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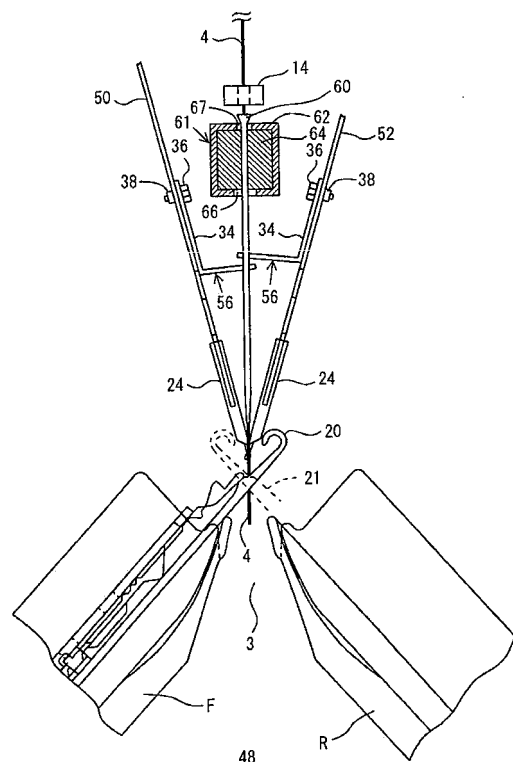
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(54) **Method for knitting multi-layer knitted fabric, and flat knitting machine and yarn carrier used therefor**

(57) Problem: To prevent interference between warp yarns (4) and yarn feeders (25) of yarn carriers (10, 50, 70; 12, 52) when knitting a multi-layer knitted fabric.

Configuration: A multi-layer knitted fabric is knitted, by feeding the warp yarns (4) to a trick gap (3) of a flat knitting machine (2, 48, 68), and feeding an inlay yarn (6, 7) and a knitting yarn (8, 9) from the yarn feeders (25) at the front ends of the yarn carriers (10, 50, 70; 12, 52). The yarn carrier (10, 50, 70; 12, 52) is provided with a guide member (26, 56) that is projected from said yarn carrier toward the trick gap (3), at a position that is closer to a base portion than is the yarn feeder (25), and the guide member (26, 56) guides the warp yarn (4) to the side opposite said yarn carrier with respect to the trick gap (3).

FIG. 10



Description

Technical Field

[0001] The present invention relates to a method for knitting a multi-layer knitted fabric, and a flat knitting machine and a yam carrier used therefor, and particularly relates to preventing interference between a warp yarn and a yam carrier.

Background Art

[0002] WO 97/21860 discloses knitting of a multi-layer knitted fabric in which a flat knitting machine is used to join a warp yam layer and a weft yam layer to each other with a knitting yam. According to WO 97/21860, a warp yam is fed from feeding means above the flat knitting machine to the trick gap of the flat knitting machine, and a weft yam and a knitting yarn are fed from yam carriers to the trick gap.

[0003] The inventor has focused on the fact that, when a yam carrier travels in this configuration, a yam feeder at the front end of the yam carrier interferes with a warp yarn. If the warp yam interferes with the yarn feeder at the front end of the yarn carrier, the warp yam is shifted along the trick gap and is easily brought into contact with a needle on the needle beds, making it difficult to perform knitting. Even when the warp yam is not brought into contact with a needle, the position of the warp yarn is shifted, and, therefore, the knitted fabric is disarranged.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 2000-501792A (Tokuhyo) (WO 97/21860)

Summary of the Invention

Problem to be Solved by the Invention

[0005] It is an object of the present invention to knit a multi-layer knitted fabric without causing interference between a warp yam and a yam carrier.

It is another object of the present invention to prevent damage of the warp yarn when guiding the warp yam with a guide member for preventing the interference.

It is another object of the present invention to allow mutually facing yarn carriers to cross each other without being obstructed by the guide member.

It is another object of the present invention to prevent interference between a needle and the warp yam deflected by the guide member on the yam carrier.

It is another object of the present invention to prevent the warp yam deflected by the guide member on the yam carrier from moving around to the back face of another yam carrier.

Means for Solving Problem

[0006] The present invention is directed to a method for knitting a multi-layer knitted fabric, including the steps of feeding warp yarn from feeding means to a trick gap, which is a space from an edge of a needle bed to the side opposite the needle bed, feeding an inlay yam to the trick gap from a yam feeder at a front end of a yam carrier for an inlay yarn that is travelling along the trick gap, feeding a knitting yarn to the trick gap from a yam feeder at a front end of a yam carrier for a knitting yam that is travelling along the trick gap, and joining a layer of the warp yam and a layer of the inlay yarn to each other by knitting stitches with the knitting yarn using needles on the needle bed, characterized in that: at least one of the yam carriers is provided with a guide member that is projected from said yam carrier toward the trick gap, at a position that is closer to a base portion of said yam carrier than is the yam feeder; and the guide member guides the warp yam to the side opposite said yam carrier with respect to the trick gap.

[0007] Furthermore, the present invention is directed to a flat knitting machine that is configured to knit a multi-layer knitted fabric, including at least one needle bed, a trick gap that is a space from an edge of the needle bed to the side opposite the needle bed, and that is used for knitting stitches using needles projected from and withdrawn into the needle bed, a plurality of yam carriers that travel along the trick gap and that each feed a knitting yarn or an inlay yarn from a yam feeder at a front end thereof to the trick gap, and feeding means for feeding warp yarns to the trick gap, characterized in that: at least one of the yam carriers is provided with a guide member that is projected from said yam carrier toward the trick gap, at a position that is closer to a base portion of said yam carrier than is the yam feeder, and that guides the warp yam that passes through the trick gap to the side opposite said yam carrier with respect to the trick gap. Note that the yam carrier and the flat knitting machine of the present invention are applicable also to knitting performed by feeding only a warp yam and a knitting yam without feeding an inlay yam. In that case, a knitted fabric is obtained that is made of only a warp yarn and a knitting yarn instead of a multi-layer knitted fabric.

[0008] Furthermore, the present invention is directed to a yam carrier for the flat knitting machine, for supplying a knitting yam or an inlay yarn (weft yam) from a yam feeder at a front end thereof to a trick gap of the flat knitting machine, characterized by including: a guide member that is projected from the yam carrier toward the trick gap, at a position that is closer to a base portion of the yam carrier than is the yam feeder, and that guides the warp yarn that passes through the trick gap to the side opposite the yam carrier with respect to the trick gap.

[0009] According to the present invention, the guide member on the yam carrier deflects the warp yarns to the opposite side with respect to the trick gap in side view of the flat knitting machine, and, therefore, the yam feeder

at the front end of the yarn carrier does not interfere with the warp yarn. Accordingly, knitting of a multi-layer knitted fabric becomes easy. It is preferable that the guide member is provided on each yarn carrier, or provided only on the yarn carrier arranged on the left or the right of the trick gap without being provided on the other yarn carriers.

[0010] It is preferable that the flat knitting machine further includes pipes that is supported in the flat knitting machine so as to be swung on a vertical plane and that passes the warp yarns; wherein the guide member swings the pipes in a direction where the pipes avoid said yarn carrier. With this configuration, the warp yarns are deflected without being damaged.

It is more preferable that the flat knitting machine further includes a member that biases the pipes such that the pipes are oriented vertically downward. With this configuration, the pipes are automatically returned to the vertically downward orientation when the yarn carrier leaves.

[0011] It is preferable that the yarn carriers are arranged on both left and right of the trick gap in side view of the flat knitting machine, and heights of the guide members on the left and the right yarn carriers are different from each other. With this configuration, the guide members on the mutually facing yarn carriers do not interfere with each other, and, therefore, these yarn carriers are allowed to travel so as to cross each other. Accordingly, for example, the yarn carriers are allowed to travel such that the yarn carrier for feeding an inlay yarn travels first and the yarn carrier for feeding a knitting yarn travels next, and, therefore, the knitting efficiency is improved. If the guide members interfere with each other, after knitting is performed for one course by causing the yarn carrier for feeding an inlay yarn to travel first and the yarn carrier for feeding a knitting yarn to travel next, knitting for the next course is performed by causing the yarn carrier for feeding a knitting yarn to travel first and the yarn carrier for feeding an inlay yarn to travel next. Furthermore, in order to perform flechage knitting, it is necessary to cause the yarn carrier for feeding a knitting yarn to travel so as to cross the yarn carrier for feeding an inlay yarn. Thus, if the yarn carriers for an inlay yarn and for a knitting yarn are allowed to cross each other, knitting of a three-dimensional knitted fabric becomes easy.

[0012] The yarn carrier for the inlay yarn and the yarn carrier for the knitting yarn are arranged so as to face each other on the left and right of the trick gap in side view of the flat knitting machine, and only one of the yarn carrier for the inlay yarn and the yarn carrier for the knitting yarn is provided with the guide member, and the feeding means is configured to feed the warp yarns at positions off a center of the trick gap toward said yarn carrier provided with the guide member. If the warp yarns are fed through positions off the center of the trick gap toward one side in the left-and-right direction, interference is avoided between the yarn carrier on the opposite side in the left-and-right direction and the warp yarns, and the yarn carrier on the opposite side in the left-and-right di-

rection does not have to be provided with the guide member. If the warp yarns are fed through the pipes, and both the left and the right yarn carriers are provided with the guide members, it is difficult for the yarn carriers to cross each other. Thus, the above-described configuration is particularly effective when feeding the warp yarn through the pipe.

