the needle body 7 to advance to the needle bed gap 1, guard cam 17 installed above the needle raising cam 16, a stitch cam 18 having an inclined cam surface that guides the needle body 7 to pull in from the needle bed gap 1 when the carriage transverses rightwards, and a select jack clearing cam 19.

**[0008]** Fig. 7 shows the routes to which each butt is guided at the time of high tuck set for knitting needles 3 on the start-end side and on the terminal-end side of each section of Fig. 6. The select jack is chosen to be at H position, and the first-half H presser 14a is set to be in non-operation while the second-half H presser 14b is set to be operation when the carriage traverses leftward. A route 22a of left traverse of a butt 21 for driving the needle body 7 ascends to the needle bed gap 1 side along the raising cam surface 16a and reaches the shoulder position of the needle raising cam 16, from which the route 22a advances to the needle bed gap 1 side further along the raising cam surface 16b of the needle raising cam 16 because the first-half H presser 14a is not in operation. To the guard cam 17, descent cam surfaces 17a and 17b of two steps are installed. The descent cam surface 17a on the left side falls under the position in which the second-half H presser 14b is operated and is therefore jumped, the butt 21 is returned to the shoulder position of the needle raising cam 16 along the descent cam surface 17b on the right side, and descends to the bottom end of the descent cam surface 17b, and then, pierces through to the right side of the figure nearly horizontally. A route 24a of left traverse of a butt 23 that drives the slider 8 advances to the needle bed gap 1 side in concert with the needle body 7 that advances to the needle bed gap 1 along the ascent cam surface 16b of the needle raising cam 16 by non-operation of the first-half H presser 14a. By operation of the second-half H-presser 14b, the butt 23 jumps the descent cam surface 12a of the cam lock for slider 12 and pierces through to the right side of the figure with the advancing position held even if the route of left traverse 22a of the needle body 7 retracts from the needle bed gap 1 along the descent cam surface 17b of the guard cam 17.

**[0009]** When the carriage traverses rightward, both H pressers 14a and 14b are set to be in operation. A route 22b of right traverse of the butt 21 of the needle body 7 traverses rightward nearly horizontally reaches the inclined cam surface of the stitch cam 18 with the shoulder position of the needle raising cam 16 held, and along this inclined cam surface, the needle body 7 is pulled from the needle bed gap 1 into the needle bed 2. A route 24b of right traverse of the butt 23 of the slider 8 is nearly horizontal until it reaches the descent cam surface 12b installed on the left side of the cam lock for slider 12 and along the descent cam surface 12b, the slider 8 is pulled from the needle bed gap 1 into the needle bed 2.

**[0010]** Fig. 8 shows a route in which each butt is guided at the time of plating set relative to the intermediate knitting needles 3 excluding those on the start-end side and on the terminal-end side of each section of Fig. 6. The select jack is chosen to be at A position and the A presser 13 is set to be in non-operation when the carriage traverses leftward. As a result, a route 26a of left traverse of a butt 25 of the needle body 7 advances from the shoulder position of the needle raising cam 16 further to the needle bed gap 1 side along the ascent cam surface 16b of the needle raising cam 16. The butt 25 is returned to the shoulder position of the needle raising cam 16 along the descent cam surface 17a on the left side of the guard cam 17, and descends to the bottom end of the descent cam surface 17a and then, pierces through to the right side of the figure nearly horizontally. A route 28a of left traverse of a butt 27 of the slider 8 advances to the needle bed gap 1 side in concert with the needle body 7 that advances to the needle bed gap 1 along the ascent cam surface 16b of the needle raising cam 16. The butt 27 retracts from the needle bed gap 1 along the descent cam surface 12a of the cam lock for slider 12, and pierces through to the right side of the figure with the position of the bottom end of the descent cam surface 12a held. Incidentally, the select jack clearing cam 19 installed on the right side of the needle raising cam 16 works to pierce through to the right after the select jack chosen to be at A position is retracted to H position.

**[0011]** When the carriage traverses rightward, the select jack chosen to be at A position at the time of leftward traverse returns at H position by the action of the select jack clearing cam 19, and passes H pressers 14a and 14b, which are both set to be in operation. In the event that no select jack clearing cam 19 is installed, the select jack pierces through to rightward with A position held when the carriage traverses leftward and returns with A position held when the carriage

traverses rightwards. In such event, too, by setting the A presser 13 to be in operation, the route of the butt 25 of the needle body 7 becomes identical to a route 26b of right traverse when the select jack returns at H position. The route 26b of right traverse of the butt 25 of the needle body 7 reaches the inclined cam surface of the stitch cam 18 with the shoulder position of the needle raising cam 16 nearly held, and the needle body 7 is pulled into the needle bed 2 from the needle bed gap 1 along this inclined cam surface. That is, the needle body 7 is pulled in equivalently to the route 22b of right traverse as shown in Fig. 7. A route 28b of right traverse of the butt 27 of the slider 8 holds a position piercing through to the right side of the figure at the time of left traverse, and is nearly horizontal until it reaches the descent cam surface 12b installed on the left side of the cam lock for slider 12, and pulls in the slider 8 from the needle bed gap 1 to the needle bed 2 along the descent cam surface 12b.

**[0012]** Fig. 9(a) shows the relative positional relation of each of butts 21, 23, 23, and 27 at the condition in which only a butt 21a of the knitting needle 3a of the high tuck on the start-end side is guided to descend at the inclined cam surface of the stitch cam 18 for one section formed by four knitting needles 3a, 3b, 3c, and 3d shown in Fig. 6(a). Fig. 9(b) shows the relative positional relation of butts 21, 23, 25 and 27 at the condition in which a butt 25b of the plating knitting needle 3b adjacent to the high tuck knitting needle 3a on the start-end side, too, is ready to be guided to descend at the inclined cam surface of the stitch cam 18. Fig. 10(a) and Fig. 10(b) corresponding to Fig. 9(a) and Fig. 9(b), respectively, show the relative positional relationship between knitting yarn 5 and hooks 6a and 6b at knitting needles 3a and 3b. The cross sections 5a, 5b, and 5d of the knitting yarn 5 show those at the positions which correspond to knitting needles 3a, 3b, and 3d, respectively.

Patent Document 1: Japanese Patent Publication No. 3452639

Patent Document 2: Japanese Unexamined Patent Application Publication No. 8-74146

## Disclosure of Invention

### Technical Problem

**[0013]** As shown in Fig. 10, with the plating knitting needle 3b adjacent to the high tuck knitting needle 3a on the start-end side of the section, the knitting yarn 5 which is hooked on the slider 8a at the knitting needle 3a must be pulled into the hook 6b. In the event that the distance between the high tuck knitting needle 3a on the start-end side of the section and the high tuck knitting needle 3d on the terminating-end side is comparatively small, and the inclined angle  $\theta$  of the hanged over knitting yarn 5 as shown in Fig. 6(a) increases. Therefore the knitting yarn 5 must be caught at a comparatively fast timing into the hook 6b of the knitting needle 3b. As shown in Fig. 10, with the knitting yarn 5 that is hanged over from above the slider 8a of the high tuck knitting needle 3a on the start-end side to the hook of the knitting needle on the terminating-end side, a level difference increases as compared to the case in which the start-end side is hanged over from inside the hook or from between the hook and the slider in the regular knitting. In particular, when the section is short, at the knitting needle 3b adjacent to the high tuck knitting needle 3a on the start-end side, the knitting yarn 5 may be split off by the head end of the hook 6b or the knitting yarn 5 may be unable to be caught at the time of yarn catching in which the knitting yarn 5 shown with cross-section 5b is caught into the hook 6b. Depending on the conditions, cases in which yarn catching is difficult to be done with a plurality of knitting needles adjacent to the high tuck knitting needle 3a on the start-end side may occur.

**[0014]** It is an object of the present invention to provide a method for knitting an intarsia pattern fabric and a flat knitting machine that can improve the yarn-catching conditions.

### Technical Solution

**[0015]** The present invention provides a method knitting method of an intarsia pattern fabric on a flat knitting machine, the flat knitting machine being provided with a pair of needle beds and lace bars, the needle beds being opposed to each other in a needle bed gap, each of the needle beds being equipped with compound needles as knitting needles, and the lace bars being capable for feeding the knitting yarns which can serve as warp yarns for a plurality of sections simultaneously from the start-end side to the terminating-end side in each section by swing action and lapping action to knitting needles which advance from one needle bed to the needle bed gap, the knitting needles on the both ends of each section being selected to be in a high-tuck state, the intarsia pattern fabric being knitted with high-tuck joints to the knitting needle of the terminating-end of the adjacent section at the boundary on the start-end side, the knitting method comprises:

pulling in the knitting needle in the high-tuck state on the terminating-end side of each section from the needle bed gap to the needle bed side, before pulling at least the knitting needle which is adjacent to the knitting needle to carry out the high-tuck joint at least on the start-end side.

