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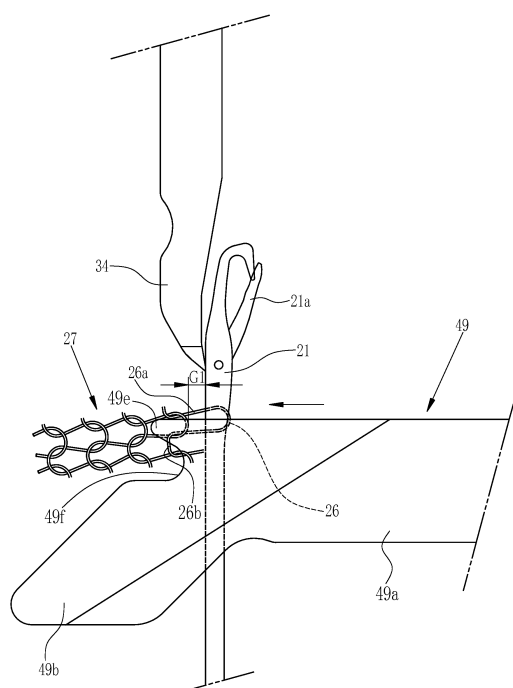
(54) **CIRCULAR KNITTING MACHINE KNITTED FABRIC FEED METHOD AND DEVICE**

(57) Provided are a knitted-fabric transferring method for a circular knitting machine, capable of surely transferring a knitted fabric which is knitted by a circular knitting machine and has a surplus portion such as a toe portion from knitting needles to transferring needles, and a knitted-fabric transferring apparatus.

Transferring needles (34) are advanced in an axial direction of knitting needles (21), such that the transferring needles (34) and the knitting needle (21) are continuous with each other in the axial direction. A transferring sinker (49) is inserted into a space between adjacent knitting needles (21) from outside to inside in a radial direction of a knitting-needle cylinder. Final loops (26) of the knitted fabric (27) caught on the knitting needles (21) are pushed to the inside of a knitting-needle cylinder (19) by engagement claws (49e) of the transferring sinkers (49). A gap (G1) is formed between an internal surface of each of the knitting needles (21) and an inner loop (26a) preceding the final loop (26). The transferring sinkers (49) are moved from the knitting needles (21) to the transferring needles (34) in an axial direction of the knitting needles (21), such that the final loops (26) are transferred from the knitting needles (21) to the transferring needles (34) by the transferring sinkers (49). The gap (G1) enables smooth transferring of the knitted fabric (27) to the transferring needles (34) while preventing the final loops (26) from being engaged by a connecting portion between the transferring needle (34) and the knitting nee-

dle (21).

FIG.26



Description

TECHNICAL FIELD

[0001] The present invention relates to a knitted-fabric transferring method and a knitted-fabric transferring apparatus for a circular knitting machine.

BACKGROUND ART

[0002] In general, a sock is knitted in order of a cuff portion, a leg portion, a heel portion, a foot portion, and a toe portion by a hosiery machine as one kind of a circular knitting machine. Thereafter, an open end of the toe portion is seamed by a sewing machine, and a sock is completed.

[0003] Various types of knitted-fabric transferring apparatuses, in each of which a knitted fabric knitted by a hosiery machine is automatically taken out of a knitting unit of the hosiery machine and set to a sewing machine unit instead of being manually set to a sewing machine and seamed, have been developed (see United States Patent Application Publication No. 2006/0144095 corresponding to Japanese Patent No. 4268136, and Japanese Patent No. 4030853). Such a knitted-fabric transferring apparatus enables automatic knitting, seaming, and transfer of a knitted fabric, and can decrease labor of workers. Thus, it is possible to efficiently produce a circular-knitted product such as a sock.

[0004] In a circular knitting machine disclosed in United States Patent Application Publication No. 2006/0144095, for example, in order to seam an edge of a tubular knitted product such as a stocking, stitches (loops) of the last knitted rank are retained by a removal means and a knitted fabric is removed from a knitting station. Then, the knitted fabric is transferred by a movable carrier to a hook-up station (seaming station), and an open end of the toe portion is hooked up (seamed) by the sewing machine unit.

[0005] Further, in a sock transferring apparatus disclosed in Japanese Patent No. 4030853, when a sock is transferred from knitting needles to transferring needles, a toe portion of the sock is nipped between a lower surface of a knitting-needle guide ring for receiving the knitting needles and upper surfaces of transfer bits, and the sock is transferred from the knitting needles to the transferring needles.

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0006] According to the method and apparatus for seaming the edge of a tubular knitted product disclosed in United States Patent Application Publication No. 2006/0144095, a distal end of each removal member for receiving the knitted fabric from the knitting needles is tapered and provided, on the tapered side, with a notch

(groove). At the time of receiving the knitted fabric from the knitting needles, a tip section of a hook of each of the knitting needles is inserted into the notch, such that each of the removal members and the corresponding knitting needle come face-to-face with each other to be integrated in a line.

[0007] Further, since the tip section of the hook of each of the knitting needles is inserted into the notch of the removal member, slight displacement of the knitting needles or the removal members results in failure of the match and fit of each of the removal members and the corresponding knitting needle, and a step arises between them. In such a case, the final loops of the knitted fabric are engaged by the stepped portion, and thereby the loops are broken or misalignment of the loops occurs. Therefore, it is impossible to stably transfer the loops from the knitting needles to the removal members.