[0013] It is preferable that the guide member is provided with a straight line portion that is parallel to a longitudinal direction of the trick gap at a center of the guide member, and is further provided with guide portions that guide the warp yarn to the straight line portion at both left and right sides of the straight line portion. Note that the straight line portion is not necessary for the yarn carrier for an inlay yarn, and the guide portion on the yarn carrier for an inlay yarn may be, for example, in the shape of an arc without the straight line portion. Without the straight line portion, the warp yarn is inclined at the center of the guide member not only in the directions in a horizontal plane at a right angle with respect to the longitudinal direction of the trick gap, that is, the directions in which needles are projected and withdrawn, but also in the longitudinal direction of the trick gap. When the knitting yarn is fed from the yarn carrier, the knitting yarn is caught by the needles on the needle bed to knit stitches immediately behind the yarn carrier in its travelling direction. In this state, if the warp yarn is inclined in the longitudinal direction of the trick gap, a problem occurs, for example, in which the warp yarns are brought into contact with the needles or are caught by the needles. With respect to this point, if the straight line portion is provided at the center on the edge of the guide member on the yarn carrier for feeding the knitting yarn, the warp yarn guided by the guide member is not inclined in the longitudinal direction of the trick gap. Accordingly, the above-described problem is avoided.

[0014] Furthermore, it is preferable that the guide portions have a shape that allows guiding of the warp yarns to be started from a position that is farther from the trick gap than is the yarn carrier. Here, "farther from the trick gap" refers to the state in which, with respect to the linear trick gap at the height position of the guide member, the guide portion is started from a location that is farther from the trick gap than is the yarn carrier when viewed from above. If at least a pair of front and rear needle beds are provided, the center of the space between the needle beds corresponds to the trick gap center line, and the guide is started from a position that is farther from the trick gap center line than is the yarn carrier. For this purpose, it is sufficient that backward portions extending to a position that is farther from the trick gap than is the back face of the yarn carrier are provided on the left and the right of the guide member. With this configuration, a warp yarn deflected by a yarn carrier does not move around to the back face of another yarn carrier.

Brief Description of the Drawings

[0015]

FIG. 1 is a diagram showing the knitting principle for a multi-layer knitted fabric.

FIG. 2 is a diagram showing a jig for warp yarn insertion.

FIG. 3 is a diagram showing a knit structure of a multi-layer knitted fabric.

FIG. 4 is a diagram showing a knit structure obtained by performing plain knitting with knitting yarns.

FIG. 5 is a diagram showing a knit structure obtained by performing rib knitting with knitting yarns.

FIG. 6 is a side view showing a portion near a trick gap of the flat knitting machine.

FIG. 7 is a plan view showing a portion near the trick gap of the flat knitting machine.

FIG. 8 is a front view of a yarn carrier according to the embodiment.

FIG. 9 is a photograph of a knitted fabric knitted according to the embodiment.

FIG. 10 is a side view showing a portion near the trick gap of a flat knitting machine according to a modified example.

FIG. 11 is a side view of essential portions showing the state where a pipe has been swung in the flat knitting machine according to the modified example.

FIG. 12 is an exploded view of a pipe guide of the flat knitting machine according to the modified example.

FIG. 13 is a front view of a yarn carrier according to the modified example.

FIG. 14 is a side view showing a portion near the trick gap of the flat knitting machine according to a second modified example.

Mode for Carrying out the Invention

[0016] Hereinafter, optimal embodiments for carrying out the present invention will be described. The scope of the invention should be construed in view of the description of the claims together with the possibility of changes according to well known techniques.

Embodiment

[0017] FIGS. 1 to 9 show an embodiment. In the drawings, 2 denotes a flat knitting machine that is provided with, for example, a front needle bed F and a rear needle bed R. However, the front needle bed F alone may be provided, or a larger number of needle beds such as four needle beds arranged at upper and lower positions in the front and the rear may be provided. Warp yarns 4 are allowed to pass from above to below through a trick gap 3 between the front and the rear needle beds F and R, an inlay yarn (weft yarn) 6 is fed by a yarn carrier 10, and a knitting yarn 8 is fed by a yarn carrier 12. The trick gap

3 is a space from the edge of a needle bed toward the side opposite the needle bed, and, in this example, refers to a space between the needle beds F and R when viewed from above. The trick gap extends in a horizontal plane at a right angle with respect to directions in which needles are projected from and withdrawn into the needle beds F and R, and is parallel to the longitudinal direction of the needle beds F and R. A "center of the trick gap" refers to a center of the trick gap with respect to the directions in which needles are projected and withdrawn. Furthermore, a trick gap center line is positioned at the center of the space between the needle beds F and R, and is a line parallel to the longitudinal direction of the needle beds F and R. The left and the right with respect to the trick gap refer to orientations connecting the center of the trick gap and the needle beds F and R. The warp yarn 4 is made of, for example, carbon fiber, glass fiber, aramid fiber, or the like, but particularly preferably made of carbon fiber that is strong and hard to bend. The inlay yarn 6 is made of glass fiber, aramid fiber, or the like, but particularly preferably made of aramid fiber that is easy to bend. The yarn carrier 10 feeds the inlay yarn 6. The inlay yarn 6 is not subjected to the knitting operation by the needles on the needle beds F and R, and is pressed by a presser (not shown) so as not to move upward from the trick gap. The knitting yarn 8 is fed from the yarn carrier 12, and subjected to the knitting operation by the needles on the needle beds F and R and formed into stitches (needle loops) and prolongations (sinker loops), thereby joining the warp yarns 4 and the inlay yarn 6 to each other.

[0018] FIG. 2 shows a jig 14 for feeding the warp yarns 4. The jig 14 is fixed to the flat knitting machine 2 above the trick gap 3. The jig 14 has, for example, a large number of holes 15. The warp yarns 4 pass through the holes 15 from above to below and are fed to the trick gap 3. In this embodiment, although the warp yarns 4 and the inlay yarns 6 are fed as reinforcement fibers, other reinforcement fibers may be obliquely fed. In this case, for example, the reinforcement fibers are fed to the needle beds F and R from the jig 14 positioned obliquely above a knitted fabric. Alternatively, the reinforcement fibers may be obliquely fed by moving a knitted fabric in the longitudinal direction of the needle beds F and R through stitch transfer between the needle beds F and R and racking operation of the needle beds. A plurality of parallel warp yarns 4 are formed into a warp yarn layer, and a plurality of parallel inlay yarns 6 are formed into an inlay yarn layer. When yarns are obliquely fed, a layer of oblique yarns is added to these layers. The oblique yarns are arranged, for example, in two directions, namely a direction inclined by 45° and a direction inclined by 135° from the horizontal direction.

[0019] FIG. 3 shows a structure of a multi-layer knitted fabric. This drawing shows a layer of the warp yarns 4, a layer of the inlay yarn 6, and a layer of the stitches 16 in this order from above to below. The layer of the warp yarns 4 is positioned near the center of the trick gap, the

layer of the inlay yam 6 is off the center of the trick gap toward one side, and the layer of the stitches 16 is farther from the center of the trick gap than is the layer of the inlay yam 6. A prolongation 18 between the stitches 16 joins the warp yam 4 and the inlay yam 6 to the stitches 16, and the stitches 16 and the prolongations 18 join the layer of the warp yarns 4 and the layer of the inlay yam 6 to each other. Here, 17 denotes stitches in the immediately preceding course that fix the stitches 16 to the inlay yam 6 on its lower side in FIG. 3. If the warp yarns 4 are removed from the knitted fabric having the structure in FIG. 3, a type of inlay knitted fabric is obtained. Note that, in an ordinary inlay knitted fabric, stitches are knitted with a knitting yam also at the positions of the warp yarns 4 in FIG. 3, forming a rib fabric.

[0020] In order to knit a knitted fabric in FIG. 3, for example, the warp yarns 4 are fed from the jig 14 so as to pass through the center of the trick gap. In this state, a yam carrier for feeding the inlay yam 6 is first caused to travel along the trick gap, feeding the inlay yam 6. Next, a yam carrier for feeding a knitting yam is caused to travel parallel to the trick gap along the side opposite the inlay yam 6 with respect to the warp yarns 4 (along the upper side in FIG. 3), knitting the stitches 16 using the needles on the needle beds. In this manner, the yam carrier 10 for feeding an inlay yam travels first, and the yam carrier 12 for feeding a knitting yam travels next. During the travel of the carriages for one course, the warp yarns 4 and the inlay yam 6 are knitted together by feeding the inlay yam 6 and knitting the stitches 16. Accordingly, the knitting is efficiently performed. Furthermore, the yam carrier 10 for feeding an inlay yam and the yam carrier 12 for feeding a knitting yam are arranged on the left and the right of the trick gap center line so as to face each other when viewed from a side of the flat knitting machine. For example, the stitches 16 are knitted by moving the needles between the warp yarns 4 without moving the needles in front of the warp yarns 4 through needle selection on the needle beds. Note that, if the needles are arranged at large intervals, the warp yarns 4 may be arranged between the needles such that all needles are moved.

[0021] FIGS. 4 and 5 show structures of multi-layer knitted fabrics. In FIG. 4, the layer of the inlay yam 6 is positioned on the front needle bed F side of the layer of the warp yarns 4, and the layer of the stitches 16 is positioned on the front needle bed F side of the layer of the inlay yam 6. In this state, the prolongations 18 pass through points behind the warp yarns 4, and, therefore, the layer of the warp yarns 4 and the layer of the inlay yam 6 are joined to the layer of the stitches 16. In FIG. 4, for example, it is possible to knit a multi-layer knitted fabric only with the needles on the front needle bed F, and the stitches 16 are formed into a plain knit structure.

[0022] In FIG. 5, a multi-layer knitted fabric is knitted through rib knitting. The layer of the warp yarns 4 is positioned between the front needle bed F and the rear needle bed R, and a pair of inlay yarns 6 and 7 are positioned on both sides of the layer of the warp yarns 4.