**[0016]** The present invention also provides the knitting method, wherein the flat knitting machine is equipped with cam mechanisms that guide and drive needle bodies and sliders of the compound needles respectively in accordance with the needle selection condition, and

selects the intermediate knitting needles excluding those on the start-end and the terminating-end of each of the sections, in such a manner that the route for needle bodies is the same to that of the knitting needles in the high-tuck state and the route for the sliders is different from that of the high-tuck state when the needle bodies and sliders are introduced into the cam mechanism, and

the cam mechanism bifurcates halfway the route of needle bodies into different routs according to the difference in the routs of sliders, and pulls in the needle bodies of knitting needles selected to be in the high-tuck state from the needle bed gaps in advance.

**[0017]** The present invention also provides the knitting method, wherein the compound needles are housed in needle grooves formed in the needle beds, in such a way that each needle body is in the bottom side of each needle groove and each slider is in the top side of each needle groove,

the cam mechanism drives the needle body and the slider by cam grooves which provided to guide butts when protruding from the needle groove,

a bifurcation area is provided on the route by which the butt of the needle body capable to be pulled in from the needle bed gap when the butt protrudes from the needle groove, and

the butt of the slider is depressed in the route that guides the butts of the sliders of the intermediate knitting needles at a position corresponding to the bifurcation area of the route that guides the butts of the needle bodies, so that the butts of the needle bodies are prevented from being bifurcated into the route that pulls in the butts from the needle bed gap at the bifurcation area.

**[0018]** Furthermore the present invention provide a flat knitting machine provided with a pair of needle beds opposed to each other in the needle bed gap, each of the needle beds being equipped with compound needles, as knitting needles, having needle bodies equipped with hooks at the head end on the needle bed gap side and sliders that open and close hooks by being relatively displaced with respect to the needle bodies, and capable for knitting intarsia patterns by crossing over the knitting yarn that can serve as a warp yarn to each of the knitting needles which advance from one needle bed to needle bed gaps, respectively, by swing action and lapping action of lace bars, thereby forming high-tuck joints at boundaries, the flat kitting machine, comprising:

a needle selection mechanism that selects knitting needles at boundaries of the section to be in the high-tuck state and that selects intermediate knitting needles of the section to be in a state different from the high-tuck state;

a slider guide mechanism that guides sliders of knitting needles in the high-tuck state and in the state different from the high-tuck state to different routes respectively; and

a needle body guiding mechanism that guides needle bodies of knitting needles in the high-tuck state and in the state different from the high-tuck state to the same route till halfway, and from halfway guides only the needle bodies in the high-tuck state in such a manner so as to bifurcate to a route to pull them in from the needle bed gap in advance by the use of the route difference in the slider guide mechanism.

### Advantageous Effects

**[0019]** According to the present invention, the knitting needle on the terminating-end side of each section of the intarsia pattern is pulled from the needle bed gap into the needle bed side preceding the knitting needle adjacent to the knitting needle that carries out a high-tuck joint, at least, on the start-end side, and therefore, the gradient angle of the knitting yarn that is hanged over from the start-end side to the terminating-end side can be reduced. Since a gradient of knitting yarn in the state same as that at the time of a large interval from the start-end side to the terminating-side can be provided for the knitting needle adjacent to the knitting needle that carries out a high-tuck joint on the start-end side, yarn catching timing can be delayed. When the high tuck knitting yarn is hanged over above sliders of knitting needles on the start-end side, the level difference of the hanged-over knitting yarn is large, but while the yarn catching timing lags behind, the knitting yarn is knocked over by pull-in of knitting needles on the start-end side and the level difference is reduced, and the yarn catching height at adjacent knitting needles is lowered, and the yarn catching condition is thereby able to be improved.

**[0020]** In addition, according to the present invention, knitting needles at the start-end and the terminal-end of a section and intermediate knitting needles are bifurcated by a cam mechanism in such a manner that routes of needle bodies differ halfway in accordance with the difference of slider routes, and needle bodies of knitting needles selected in the high-tuck state are able to be pulled in from the needle bed gap in advance. Since the difference of slider routes are utilized, bifurcation of routes of needle bodies can be achieved without adding any new selection mechanism.

**[0021]** In addition, according to the present invention, because the bifurcation at the route that guides a butt of a needle body is changed over by depressing a butt of a slider in the route that guides the butt of the slider, precedent pull-in of

the needle body of a high tuck knitting needle can be achieved without providing any mobile type change-over mechanisms and the like.

[0022] Furthermore, according to the present invention, because a knitting needle in the high-tuck state on the terminating-end side of each section is pulled from the needle bed gap into the needle bed side preceding a knitting needle adjacent to a knitting needle that carries out high-tuck joint, at least, on the start-end side, the yarn catching timing at the knitting needle adjacent to the start-end side can be delayed. While the yarn catching timing lags behind, the knitting yarn is knocked over by the pull-in of the knitting needle on the start-end side, the yarn catching height at the adjacent knitting needle is lowered, and the yarn catching condition can be improved.

**Brief Description of Drawings**

**[0023]**

[Fig. 1] Fig. 1 is a partial plan view and a side view showing a basic concept on a method for knitting intarsia pattern fabrics as one embodiment of the present invention.

[Fig. 2] Fig. 2 is a partial plan view and a side view following Fig. 1, which shows the condition of each of knitting needles 3a, 3b, 3c, and 3d and knitting yarn 5 at a timing to catch yarn at the knitting needle 3b adjacent to the knitting needle 3a on the start-end side.

[Fig. 3] Fig. 3 is a side view showing configuration of essential parts of the knitting needle 3 of Fig. 1.

[Fig. 4] Fig. 4 is a plan view schematically showing partial construction of a cam lock for warp yarn 40 that carries out drive of knitting action for the knitting needle 3 shown in Fig. 1 together with a butt route at the time of high tuck.

[Fig. 5] Fig. 5 is a plan view schematically showing partial configuration of the cam lock for warp yarn 40 that carries out drive of knitting action for the knitting needle 3 shown in Fig. 1 together with a butt route at the time of plating.

[Fig. 6] Fig. 6 is a partial plan view and a side view showing the condition in which the knitting yarn 5 is crossed over from a feeder tube 4 attached to a lace bar to a plurality of knitting needles 3 advanced from the needle bed 2 to the needle bed gap 1 when conventional intarsia pattern fabrics are knitted. [Fig. 7] Fig. 7 is a plan view schematically showing partial configuration of a cam lock for warp yarn 10 that carries out drive of knitting action for the knitting needle 3 shown in Fig. 6 together with a butt route at the time of high tuck.

[Fig. 8] Fig. 8 is a plan view schematically showing partial configuration of the cam lock for warp yarn 10 that carries out drive of knitting action for the knitting needle 3 shown in Fig. 6 together with a butt route at the time of plating.

[Fig. 9] Fig. 9 is a partial plan view showing relative positional relation of each of butts 21, 23, 25, and 27 around at the time of yarn catching for one section composed of four knitting needles 3a, 3b, 3c, and 3d shown in Fig. 6(a).

[Fig. 10] Fig. 10 is a partial side view showing relative positional relation between knitting yarn 5 and hooks at each of knitting needles 3a and 3b in correspondence with Fig. 9(a) and Fig. 9(b), respectively.

**Explanation of Reference**

**[0024]**

- 1. Needle bed gap
- 2. Needle bed
- 3. Knitting needle
- 4. Feeder tube
- 5. Knitting yarn
- 6. Hook
- 7. Needle body
- 8. Slider
- 11. Cam lock for needle body
- 12. Cam lock for slider
- 16. Needle raising cam
- 17. Guard cam
- 18. Stitch cam
- 21, 23, 25, and 27. Butt
- 22a, 24a, 26a, and 28a. Route of left traverse
- 22b, 24b, 26b, and 28b. Route of right traverse
- 31. Needle jack
- 32. Slider jack
- 40. Cam lock for warp yarn

41. Bifurcation cam area  
 41a. Descent cam surface  
 41b. Inclined surface  
 42 and 43. Presser portion

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### Best Mode for Carrying Out the Invention

[0025] Referring to Fig. 1 through Fig. 5, one embodiment of the present invention will be described, and the same reference marks are provided for the corresponding portions to those in Fig. 6 through Fig. 10 and redundant description may be omitted. For an intarsia pattern, an example in which one section is knitted by four knitting needles 3a, 3b, 3c, and 3d is shown, but even when three knitting needles are used where the yarn catching condition is still degraded, the yarn catching condition can be improved in the same manner by the present invention.