Furthermore, a pair of knitting yarns 8 and 9 are used as knitting yarns, and these yarns are used for performing rib knitting. The knitting yarns 8 and 9 are formed into the stitches 16 on the front needle bed F side and the rear needle bed R side, and prolongations 18 and 19 between the stitches 16 are used for joining the warp yarns 4 and the inlay yarns 6 and 7 to the layers of the stitches 16.

[0023] In this embodiment, the warp yam 4 may interfere with yam feeders 25 that are arranged in tips 24 at the front ends of the yam carriers 10 and 12 at a point near the trick gap 3. That is to say, at a point near the yarn feeders 25, the warp yam 4 that passes through the trick gap 3 from above to below may be brought into contact with the yam carriers 10 and 12, in particular, the tips 24 at the front ends of the yam carriers 10 and 12, and, in that case, the warp yam 4 may be moved, or the position where the warp yam 4 passes through the trick gap 3 may be shifted. If the position of the warp yam 4 is shifted, the warp yam 4 may be brought into contact with a needle that has moved forward from the needle bed or may be caught by the needle. Even when the warp yam 4 is not brought into contact with a needle, the knitted fabric may be disarranged. FIGS. 6 to 8 show a mechanism for preventing the warp yam 4 from interfering with the yam feeders 25 at the front ends of the yam carriers 10 and 12.

[0024] As shown in FIGS. 6 to 8, the yam carriers 10 and 12 are provided with plate-like guide members 26, thereby guiding the warp yam 4. As shown in FIG. 6, needles 20 and 21 are projected from and withdrawn into the needle beds F and R, and knit stitches with the knitting yam 8 fed from the yam carrier 12. Furthermore, the front ends of the yam carriers 10 and 12 are provided with the tips 24 (FIG. 8), and the inlay yam 6 and the knitting yam 8 are fed via the yam feeders 25 of the tips 24. The guide members 26 are secured to the yam carriers 10 and 12 at plate-like attachment portions 34, for example, using bolts 36 and nuts 38. The securing means may be of any type. The guide members 26 are provided with projections 28 that are projected from the yam carriers 10 and 12 toward the center of the trick gap 3. Upon being brought into contact with the warp yam 4, the projections 28 deflect the warp yam 4 along their edges. As a result, the yam carriers 10 and 12 travel without causing the warp yam 4 to interfere with the yam feeders 25 of the tips 24 or the like.

[0025] As shown in FIG. 7, a straight line portion 30 formed by an end portion in the shape of a straight line parallel to the trick gap is disposed at the center of the projection 28, and guide portions 31 for guiding a warp yam to the straight line portion 30 are arranged on the left and the right of the straight line portion 30. A length w of the straight line portion 30 is at most approximately twice the length of a zone in which the needles 20 and 21 are moved forward from the needle beds F and R by a carriage (not shown) for operating these needles or the like, and a shorter length may be adopted. This length is

a length along the trick gap, and is determined by a product of the arrangement pitch of needles and the number of needles simultaneously moved by a carriage forward from the needle beds F and R. Furthermore, backward portions 32 are provided on the left and right guide portions 31 continuously from the projections 28. The backward portions 32 are farther from the trick gap than are the back faces (faces opposite the trick gap) of the yam carriers 10 and 12. Here, the yam carrier 10 for the inlay yam 6 may not be provided with the straight line portion 30.

[0026] Returning to FIG. 6, the guide members 26 are attached at different heights to the yam carriers 10 and 12 that are arranged on the left and the right of the trick gap in side view of the flat knitting machine, so as to face each other. For example, several yam carriers 10 and several yam carriers 12 may be arranged on the left and the right of the line of the warp yarns 4 (trick gap center line), and the heights at which the guide members 26 are attached to the yam carriers positioned on the same side with respect to the line of the warp yarns 4 may be the same or different.

[0027] As shown in FIG. 8, a conveyance portion 40 is disposed on the upper portion (base portion) of the yam carrier 10, 12. For example, the yam carrier 10, 12 is caused to travel along a yam carrier rail (not shown) by a toothed belt 41 and idler rollers 42. The yam carrier 10, 12 may be conveyed, for example, by a pin that is projected from and withdrawn into a member travelling together with the carriage for operating the needles.

[0028] Hereinafter, the action of the guide member 26 will be described. As shown in FIG. 7, when the yam carrier 10, 12 travels, the warp yam 4 is brought into contact with the guide portion 31 and guided so as to be deflected over trick gap center line 39 with respect to the yam carrier, and then is guided along the straight line portion 30 to the next guide portion 31. Accordingly, as shown in FIG. 6, the warp yam 4 is prevented from being brought into contact with the tip 24.

[0029] When guiding the warp yam 4 along the guide member 26, the warp yam 4 is shifted also in the longitudinal direction of the trick gap at a portion other than the straight line portion 30. If the warp yam 4 is shifted in the longitudinal direction of the trick gap, the warp yam 4 may interfere with a needle that has moved forward from the needle bed F or R. However, at the straight line portion 30, the warp yam 4 is not shifted in the longitudinal direction of the trick gap, and, therefore, the warp yam 4 does not interfere with needles. Typically, approximately several needles move forward in a zone from the center in the travelling direction of the yam carrier 12 to its following area. FIG. 7 schematically shows this zone as a semicircle. If the length of the straight line portion 30 is at least twice the length of the zone, then the warp yam 4 that has been inclined in the longitudinal direction of the trick gap has no risk of being brought into contact with the needles. Furthermore, since the warp yam 4 is not brought into contact with the needles unless the front

ends of the needles have moved forward to a point near the trick gap center line 39, the length of the straight line portion 30 may be shorter. Note that, since the needles are not moved forward under the yam carrier 10 for an inlay yam, it is sufficient that the straight line portion 30 is provided only on the yam carrier 12 for a knitting yam.

[0030] When guiding the warp yam 4 along the straight line portion 30, if one of the yam carriers 10 and 12 that face each other crosses the other yam carrier, the warp yam 4 may be shifted to the back face of the other yam carrier. Thus, the left and the right backward portions 32 are provided, and guiding of the warp yam 4 to the straight line portion 30 is started from a position that is farther from the trick gap center line 39 than is the back face of the yam carrier 12, 10, and, therefore, the warp yam 4 is not shifted to the back face of the yam carrier 12, 10.

[0031] It is necessary that, when the mutually facing yam carriers 10 and 12 cross each other, the guide members 26 are prevented from being brought into contact with each other. Thus, the guide members 26 are attached at different heights to the mutually facing yam carriers 10 and 12.

[0032] Also, the inventor conducted research on the configuration near the tips 24, attached to the front ends of the yam carriers 10 and 12, in which the warp yam 4 is prevented from being brought into contact with the tips 24 by increasing the width of the trick gap 3 instead of providing the guide members 26. However, with this configuration, the stitch layer becomes loose because larger stitches are knitted. Thus, the guide members 26 are arranged to deflect the warp yam 4 to the opposite side with respect to the trick gap. Furthermore, the inventor conducted research on the configuration in which the jig 14 is swung between the front needle bed F and the rear needle bed R such that, for example, when feeding the inlay yam 6 from the yam carrier 10, the jig 14 is swung toward the rear needle bed R so as to prevent interference with the warp yam 4, and, when feeding the knitting yam from the yam carrier 12, the jig 14 is swung toward the front needle bed F so as to prevent interference with the warp yam 4. However, with this configuration, a mechanism for swinging the jig 14 in synchronization with the travel of the yam carriers 10 and 12 has to be provided, and, furthermore, the time during which the carrier passes through a point near the jig 14 has to be made different between the yam carrier 10 and the yam carrier 12 such that the jig 14 is allowed to swung in opposite directions. Accordingly, the knitting efficiency deteriorates.

[0033] FIG. 9 shows a multi-layer knitted fabric knitted in a spiral shape. In this example, plaited cord-like yarns are used as warp yarns and inlay yarns because this knitted fabric is knitted as a trial model. In FIG. 9, the plaited cord-like yarns extending from the front and the rear of the multi-layer knitted fabric are warp yarns, and the plaited cord-like yarns folded back along the lateral directions of the multi-layer knitted fabric are inlay yarns. The multi-layer knitted fabric has a spiral shape because

of flechage knitting where the number of stitches on the inner side of the knitting width is made different from that on the outer side thereof, more specifically, the number of stitches on the inner side is less than that on the outer side. Accordingly, this multi-layer knitted fabric is curled with the side having the lesser number of stitches as the inner side and the side having the greater number of stitches as the outer side, and, therefore, a shape shown in FIG. 9 is obtained. The multi-layer knitted fabric in FIG. 9 is in the shape of a spiral if the knitted fabric is long, and is in the shape of part of a spiral if the knitted fabric is short.

[0034] FIGS. 10 to 14 show two types of modified examples. The same reference numerals as those in FIGS. 1 to 8 denote the same constituent elements, and these modified examples are similar to the embodiment in FIGS. 1 to 8 unless otherwise specified. FIGS. 10 to 13 show a first modified example where 48 denotes a flat knitting machine, 50 denotes a yarn carrier for an inlay yarn, 52 denotes a yarn carrier for a knitting yarn, and 56 denotes a guide member. The warp yarn 4 is fed via a pipe 60 to the trick gap 3, and a pipe guide 61 is disposed below the jig 14. The jig 14 and the pipe guide 61 may be unitarily formed. FIG. 12 shows the structures of the pipe 60 and the pipe guide 61. The upper end of the pipe 60 has a funnel portion that becomes narrower toward the lower side and is supported by the pipe guide 61 in a freely swingable manner. The means for supporting the pipe in a freely swingable manner may be a constituent element other than the funnel portion.

[0035] The pipe guide 61 is provided with, for example, a sleeve member 62 that is in the shape of a sleeve having corners and that has a longitudinal direction parallel to the longitudinal direction of the trick gap 3. Circular holes 67 are arranged in the longitudinal direction of the trick gap 3 on the upper face of the sleeve member 62. Furthermore, elongated holes 66 that are long in a horizontal plane at a right angle with respect to the longitudinal direction of the trick gap 3 are arranged in the longitudinal direction of the trick gap 3 on the bottom face of the sleeve member 62. Furthermore, the sleeve member 62 accommodates an elastic member 64 made of sponge-like synthetic resin foam, rubber, or the like, and holes 69 are arranged in the longitudinal direction of the trick gap 3 through the elastic member 64. The pipe 60 penetrates the pipe guide 61 from above to below through the circular hole 67, the hole 69, and the elongated hole 66, and such pipes 60 are arranged in the longitudinal direction of the trick gap 3. Furthermore, the pipe guide 61 is fixed to, for example, a carrier rail (rail supporting the yarn carriers 50 and 52) of the flat knitting machine 48, and may be unitarily formed with the jig 14. Also, instead of the elastic member 64, a spring may be provided on the pipe 60 such that one end of the spring is attached to the pipe 60 and the other end is fixed to the sleeve member 62, thereby biasing the pipe 60 so as to be oriented vertically downward. An important aspect of the pipe guide 61 is that the circular hole 67 and the elongated hole 66 are

arranged in an overlapping manner when viewed from above, and the elastic member 64 is disposed between these holes. Accordingly, the pipe guide may be configured by, for example, two separate plates, namely a plate on which the circular holes 67 are arranged and a plate on which the elongated holes 66 are arranged.

[0036] FIG. 13 shows the guide member 56 according to the modified example. The elongated hole 66 allows the pipe 60 to be swung only in directions in a horizontal plane at a right angle with respect to the longitudinal direction of the trick gap 3. Thus, the straight line portion 30 shown in FIGS. 7 and 8 does not have to be provided on the guide member 56. The guide member 56 is similar to the guide member 26 in the other aspects.

[0037] As shown in FIG. 10, when not in contact with the guide members 56, the pipe 60 is vertically oriented. As shown in FIG. 11, when in contact with the guide member 56, the pipe 60 is swung along the elongated hole 66, and then is returned to the vertical orientation due to the force from the elastic member 64 after the guide member 56 has passed through the contact area with the pipe 60. In the modified example, the warp yarn 4 is not brought into contact with the guide members 56, and, therefore, the warp yarn is not damaged.

[0038] In the modified example in FIGS. 10 to 13, the yarn carriers 50 and 52 are not allowed to cross each other at a position for feeding a warp yarn. FIG. 14 shows a modified example that has made an improvement to this aspect, where 70 denotes a yarn carrier for a knitting yarn that is not provided with a guide member, while only the yarn carrier 50 for an inlay yarn is provided with the guide member 56, and CL denotes a center line of the trick gap 3. A center line in the left-and-right direction of the pipe 60 and a pipe guide 71 is off the center line CL of the trick gap 3 toward the yarn carrier 50 for an inlay yarn. Accordingly, the yarn carrier 70 for a knitting yarn does not interfere with the pipe 60 or the warp yarn 4 not guided by the guide member 56, and, therefore, the yarn carrier 70 for a knitting yarn does not have to be provided with the guide member 56. Accordingly, it is sufficient that the guide member 56 is provided only on the yarn carrier 50 for an inlay yarn, and the yarn carriers 50 and 70 are allowed to cross each other also at a position for feeding the warp yarn 4. In the case where the pipe 60 is provided, if both the yarn carriers 50 and 70 are provided with the guide members 56, the yarn carriers 50 and 70 are not allowed to cross each other at a position where the pipe 60 is disposed. Furthermore, in the modified example in FIG. 14, the directions in which the pipe 60 is swung are limited to those on the yarn carrier 70 side, and, therefore, the pipe guide 71 accommodates an elastic member 74 only on the yarn carrier 70 side, and elongated holes 76 of a sleeve member 72 are arranged extending from a position directly below the circular holes 67 toward the yarn carrier 70.

[0039] In the modified example in FIG. 14, the center in the left-and-right direction of the pipe guide 71 is off the center of the trick gap 3. However, the pipe guide 71

does not necessarily have to be off the center in the left-and-right direction as long as the pipe 60 not in contact with the guide members 56 is off the center in the left-and-right direction of the trick gap 3 toward one side. Furthermore, in the modified example in FIG. 14, the yarn carrier 50 for an inlay yarn is provided with the guide member 56, and the yarn carrier 70 for a knitting yarn is not provided with the guide member 56. However, a configuration is possible in which only the yarn carrier 70 for a knitting yarn is provided with the guide member 56 and the yarn carrier 50 for an inlay yarn is not provided with the guide member 56. In the embodiment in FIGS. 1 to 8, in order to provide the guide member 26 only on one of the yarn carriers 10 and 12, the holes 15 arranged in the jig 14 may be made off the center in the left-and-right direction of the trick gap 3 toward that yarn carrier. If the yarn carriers 50 and 70 are allowed to cross each other also at a position for feeding the warp yarn 4, the knitting efficiency increases and the flechage knitting becomes easy, and, therefore, knitting of a three-dimensional knitted fabric becomes easier. This aspect is applicable also to the embodiment in FIGS. 1 to 8.

[0040] The foregoing embodiment achieves the following effects.

- 1) The warp yarn 4 has no risk of interfering with the tips 24 at a point near the yarn feeders 25.
 - 2) The guide members 26 on the mutually facing yarn carriers 10 and 12 do not interfere with each other.
 - 3) If the straight line portion 30 is provided, the warp yarn 4 is not brought into contact with needles that have moved forward from the needle beds F and R.
 - 4) If the left and the right backward portions 32 are provided, the warp yarn 4 is not shifted to the back faces of the yarn carriers 10 and 12.
- The modified example in FIGS. 10 to 13 further achieves the following effect.
- 5) The warp yarn 4 is not damaged because the warp yarn 4 is not brought into contact with the guide members 56.

If the yarn carrier 12, 70 for a knitting yarn and the yarn carrier 10, 50 for an inlay yarn are allowed to cross each other, the knitting efficiency is improved, and a three-dimensional knitted fabric is easily knitted. In particular, when the warp yarn 4 is fed through a position off the center of the trick gap 3 toward one side in the left-and-right direction as shown in the modified example in FIG. 14, it is sufficient that the guide member 56 is provided only on the yarn carrier 50 on the side of the off-center warp yarn 4.

Reference Signs List

[0041]

2 Flat knitting machine

3	Trick gap
4	Warp yarn
6, 7	Inlay yarn
8, 9	Knitting yarn
5 10, 12	Yarn carrier
14	Jig
15	Hole
16, 17	Stitch
18, 19	Prolongation
10 20, 21	Needle
24	Tip
25	Yarn feeder
26	Guide member
28	Projection
15 30	Straight line portion
31	Guide portion
32	Backward portion
34	Attachment portion
36	Bolt
20 38	Nut
39	Trick gap center line
40	Conveyance portion
41	Toothed belt
42	Idler roller
25 48, 68	Flat knitting machine
50, 52	Yarn carrier
56	Guide member
60	Pipe
61, 71	Pipe guide
30 62, 72	Sleeve member
64, 74	Elastic member
66, 76	Elongated hole
67	Circular hole
69	Hole
35 70	Yarn carrier
F	Front needle bed
R	Rear needle bed
CL	Center line

Claims

1. A method for knitting a multi-layer knitted fabric, comprising the steps of
 - 45 feeding warp yarns (4) from feeding means to a trick gap (3), which is a space from an edge of a needle bed (F, R) to the side opposite the needle bed (F, R),
 - feeding an inlay yarn (6, 7) to the trick gap (3) from a yarn feeder (25) at a front end of a yarn carrier (10, 50, 70) for an inlay yarn travelling along the trick gap (3),
 - 50 feeding a knitting yarn (8, 9) to the trick gap (3) from a yarn feeder (25) at a front end of a yarn carrier (12, 52) for a knitting yarn travelling along the trick gap (3), and
 - 55 joining a layer of the warp yarn and a layer of the inlay yarn to each other by knitting stitches (16, 17) with the knitting yarn (8, 9) using needles (20, 21) on

the needle bed (F, R), **characterized in that:**

at least one of the yam carriers (10, 50, 70; 12, 52) is provided with a guide member (26, 56) projected from said yam carrier toward the trick gap (3), at a position that is closer to a base portion of said yam carrier than is the yam feeder (25); and
the guide member (26, 56) directly or indirectly guides the warp yarn (4) to the side opposite said yam carrier with respect to the trick gap (3).

2. The method for knitting a multi-layer knitted fabric according to claim 1, **characterized in that:**

the warp yarns (4) are fed via pipes (60) configured to be swung on a vertical plane; and
the guide member (26, 56) swings the pipes (60) in a direction where the pipes (60) avoid said yam carrier.

3. The method for knitting a multi-layer knitted fabric according to claim 1 or 2, **characterized in that:**

the yam carrier (10, 50, 70) for the inlay yam and the yam carrier (12, 52) for the knitting yam are arranged so as to face each other on left and right of the trick gap (3) in side view of the flat knitting machine (2, 48, 68), and only one of the yam carrier (10, 50, 70) for the inlay yam and the yam carrier (12, 52) for the knitting yam is provided with the guide member (26, 56); and
the feeding means is caused to feed the warp yarns (4) at positions off a center of the trick gap (3) toward said yam carrier (10, 50, 70; 12, 52) provided with the guide member (26, 56), thereby avoiding interference between the warp yarns (4) and the yam carrier not provided with the guide member (26, 56).