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[0026] Fig. 1 shows a basic concept on a method for knitting intarsia pattern fabrics as one embodiment of the present invention. That is, as shown in Fig. 1(a) by a dashed line, when a knitting yarn 5 is held hanged over from the high tuck knitting needle 3a on the start-end side of a section to the high tuck knitting needle 3d on the terminating-end side, the inclination angle of the knitting yarn 5 becomes  $\theta$ , whereas pull-in of the knitting needle 3d on the terminating side is conducted in advance. As a result of preceding pull-in, the inclination angle of the knitting yarn 5 is reduced to  $\varphi$  as shown by a chain double-dashed line. Yarn catching at the knitting needle 3b adjacent to the start-end side is intended to be delayed. As discussed later with respect to Fig. 4 and Fig. 5, before pull-in of the knitting needles 3b and 3c in the intermediate plating state starts, pull-in of the knitting needles 3a and 3d in the high-tuck state on both sides of the section begins. As a result, as shown in Fig. 1(b), the knitting yarn 5, which is hanged over from above the slider 8 of the knitting needle 3a on start-end side into the hook 6d of the knitting needle 3d on terminal-end side, reverses from the needle bed gap 1, too, and timing for catching the knitting yarn 5 into the hook 6b of the knitting needle 3b when the hook 6b is pulled in is delayed, too.

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[0027] Fig. 2 shows the condition of each of the knitting needles 3a, 3b, 3c, and 3d as well as knitting yarn 5 in the timing of carrying out yarn catching in the knitting needle 3b adjacent to knitting needle 3b on the start-end side when cams shown in Fig. 4 and Fig. 5 are used. As shown in Fig. 2(a), preceding yarn catching by the knitting needle 3b, in the knitting needle 3a on the start-end side, knock-over of the knitting yarn 5 caught on a slider 8a as a high tuck has begun. As a result, as shown as a cross-section 5a of Fig. 2(b), the knitting yarn 5 caught in the knitting needle 3a is on the way of leaving along the outer circumference of the hook 6a from above the slider 8a. A level difference between the cross-section 5a of the knitting yarn 5 on the start-end side and the cross-section 5d of the knitting yarn 5 in the hook 6d on the terminating-end side is reduced, too, and at the hook 6b, the knitting yarn can be caught at the position of the cross-section 5b and definite yarn catching is enabled.

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[0028] Fig. 3 shows construction of the essential part of the knitting needle 3. The knitting needle 3 has a needle body 7 and a slider 8 separated and the hook 6 at the head end of the needle body 7 is opened and closed by relative displacement of the slider 8 to the needle body 7. Butts 21 and 25 for driving the needle body 7 cited in the description in Fig. 7 and Fig. 8 and butts 23 and 27 for driving the slider 8 are installed to a needle jack 31 and a slider jack 32 connected to a tail portion of the needle body 7 and the slider 8, respectively. In the vicinity of butts 21 and 25 of the needle jack 31, a forked portion 31a is installed and the tail part of the slider jack 32 is housed therein. The slider 8 is prevented from relative reversal to the needle body 7 when the tail end of the slider jack 32 comes in contact with the inner surface of the forked portion 31a of the needle jack 31. That is, with the tail end of the slider jack 32 in contact with the inner surface of the forked portion 31a, the hook 6 opens to the maximum. Under this condition, when the needle body 7 advances to the needle bed gap 1, the slider 8, too, advances to the needle bed gap 1. Driving butts 23 and 27 of the slider jack 32 for advancing the slider 8 only to the needle bed gap 1 side stops the needle body 7 and is able to close the hook 6 at the head end of the slider 8. The slider of a compound needle described in Patent Document 2 is able to move only to the position to close the hook with respect to the needle body, but with the knitting needle 3 of this embodiment can further move the slider 8. This kind of difference does not exert any effect on working of the present invention and the present invention is able to be applied to the compound needle described in Patent Document 2 in the similar manner.

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[0029] The knitting needle 3 is housed in a needle groove formed on the needle bed 2 and slides and displaces the needle groove inside. It is when the butts 21 and 25; 23 and 27 of the needle jack 31 and the slide jack 32 are in a condition where these butts protrude to the outside of the needle groove that the butts 21 and 25; 23 and 27 are subject to action of cams. In the needle groove a select jack not shown is disposed above the tail part of the needle jack 31. The select jack is sunk in the needle groove when the select jack is subject to action of A presser 13, H presser 14, or B presser 15 discussed in above-mentioned Fig. 9 and Fig. 10 and in Fig. 4 and Fig. 5, later discussed, and the needle jack 31 is sunk in the needle groove in linkage, and as a result, butts 21, and 25; 23 and 27 do not protrude to the outside of the needle groove, either,

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**[0030]** Fig. 4 and Fig. 5 schematically show partial construction of a warp-yarn cam lock 40 that carries out drive of knitting action for the knitting needle 3 shown in Fig. 1. In Fig. 4, for the high tuck knitting needle 3, routes 22a and 24a of left traverse and routes 22b and 24b of right traverse in which the butt 21 that drives the needle body 7 and the butt 23 that drives the slider 8, are shown, respectively, too. In Fig. 5, for the plating needle 3, routes 26a and 28a of left traverse and routes 26b and 28b of right traverse in which the butt 25 that drives the needle body 7 and the butt 27 that drives the slider 8 are shown, respectively, too. The warp-yarn cam lock 40 adds partial change as discussed later to a weft-yarn cam lock 10 shown in Fig. 7 and Fig. 8 but is same as the warp-yarn cam lock 10 except the changed portion. In addition, the warp-yarn cam lock mounted to the right side of the carriage is discussed, but needless to say, the same discussion is applied to the warp-yarn cam lock mounted to the left side.

**[0031]** As shown in Fig. 4, in the warp-yarn cam lock 40, a bifurcation cam area 41 is added to a guard cam 17 of a cam lock for needle body 11 that guides the butt 21 for driving the needle body 7. The bifurcation cam area 41 bifurcates the butt in such a manner that the route 22b of right traverse of the butt 21 for driving the high tuck needle body 7 reverses from the needle bed gap 1 along the descent cam surface 41a of the bifurcation cam area 41 when a carriage traverses rightwards. The route 22b of right traverse of the butt 21 after bifurcation passes the position further reversed from the needle bed gap 1, whereas it passes the shoulder position of a needle raising cam 16 at a conventional high tuck shown in Fig. 7. On the left of the bifurcation cam area 41, an inclined surface 41b that increases height from the cam plate surface of a carriage is installed, so that the butt 21 is able to climb over the bifurcation cam area 41 and travel when the carriage traverses leftward.

**[0032]** When the carriage traverses rightward in Fig.4, the position in which the butt 21 bifurcates at the bifurcation cam area 41 and reverses from the needle bed gap 1 should be in a range that satisfies the condition where the knitting yarn 5 is smoothly fed from the feeder tube 4 shown in Fig. 1(a). Though not shown, a sinker is disposed between knitting needles 3, and when the hook 6 of the knitting needle 3 is pulled into the needle bed 2, the knitting yarn 5 first comes in contact with the head end of the sinker, the knitting yarn 5 is hauled between the sinker and the hook 6 to form a new knitted loop, and then, an old loop is knocked over. When the high tuck knitting needle 3d on the terminating-end side knocks over first, the interval between the sinker of the new knitted loop and the hook 6 of the new knitted loop is tightened by the former loop, and feed of the knitting yarn 5 to other knitting needles that belong to the section is stopped. Even when no knock-over is performed, pulling in the knitting needle 3d and allowing the knitting yarn 5 to come in contact with the sinker increase friction between the sinker and the knitting yarn 5, and the knitting yarn 5 may not be smoothly fed. In knitting needles 3a, 3b, 3c, and 3d of each section, knitted stitch must be formed successively from the knitting needle 3a on the start-end side to the knitting needle 3d on the terminating-end side. Consequently, the preceding pull-in of the knitting needle 3d on the terminating-end side by the bifurcation cam area 41 should be a range free of knock-over and more preferably a range in which the knitting yarn 5 does not come in contact with the sinker, either.

**[0033]** Since the position of H presser 14b that works on the needle jack 31 is unable to be in time for the timing that the route of right traverse 22b at the retracted position comes in contact with the inclined cam surface of the needle raising cam 16, a presser portion 42 that depresses the butt 23 of the slider jack 32 down into the needle groove, that is, to the front side of this paper, is added to the cam lock for slider 12. Depressing the butt 23 by the presser portion 42 in the route 24b of right traverse of the butt 23 depresses the needle jack 31, too, because of the structure connecting the slider jack 32 to the needle jack 31 as shown in Fig. 3, and sinks the butt 21 in the needle groove inside. As a result, the butt 21 jumps the inclined cam surface of the needle raising cam 16 and travels horizontally until it comes in contact with the inclined cam surface of the stitch cam 18 on the left side. When the carriage traverses rightward, both H pressers 14 are set to be in non-operation. When the carriage traverses leftward, the second-half H presser 14b is set to be in operation so that the butt 21 jumps the descent cam surface 17a of the guard cam 17.