4. A flat knitting machine (2, 48, 68) configured to knit a multi-layer knitted fabric, comprising
at least one needle bed (F, R),
a trick gap (3) being a space from an edge of the needle bed (F, R) to the side opposite the needle bed (F, R), and being used for knitting stitches (16, 17) using needles (20, 21) projected from and withdrawn into the needle bed (F, R),
a plurality of yam carriers (10, 50, 70; 12, 52) traveling along the trick gap (3) and each feeding a knitting yarn (8, 9) or an inlay yam (6, 7) from a yam feeder (25) at a front end thereof to the trick gap (3), and
feeding means for feeding warp yarns (4) to the trick gap (3), **characterized in that:**

at least one of the yam carriers (10, 50, 70; 12, 52) is provided with a guide member (26, 56)

projected from said yam carrier toward the trick gap (3), at a position that is closer to a base portion of said yam carrier than is the yam feeder (25), and guiding the warp yarns (4) passing through the trick gap (3) to the side opposite said yam carrier with respect to the trick gap (3).

5. The flat knitting machine (2, 48, 68) according to claim 4, **characterized by** further comprising: pipes (60) supported so as to be swung on a vertical plane and passing the warp yarn (4); the guide member (26, 56) swinging the pipes (60) in a direction where the pipes (60) avoid said yam carrier.

6. The flat knitting machine (2, 48, 68) according to claim 5, **characterized by** further comprising: a member biasing the pipes (60) such that the pipes (60) are oriented vertically downward.

7. The flat knitting machine (2, 48, 68) according to claim 4, **characterized in that:** the yam carriers (10, 50, 70; 12, 52) are arranged on both left and right of the trick gap (3) in side view of the flat knitting machine (2, 48, 68), and heights of the guide members (26, 56) on the left and the right yam carriers (10, 50, 70; 12, 52) are different from each other.

8. The flat knitting machine (2, 48, 68) according to any one of claims 4 to 6, **characterized in that:**

the yam carrier (10, 50, 70) for the inlay yam and the yam carrier (12, 52) for the knitting yam are arranged so as to face each other on left and right of the trick gap (3) in side view of the flat knitting machine (2, 48, 68), and only one of the yam carrier (10, 50, 70) for the inlay yam and the yam carrier (12, 52) for the knitting yam is provided with the guide member (26, 56); and
the feeding means is configured to feed the warp yarns (4) at positions off a center of the trick gap (3) toward said yam carrier (10, 50, 70; 12, 52) provided with the guide member (26, 56).

9. The flat knitting machine (2, 48, 68) according to any one of claims 4, 7, and 8, **characterized in that:**

the guide member (26, 56) is provided with a straight line portion (30) parallel to a longitudinal direction of the trick gap (3) at a center of the guide member (26, 56), and is further provided with guide portions (31) that guide the warp yarns straight line portion (30) at both left and right sides of the straight line portion (30).

10. The flat knitting machine (2, 48, 68) according to any one of claims 4, 7, and 9, **characterized in that:** the guide portions (31) have a shape allowing guiding of the warp yarn (4) to be started from a position that

is farther from the trick gap (3) than is said yarn carrier.

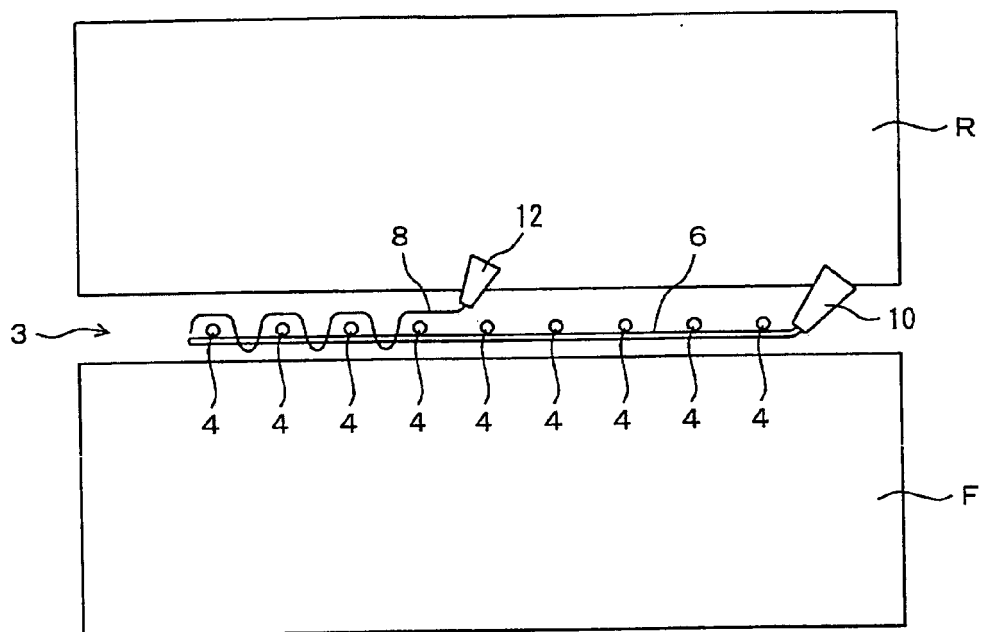
11. A yarn carrier (10, 50, 70; 12, 52) for supplying a knitting yarn (8, 9) or an inlay yarn (6, 7) from yarn feeder (25) at a front end thereof to a trick gap (3) of a flat knitting machine (2, 48, 68) to which warp yarns (4) have been inserted, **characterized by:**

a guide member (26, 56) projected from the yarn carrier (10, 50, 70; 12, 52) toward the trick gap (3), at a position that is closer to a base portion of the yarn carrier (10, 50, 70; 12, 52) than is the yarn feeder (25), and guiding the warp yarns (4) passing through the trick gap (3) to the side opposite the yarn carrier (10, 50, 70; 12, 52) with respect to the trick gap (3).

12. The yarn carrier (10, 50, 70; 12, 52) for a flat knitting machine (2, 48, 68) according to claim 11, **characterized in that:** the guide member (26, 56) is provided with a straight line portion (30) parallel to a longitudinal direction of the trick gap (3) at a center of the guide member (26, 56), and is further provided with guide portions (31) guiding the warp yarn (4) to the straight line portion (30) at both left and right sides of the straight line portion (30).

13. The yarn carrier (10, 50, 70; 12, 52) for a flat knitting machine (2, 48, 68) according to claim 11 or 12, **characterized in that:** the guide portions (31) have a shape allowing guiding of the warp yarns (4) to be started from a position that is farther from the trick gap (3) than is the yarn carrier (10, 50, 70; 12, 52).