**[0034]** As shown in Fig. 5, for the butt 25 that drives the needle body 7 at the time of plating, no bifurcation is allowed to make and the butt 25 is made to jump the descent cam surface 41a of the bifurcation cam area 41. For this reason, the presser portion 43 is provided in the route 28b of right traverse of the butt 27 that drives the slider 8, and as is the case of the above-mentioned presser portion 42, the slider jack 32 is sunk in the needle groove, the needle jack 31 is sunk in the needle groove, too, in linkage, so that the butt 27 jumps the descent cam surface 41a.

**[0035]** In the present embodiment, using the difference between the routes 24b and 28b of right traverse of butts 23 and 27 that drive the slider 8 at high tuck and at plating, the presser portion 43 is provided in the route 28b of right traverse at the time of plating, and bifurcation is generated in the route 22b of right traverse of the butt 21 that drives the needle body 7 at the time of high tuck only. At the position where the presser portion 43 is installed, the route 28a of left traverse of the butt 27 coincides with the route 28b of right traverse, too, and the presser portion 43 works on the butt 27 even when the carriage traverses leftward, but does not exert effect on the route 22a of left traverse of the butt 21. This is because in the route 22a of left traverse, as discussed before, the butt 21 climbs over the inclined surface 41b of the bifurcation cam area 41.

**[0036]** The basic concept as shown in Fig. 1 is able to be materialized by a construction, for example, in Fig. 5 in which the select jack is allowed to keep A position when plating is chosen without using the select jack clearing cam 19, and a presser that works on the select jack is added at a position corresponding to the position where the bifurcation

cam area 41 is installed to jump the descent cam surface 41a of the bifurcation cam area 41. In addition, the concept is able to be materialized by changing control even in a flat knitting machine that drives knitting needles 3 individually by not driving the knitting needles 3 by cams mounted to the carriage but, for example, by installing an actuator such as linear motor and the like to the knitting needles 3. That is, needless to say, various changes and modifications may be made in the invention without departing from the spirit and scope thereof.

## Claims

1. A knitting method of an intarsia pattern fabric on a flat knitting machine, the flat knitting machine being provided with a pair of needle beds and lace bars, the needle beds being opposed to each other in a needle bed gap, each of the needle beds being equipped with compound needles as knitting needles, and the lace bars being capable for feeding the knitting yarns which can serve as warp yarns for a plurality of sections simultaneously from the start-end side to the terminating-end side in each section by swing action and lapping action to knitting needles which advance from one needle bed to the needle bed gap, the knitting needles on the both ends of each section being selected to be in a high-tuck state, the intarsia pattern fabric being knitted with high-tuck joints to the knitting needle of the terminating-end of the adjacent section at the boundary on the start-end side, the knitting method comprises:

pulling in the knitting needle in the high-tuck state on the terminating-end side of each section from the needle bed gap to the needle bed side, before pulling at least the knitting needle which is adjacent to the knitting needle to carry out the high-tuck joint at least on the start-end side.

2. The knitting method of an intarsia pattern fabric according to claim 1, wherein the flat knitting machine is equipped with cam mechanisms that guide and drive needle bodies and sliders of the compound needles respectively in accordance with the needle selection condition, and selects the intermediate knitting needles excluding those on the start-end and the terminating-end of each of the sections, in such a manner that the route for needle bodies is the same to that of the knitting needles in the high-tuck state and the route for the sliders is different from that of the high-tuck state when the needle bodies and sliders are introduced into the cam mechanism, and the cam mechanism bifurcates halfway the route of needle bodies into different routs according to the difference in the routs of sliders, and pulls in the needle bodies of knitting needles selected to be in the high-tuck state from the needle bed gaps in advance.

3. The knitting method of an intarsia pattern fabric according to claim 2, wherein the compound needles are housed in needle grooves formed in the needle beds, in such a way that each needle body is in the bottom side of each needle groove and each slider is in the top side of each needle groove, the cam mechanism drives the needle body and the slider by cam grooves which provided to guide butts when protruding from the needle groove, a bifurcation area is provided on the route by which the butt of the needle body capable to be pulled in from the needle bed gap when the butt protrudes from the needle groove, and the butt of the slider is depressed in the route that guides the butts of the sliders of the intermediate knitting needles at a position corresponding to the bifurcation area of the route that guides the butts of the needle bodies, so that the butts of the needle bodies are prevented from being bifurcated into the route that pulls in the butts from the needle bed gap at the bifurcation area. 4. A flat knitting machine provided with a pair of needle beds opposed to each other in the needle bed gap, each of the needle beds being equipped with compound needles, as knitting needles, having needle bodies equipped with hooks at the head end on the needle bed gap side and sliders that open and close hooks by being relatively displaced with respect to the needle bodies, and capable for knitting intarsia patterns by crossing over the knitting yarn that can serve as a warp yarn to each of the knitting needles which advance from one needle bed to needle bed gaps, respectively, by swing action and lapping action of lace bars, thereby forming high-tuck joints at boundaries, the flat knitting machine, comprising:

a needle selection mechanism that selects knitting needles at boundaries of the section to be in the high-tuck state and that selects intermediate knitting needles of the section to be in a state different from the high-tuck state; a slider guide mechanism that guides sliders of knitting needles in the high-tuck state and in the state different from the high-tuck state to different routes respectively; and a needle body guiding mechanism that guides needle bodies of knitting needles in the high-tuck state and in

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the state different from the high-tuck state to the same route till halfway, and from halfway guides only the needle bodies in the high-tuck state in such a manner so as to bifurcate to a route to pull them in from the needle bed gap in advance by the use of the route difference in the slider guide mechanism.

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Fig. 1

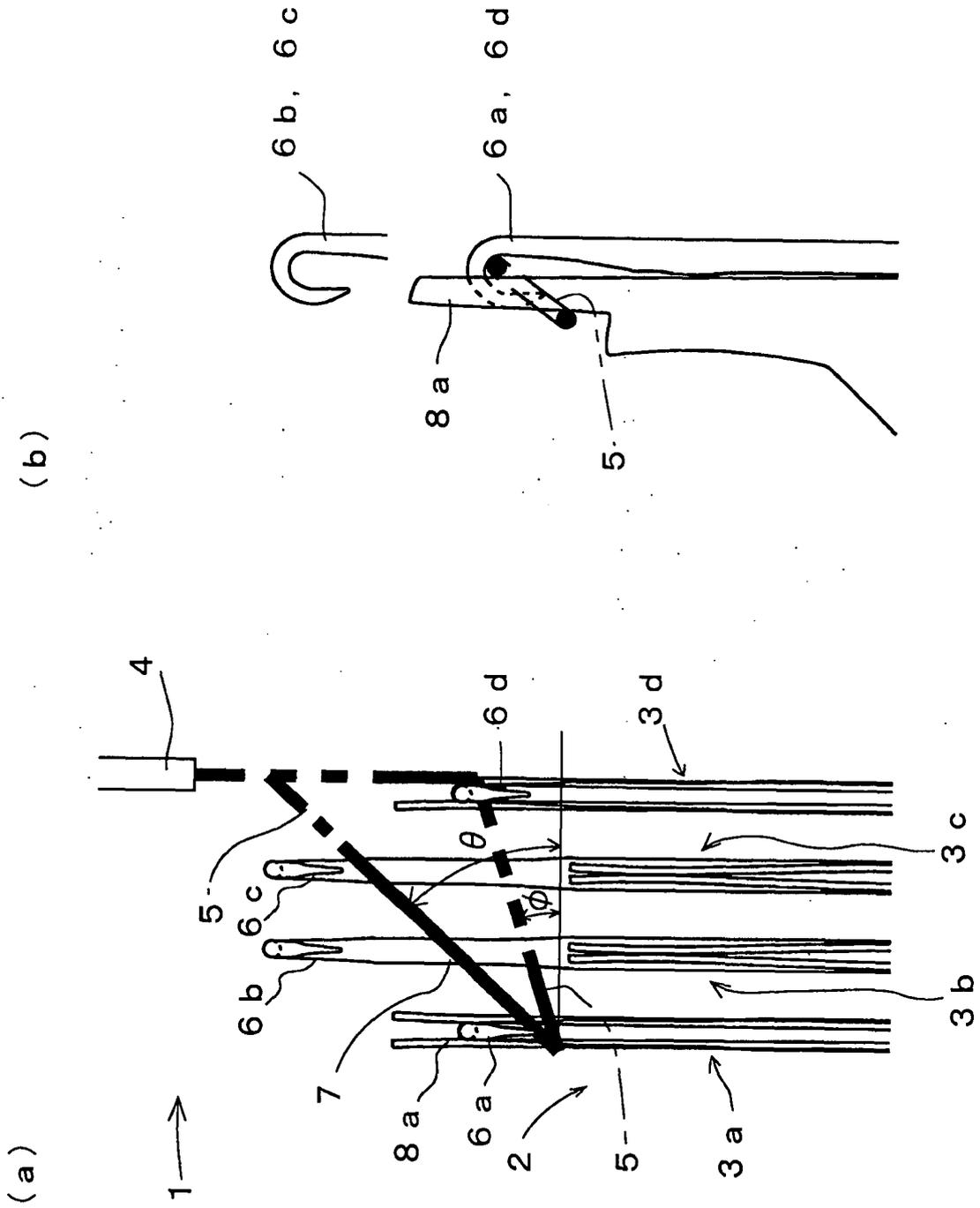


Fig. 2

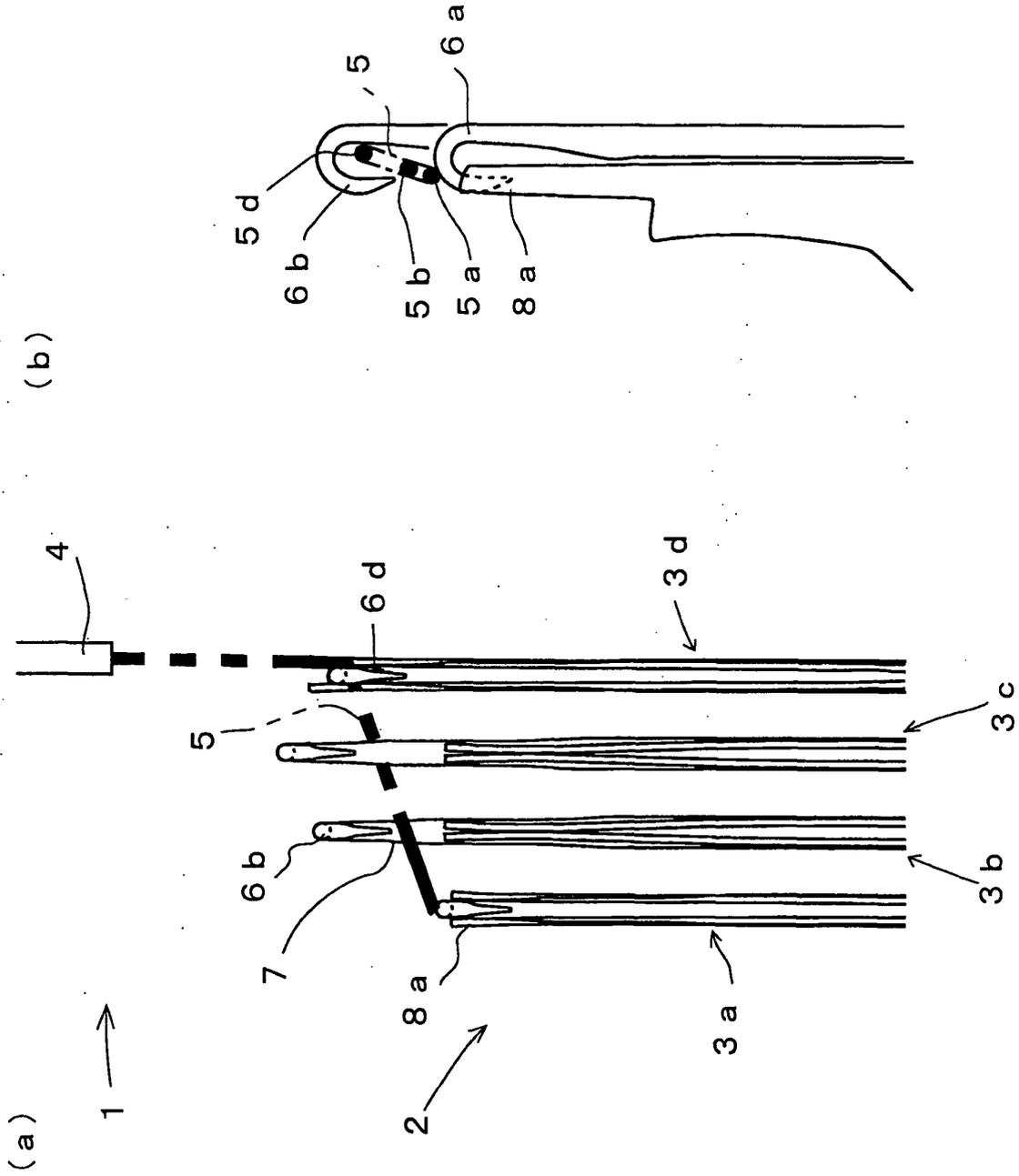


Fig. 3

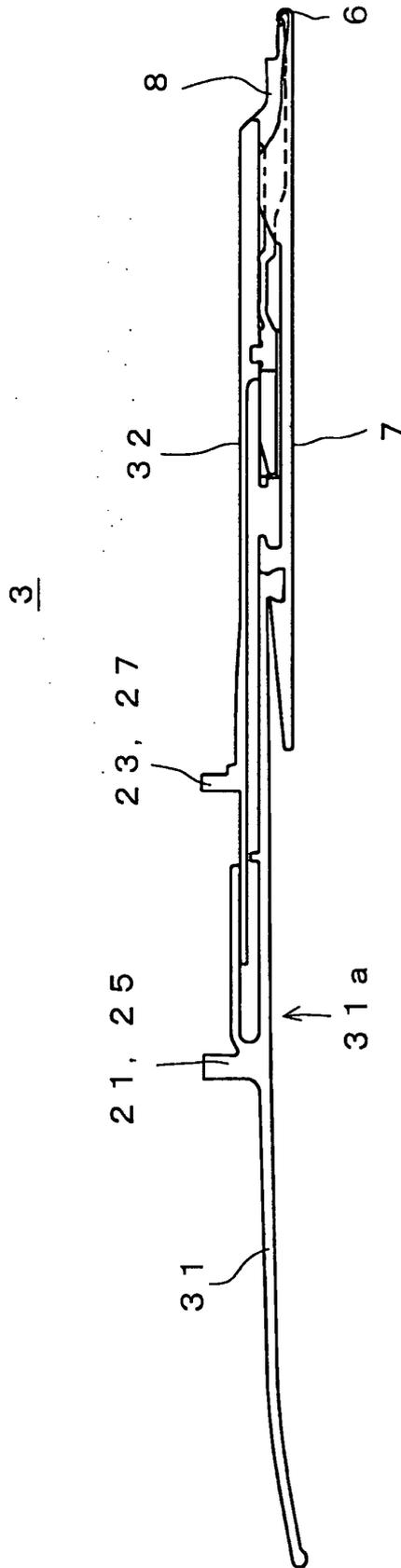


Fig. 4

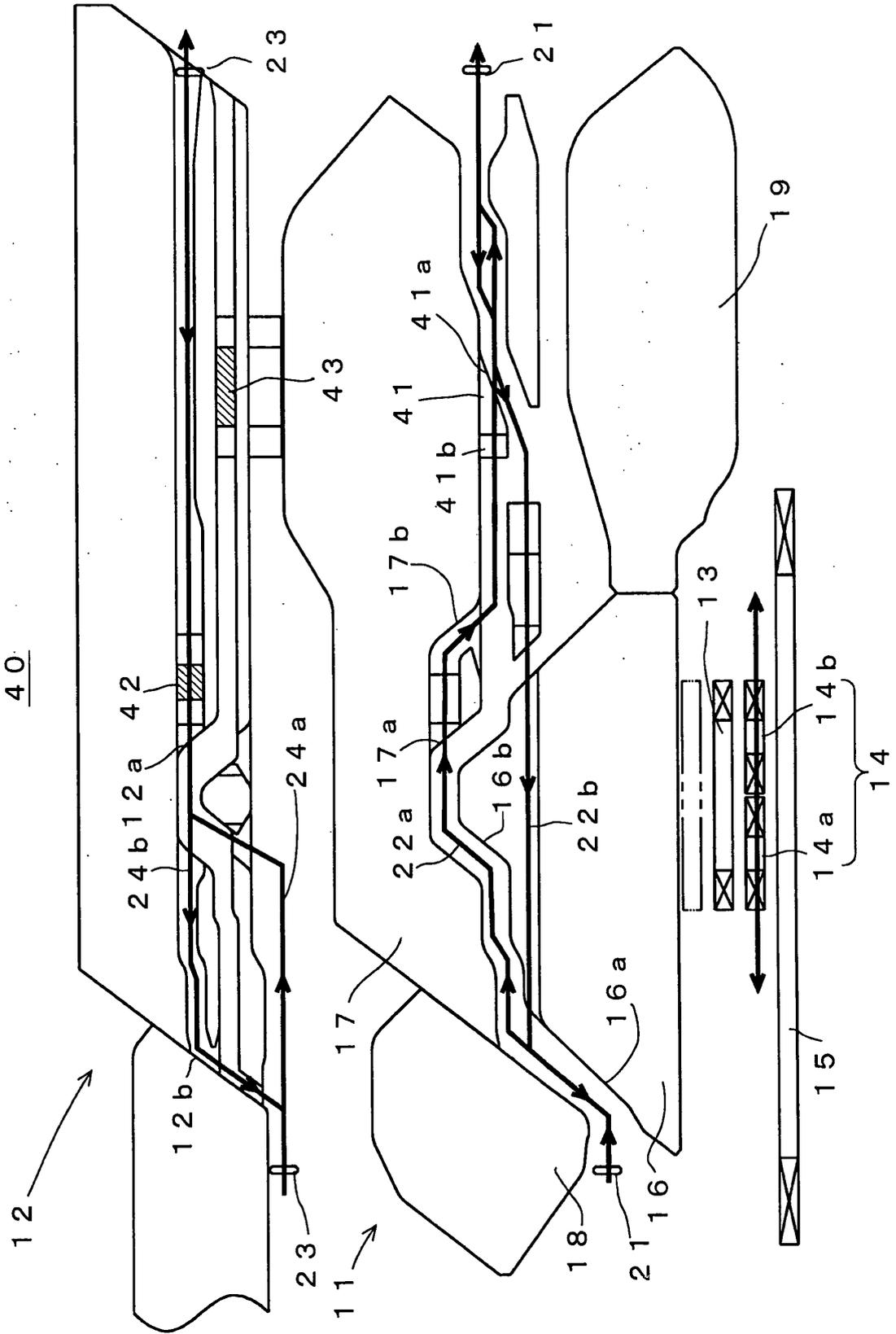


Fig. 5

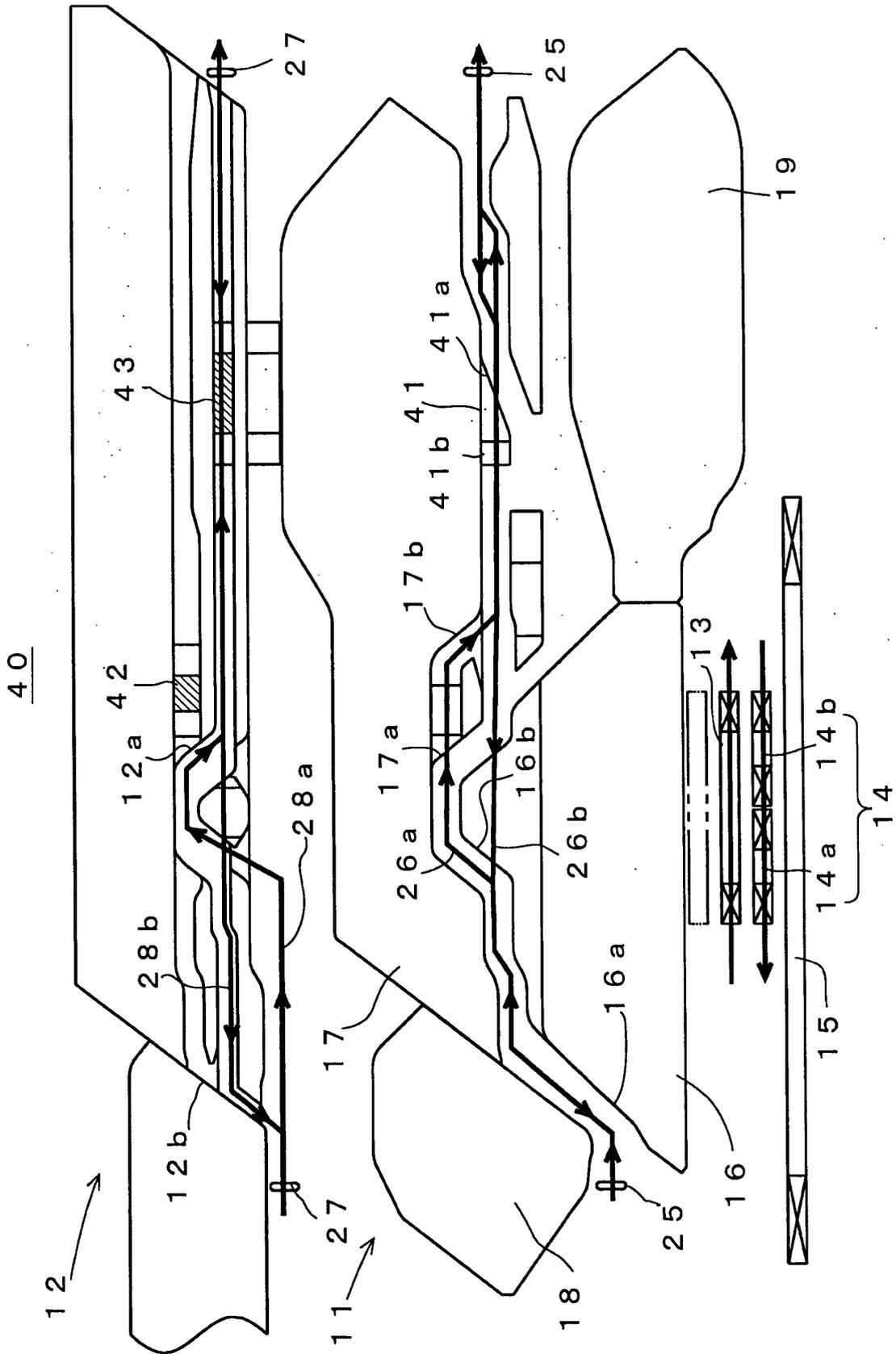


Fig. 6

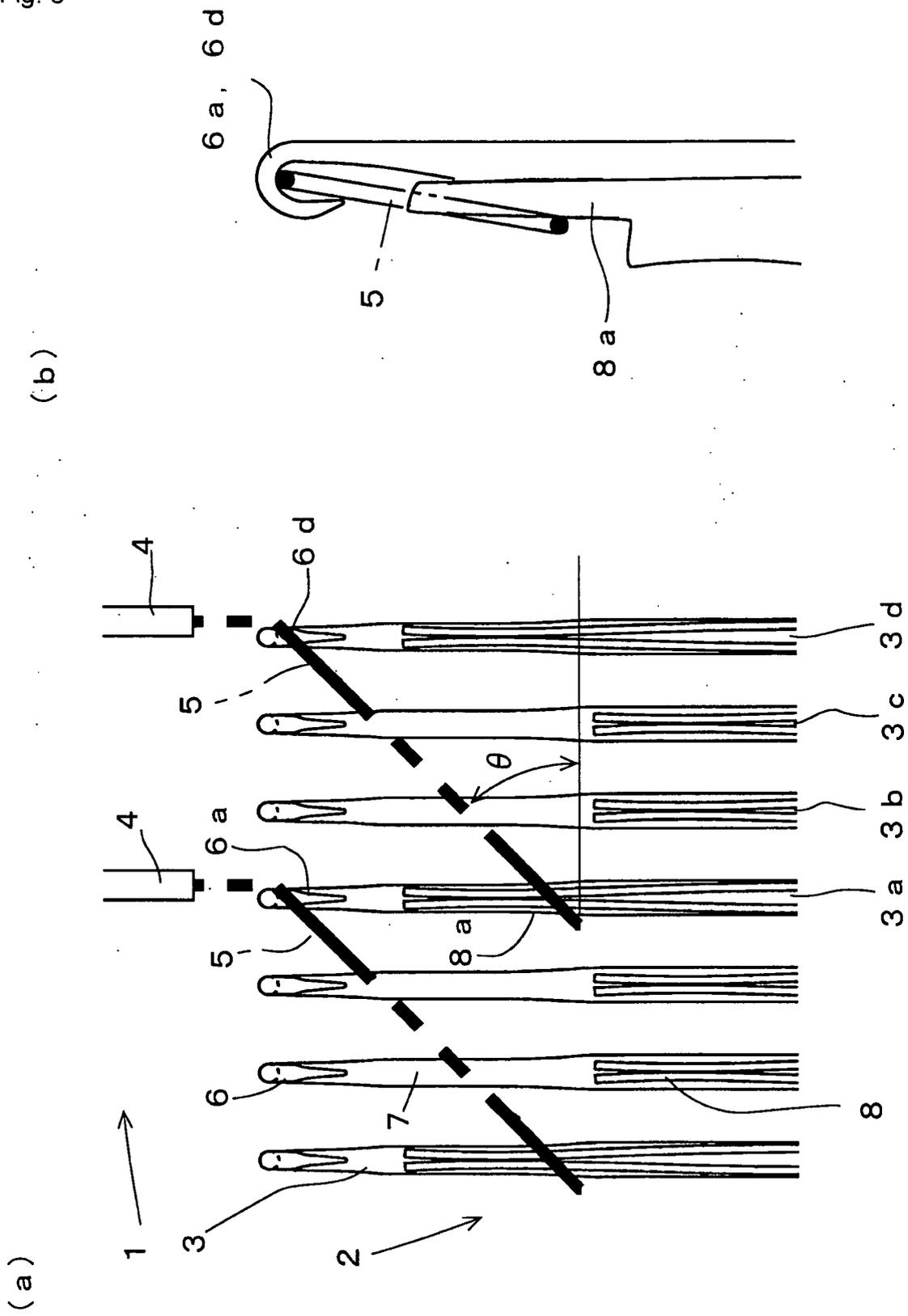


Fig. 7

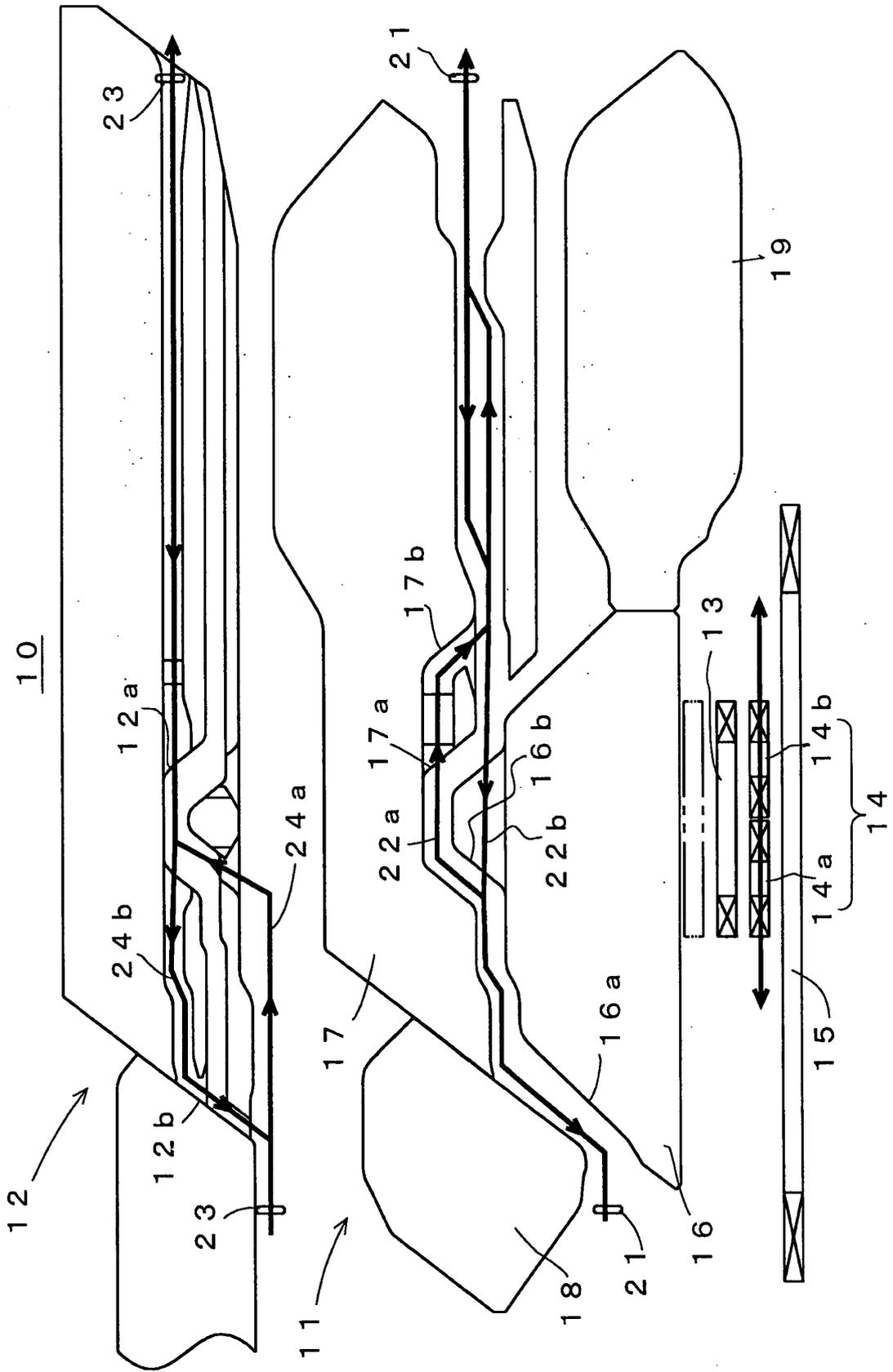