FIG. 1



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FIG. 2

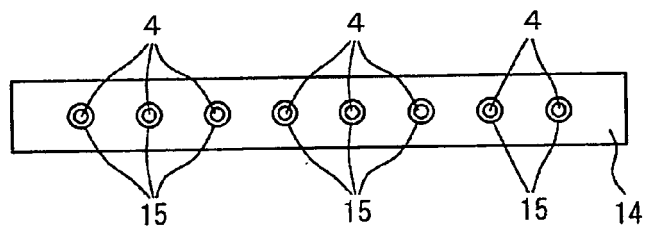


FIG. 3

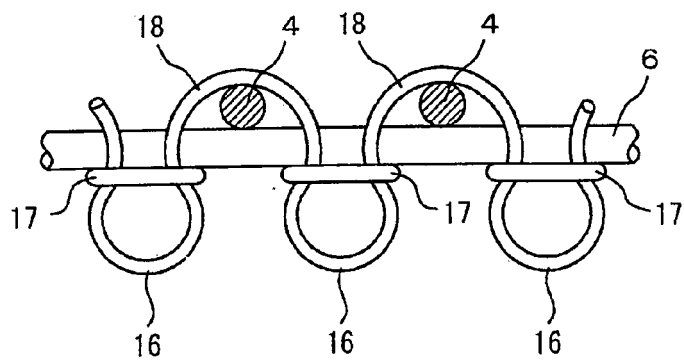


FIG. 4

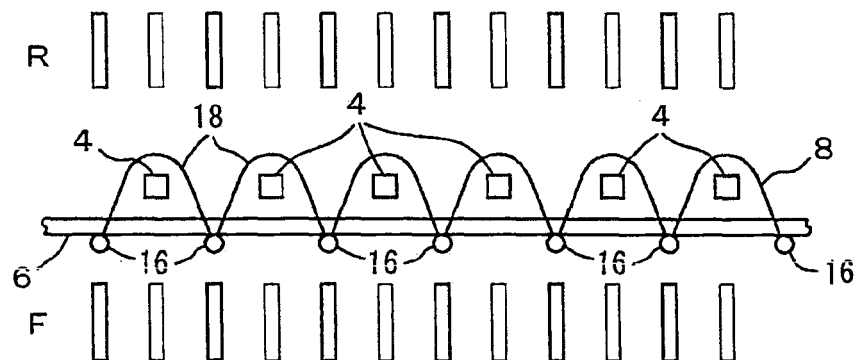


FIG. 5

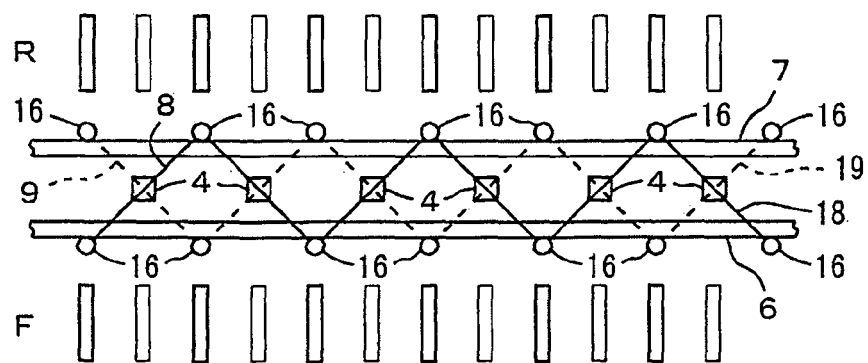


FIG. 6

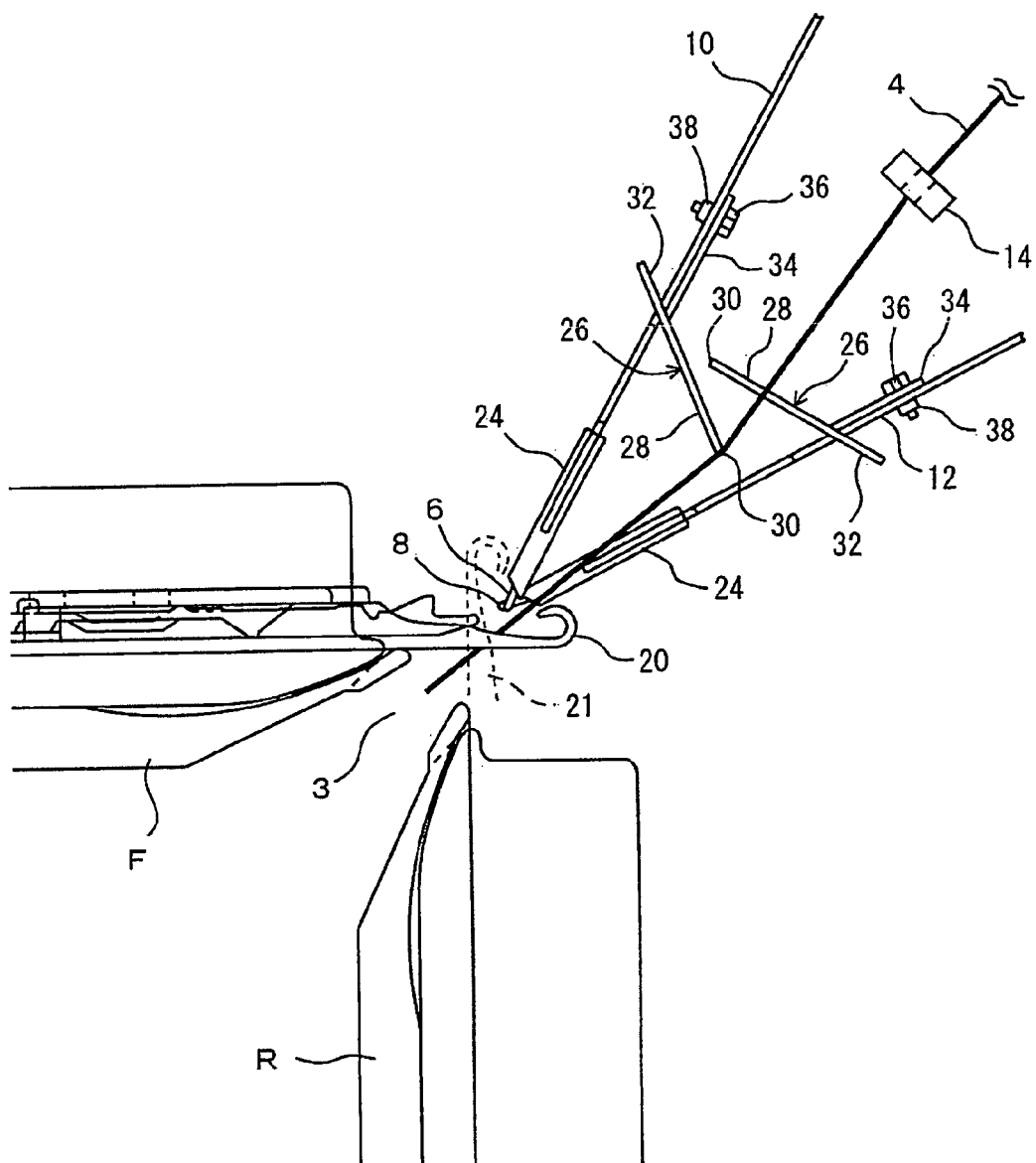


FIG. 7

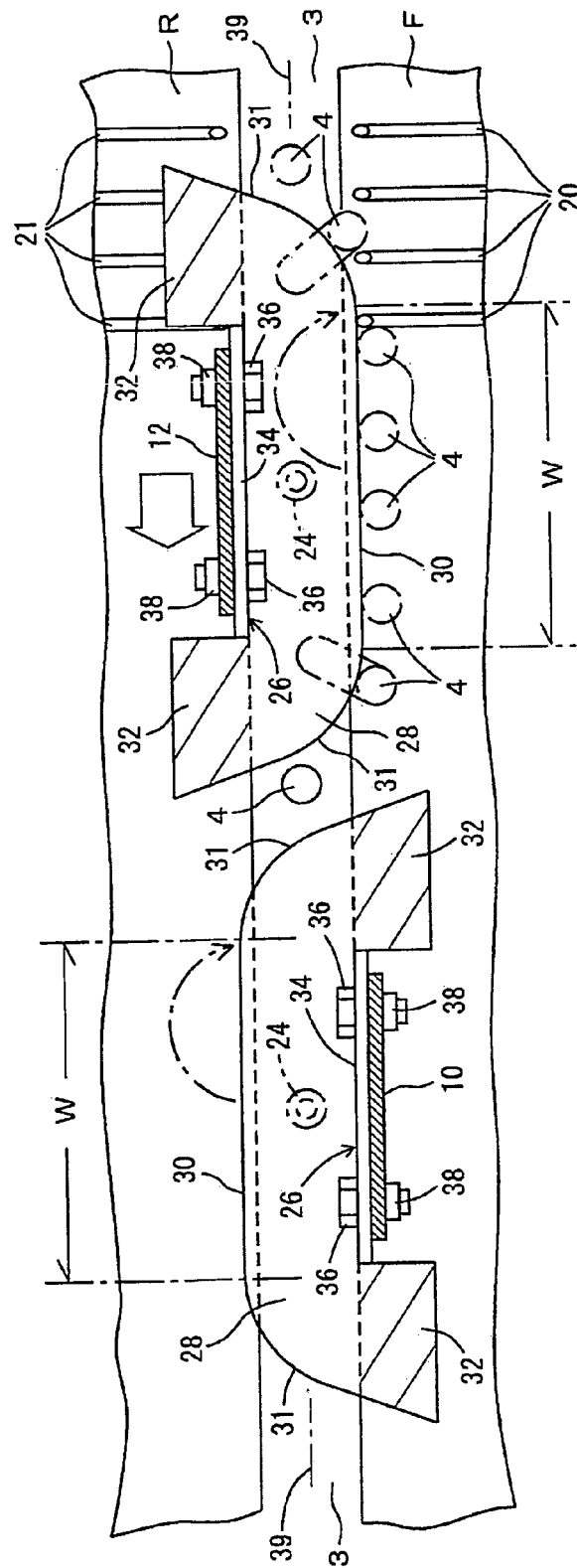


FIG. 8

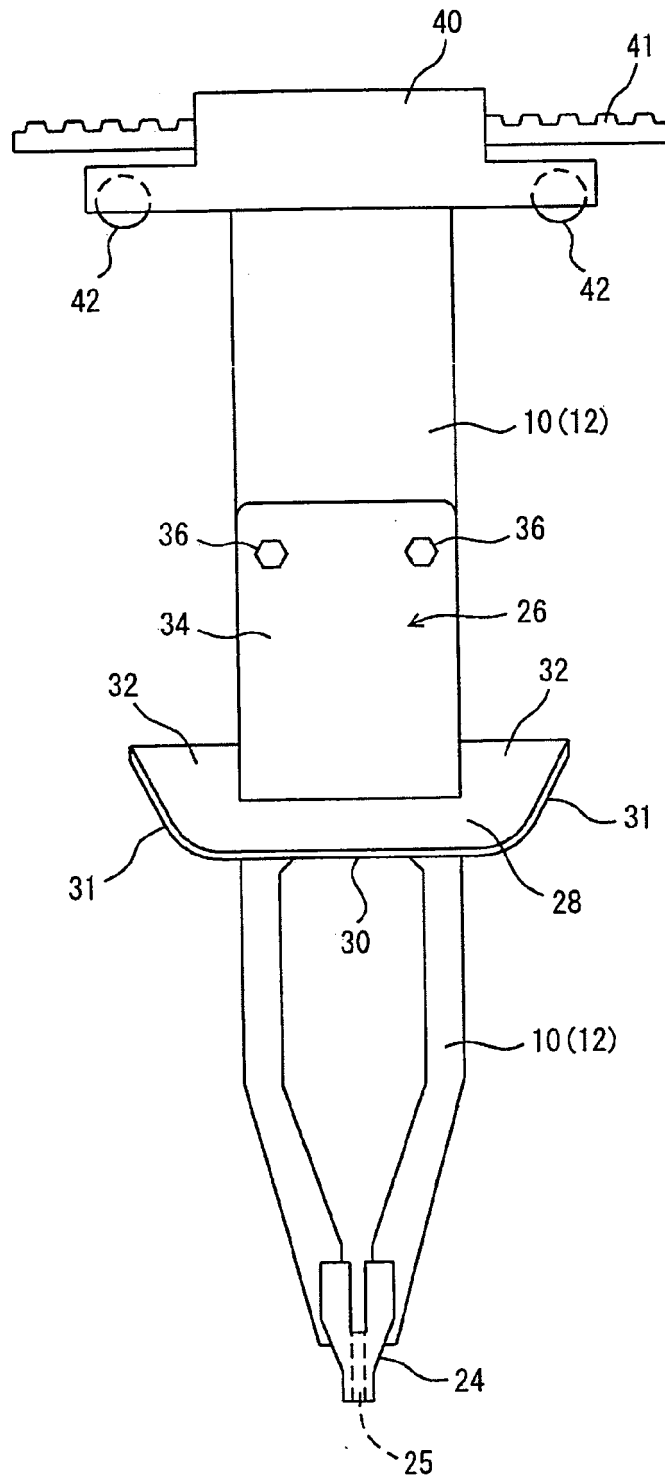


FIG. 9

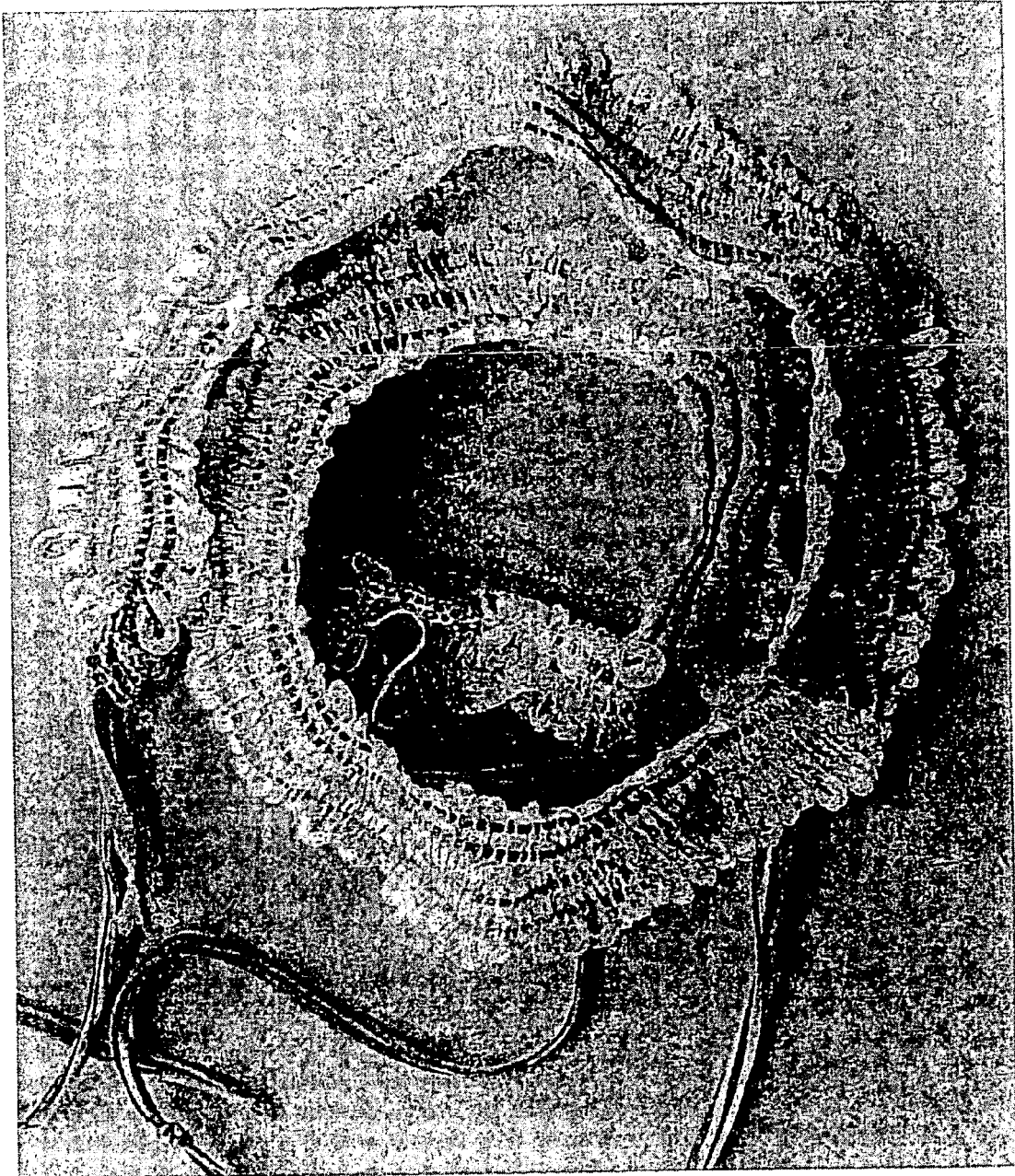


FIG. 10

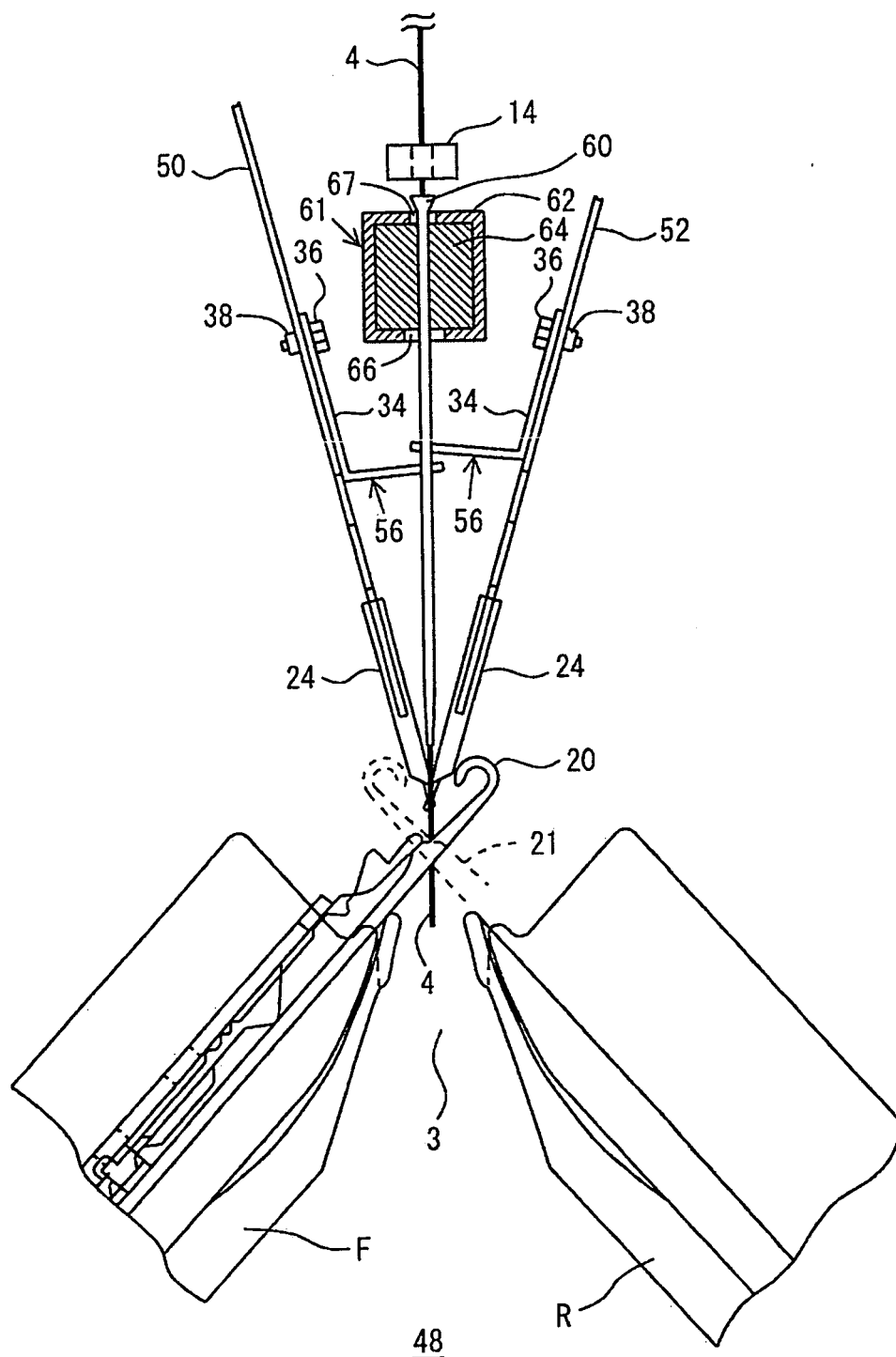


FIG. 11

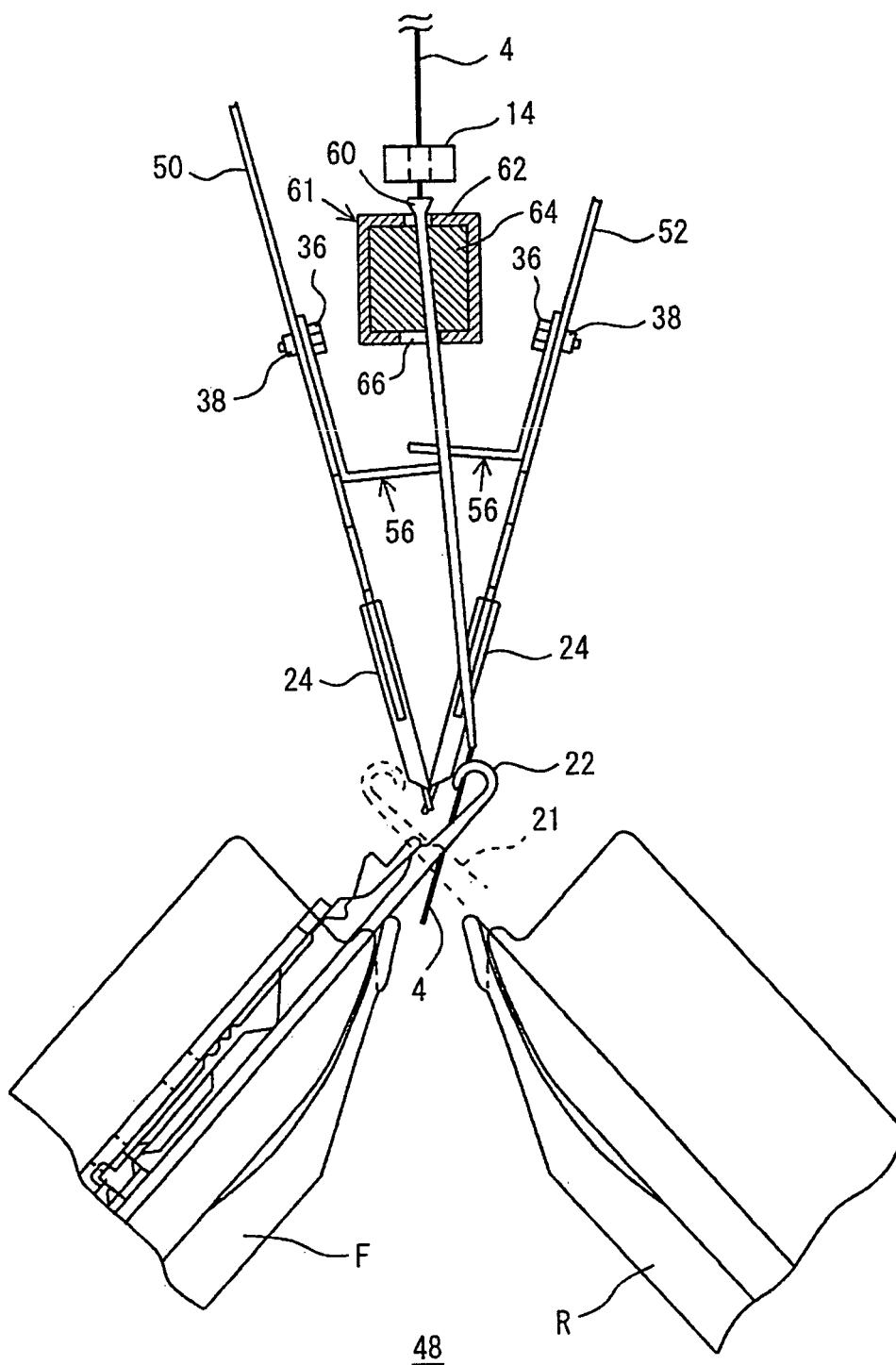


FIG. 12