Fig. 8

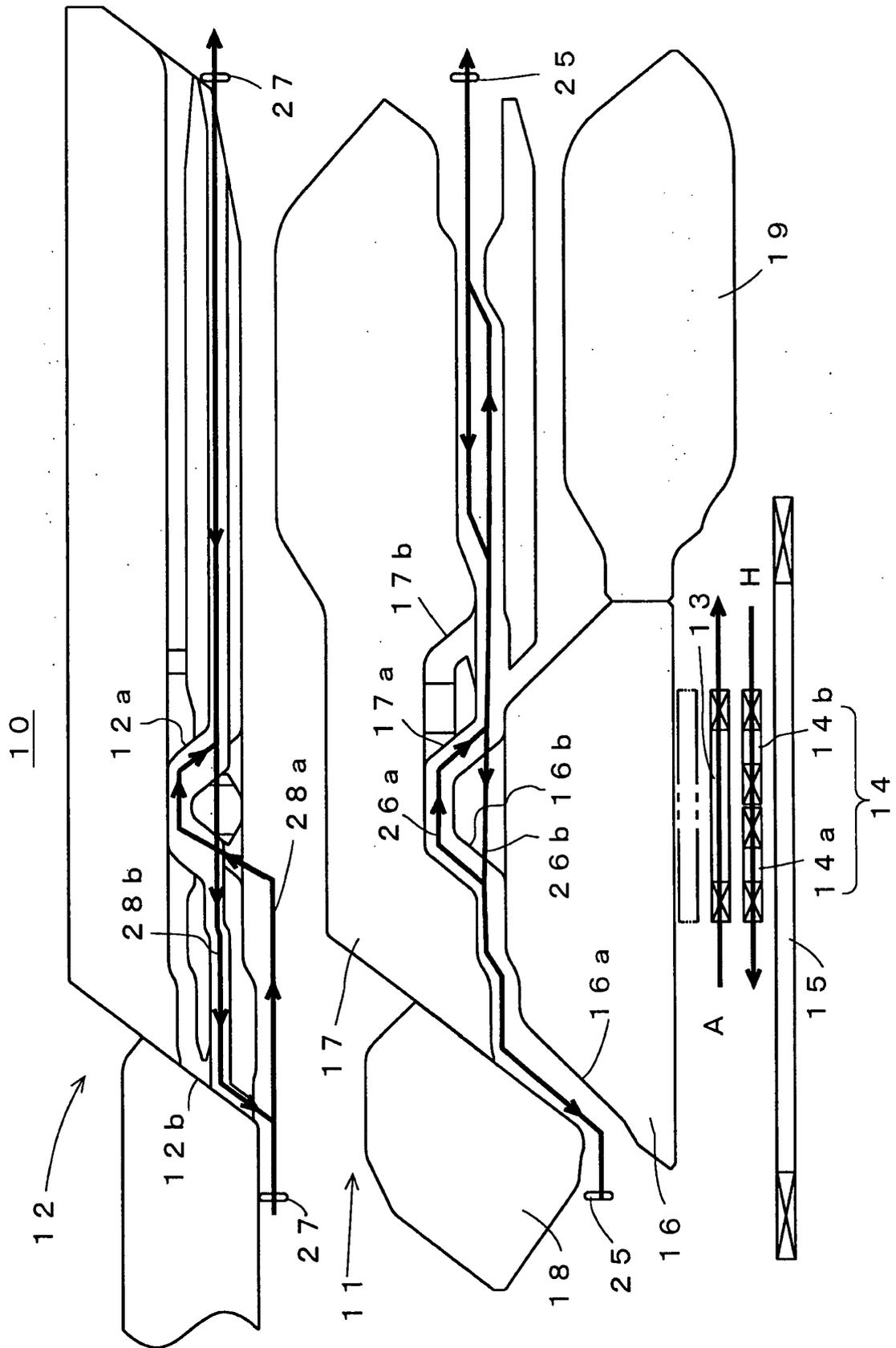


Fig. 9

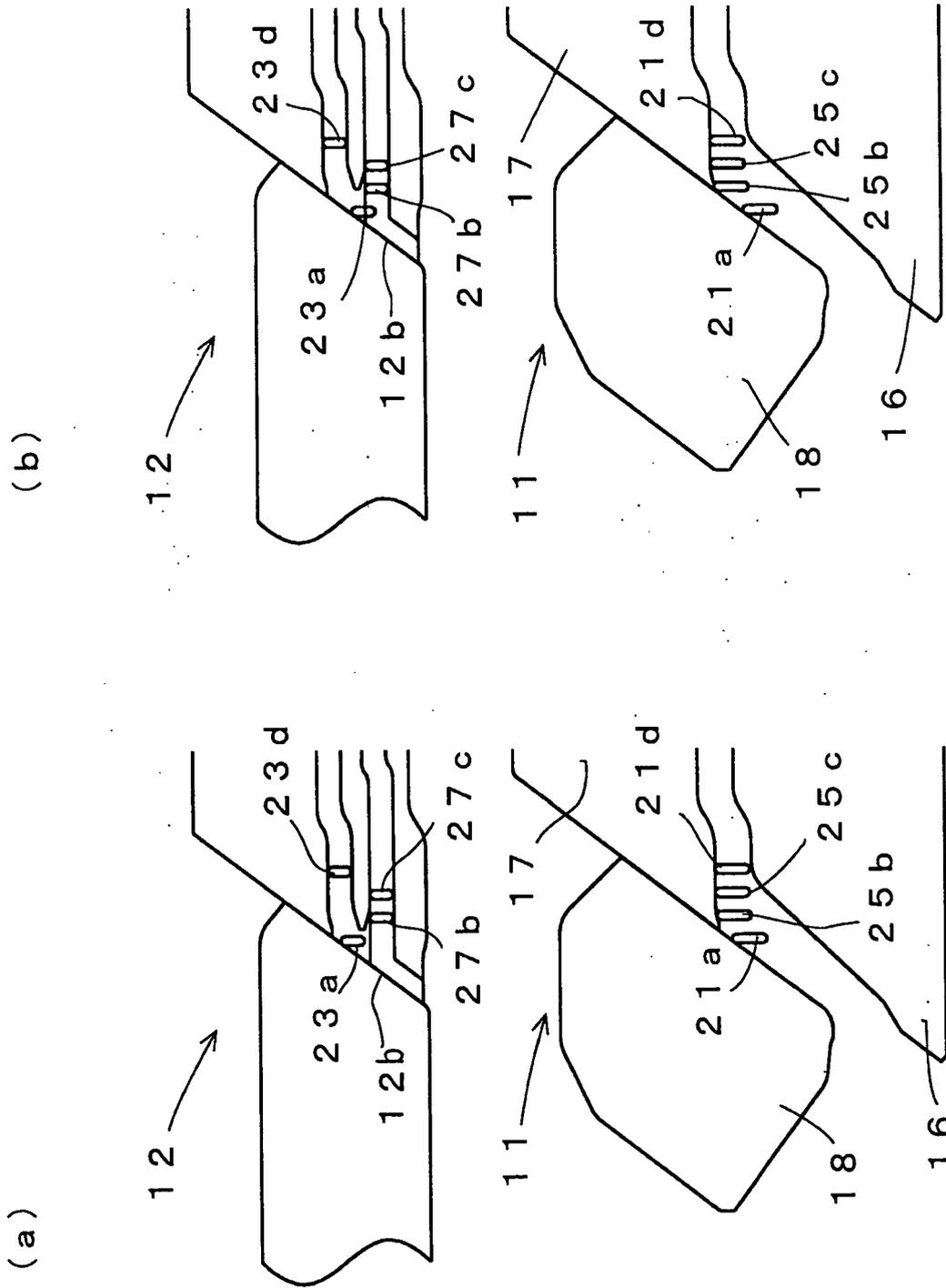
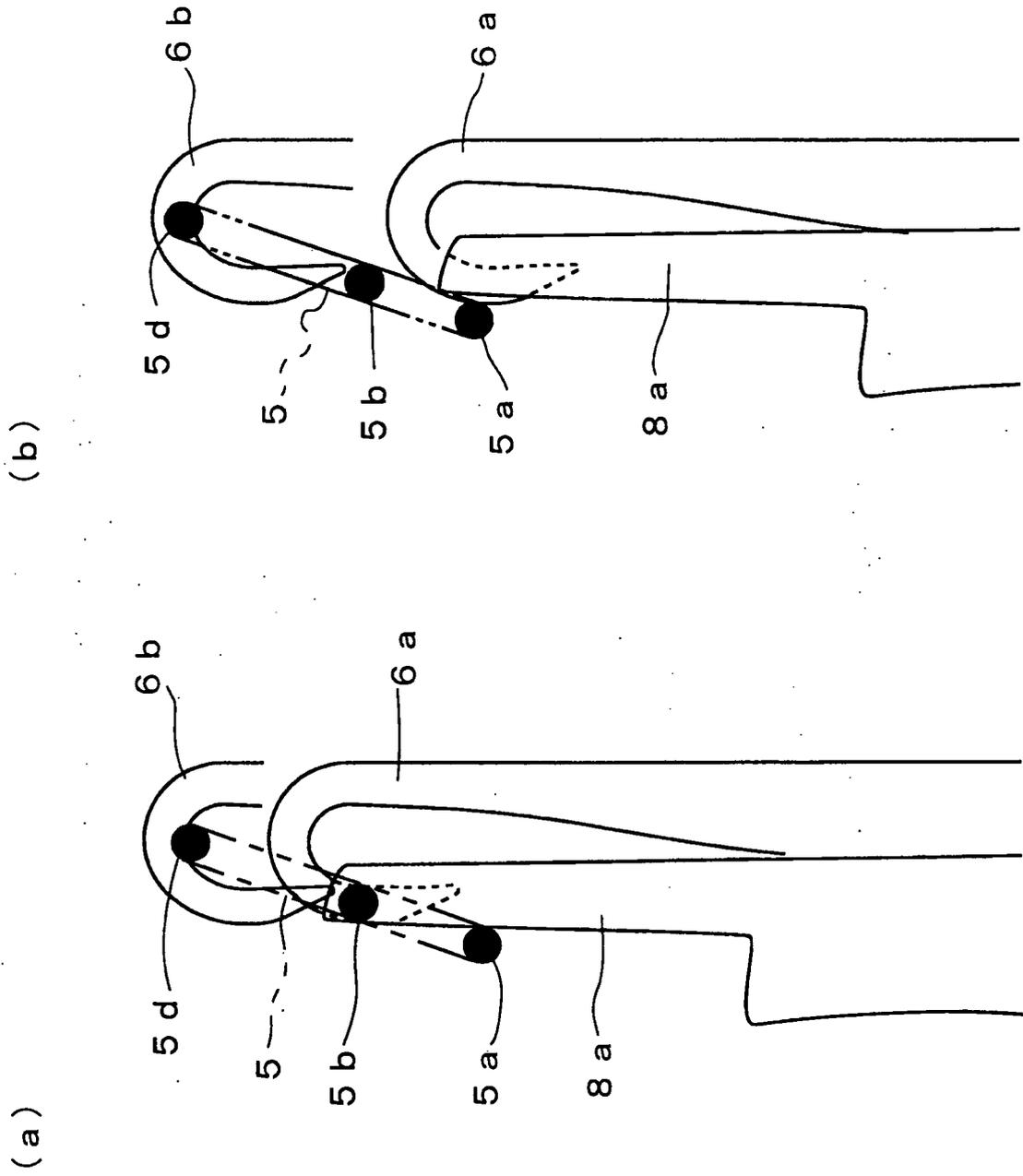


Fig. 10



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/000508

## A. CLASSIFICATION OF SUBJECT MATTER

D04B7/26(2006.01) i, D04B15/36(2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D04B7/26, 15/36, 15/56

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 3452639 B2 (Shima Seiki Mfg., Ltd.), 29 September, 2003 (29.09.03), & US 5544502 A & EP 682133 B1 & KR 161162 B1	1-4
A	JP 8-74146 A (Shima Seiki Mfg., Ltd.), 19 March, 1996 (19.03.96), (Family: none)	1-4
A	WO 2003/010378 A1 (Shima Seiki Mfg., Ltd.), 06 February, 2003 (06.02.03), & EP 1418263 A1 & KR 2004025696 A & AU 2002318558 A1 & CN 1535337 A & US 6988385 B2	1-4

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Date of the actual completion of the international search  
20 July, 2007 (20.07.07)Date of mailing of the international search report  
31 July, 2007 (31.07.07)Name and mailing address of the ISA/  
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**REFERENCES CITED IN THE DESCRIPTION**

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