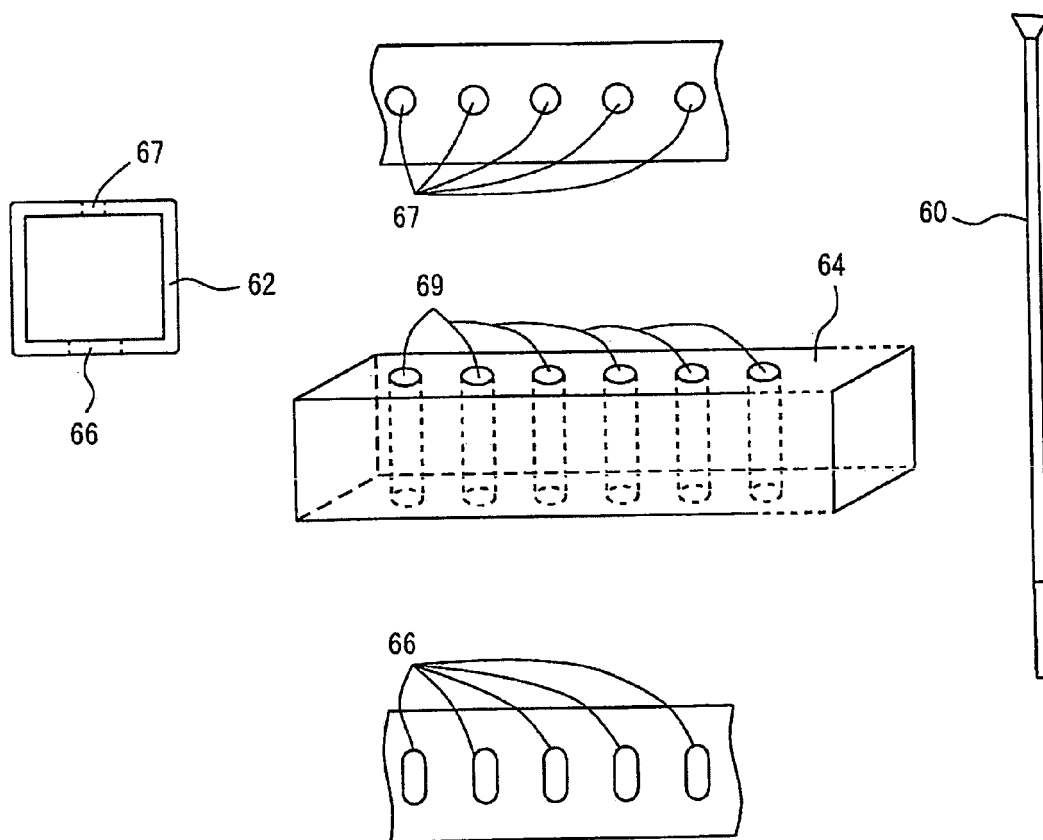


FIG. 13

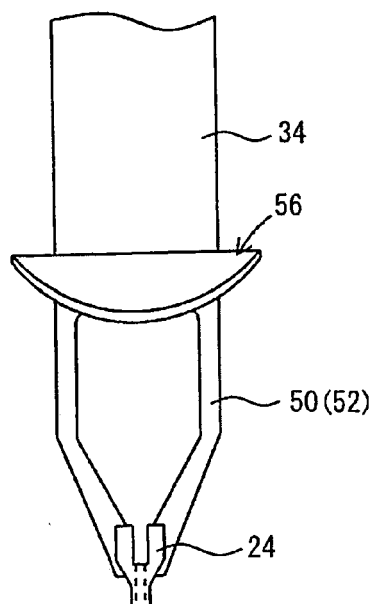
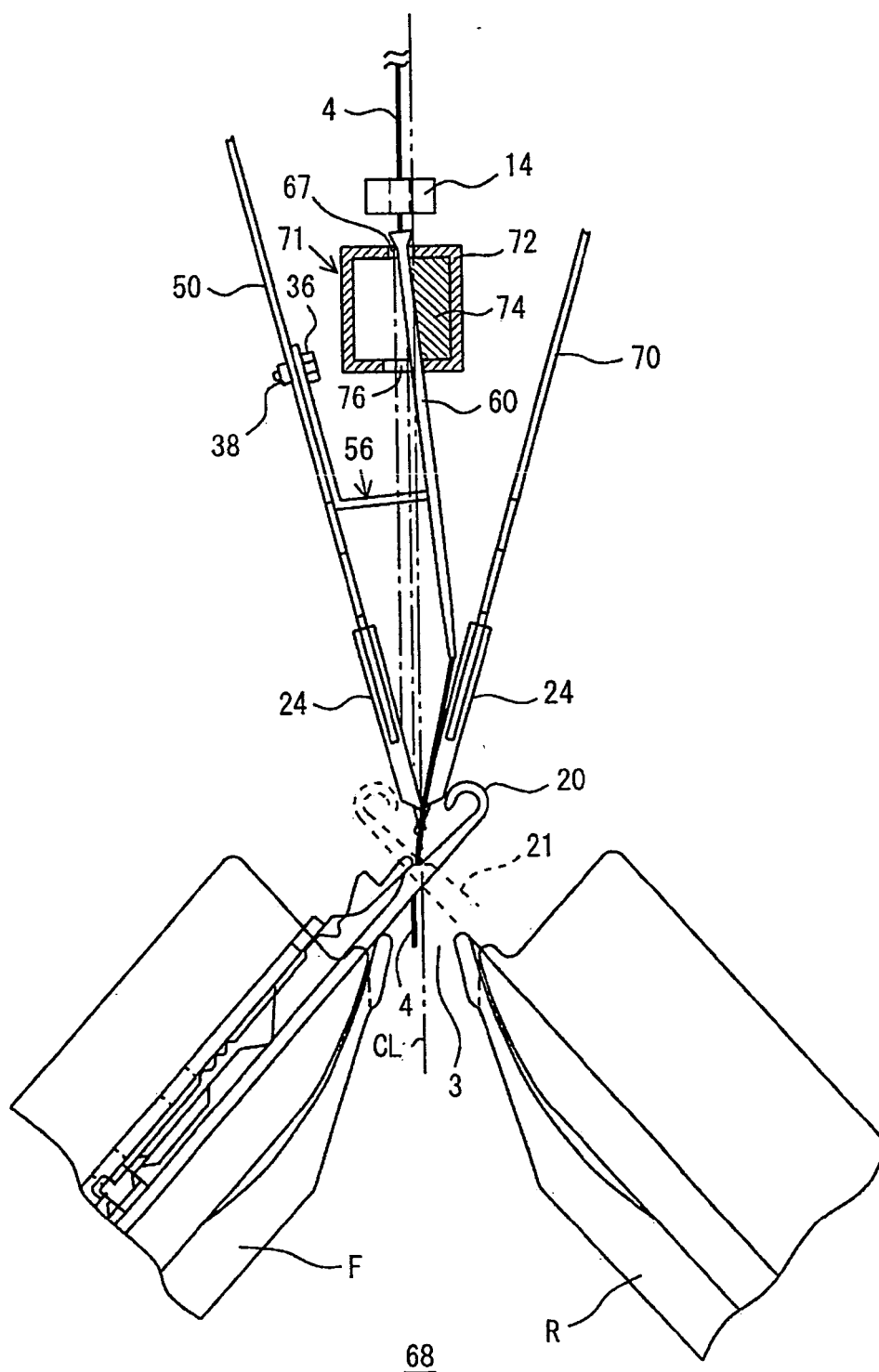


FIG. 14



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REFERENCES CITED IN THE DESCRIPTION

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