[0008] Although the hooks for moving the stitches on the knitting needles upward so as to remove the stitches from the knitting needles are shown, each of the hooks is inserted between the knitting needles only to move the stitches on the knitting needles upward. However, the hosiery has a surplus portion, such as a heel portion and a toe portion, which extends from part of its circumference. Loosening of the surplus portion results in difference in tension applied to the knitting needles between an instep side and a bottom side having the surplus portion. In particular, it is hard to apply tension to the loops at the bottom side. As a result, the shape of each of the loops at the loosen bottom side becomes different, and it is impossible to stably transfer the loops from the knitting needles to the removal members in some cases. In such a case, it is impossible to surely seam the open end of the toe portion by the sewing machine unit used in the following step, and thereby defective products due to failure in the seaming tend to be produced.

[0009] In a sock transferring apparatus disclosed in Japanese Patent No. 4030853, a knitting-needle guide ring for receiving the knitting needles and transfer bits disposed inside a knitting-needle cylinder are used, the knitted toe portion of the sock is held between upper surfaces of the transfer bits and the lower surface of the knitting-needle guide ring, and the final loops on the knitting needles are moved to the transferring needles. However, the necessity of disposing the transfer bits in the knitting-needle cylinder not only increases the number of the components but also interferes with the knitting of the fabric using the knitting machine in some cases. Additionally, since the respective knitting needles are received by the grooves of the knitting-needle guide ring, the knitting-needle guide ring functions as a guide for connecting the knitting needles to the transferring needles and for transferring the loops from the knitting needles to the transferring needles. Therefore, unlike the invention disclosed in United States Patent Application Publication No. 2006/0144095, the knitting needles or the removal members are not displaced, and connected to each other. However, the knitting-needle guide ring is

necessary, and therefore not only the number of components increases, but also the structure of the apparatus becomes complicated.

[0010] In view of the foregoing problems, an object of the present invention is to provide a knitted-fabric transferring method and a knitted-fabric transferring apparatus for a circular knitting machine, capable of surely transferring a knitted fabric, which is knitted by a circular knitting machine and has a surplus portion extending from part of its circumference, from knitting needles to transferring needles.

Means for Solving the Problems

[0011] To achieve the above and other objects, according to a knitted-fabric transferring method for a circular knitting machine of the present invention, in order to close one end of a knitted fabric knitted by a circular knitting machine, at the time of transferring the knitted fabric from knitting needles of a knitting-needle cylinder of the circular knitting machine to transferring needles, the transferring needles and the knitting needles are advanced relative to each other in an axial direction of the knitting needles such that the transferring needles and the knitting needles are continuous with each other. Next, a transferring sinker is inserted into a space between the adjacent knitting needles of the knitting-needle cylinder from outside to inside in a radial direction of the knitting-needle cylinder, so as to push final loops of the knitted fabric caught on the knitting needles to an inside of the knitting-needle cylinder by an engagement portion of a distal end portion of each of the transferring sinkers. Thereby, a gap is formed between an internal surface of each of the knitting needles and an inner loop preceding each of the final loops. Next, the transferring sinkers are moved from the knitting needles to the transferring needles in the axial direction of the knitting needles, so as to transfer the final loops from the knitting needles to the transferring needles by the transferring sinkers.

[0012] A knitted-fabric transferring apparatus for a circular knitting machine of the present invention is configured to transfer a knitted fabric knitted by a circular knitting machine from knitting needles of a knitting-needle cylinder of a circular knitting machine to transferring needles in order to close one end of the knitted fabric. The knitted-fabric transferring apparatus for a circular knitting machine includes a transferring needle holding cylinder, transferring sinkers, and transferring-sinker vertically-moving mechanism. The transferring needle holding cylinder is disposed above the knitting-needle cylinder so as to be vertically movable along a center line of the knitting-needle cylinder, and has transferring needles arranged at a constant pitch in a circumferential direction thereof. In a state that the transferring needle holding cylinder moves downward, the transferring needles come close to the internal surfaces of the knitting needles, such that the transferring needles and the knitting needles are continuous with each other in the axial di-

rection. Each of the transferring sinkers is disposed in the space between the adjacent knitting needles of the knitting-needle cylinder so as to freely advance or retreat from outside to inside in a radial direction of the knitting-needle cylinder. Each of the transferring sinkers has an engagement portion. The transferring sinkers push final loops of the knitted fabric caught on the knitting needles to an inside of the knitting-needle cylinder by the engagement portions in a state that the transferring sinkers are advanced into the knitting-needle cylinder. Thereby, a gap is formed between an internal surface of each of the knitting needles and an inner loop preceding each of the final loops. The transferring-sinker vertically-moving mechanism moves the transferring sinkers from the knitting needles to the transferring needles in the axial direction of the knitting needles in a state that the transferring needles and the knitting needles are continuous with each other.

[0013] Each of the transferring sinkers includes a transferring sinker main body having the shape of a belt plate, the distal end portion having a tapered portion so as to be formed to have an acute angle, and an engagement portion formed at the tapered portion and engaged by the corresponding final loop. Preferably, each of the distal end portion and the engagement portion is thinner than the transferring sinker main body, and the thickness of the transferring sinker main body is the same as the space between the adjacent knitting needles. In this case, the transferring sinker main body inserted into the space between the adjacent knitting needles can guide the position of the tip end of each of the knitting needles and the transferring needles and transfer the loops at the time of transferring the knitted fabric. Consequently, a guide member such as the knitting-needle guide ring disclosed in Japanese Patent No. 4030853 becomes unnecessary, and it is possible to achieve reduction in the number of components and simplification of the structure. Incidentally, in the case where the thickness of the transferring sinker main body is the same as the space between the adjacent knitting needles, there is room for the transferring sinker main body to enter the space between the adjacent knitting needles and moves in the space. In other words, the thickness of the transferring sinker main body is approximately the same as the space between the adjacent knitting needles.

[0014] The knitting needles and the transferring needles are arranged at a constant pitch in a circumferential direction of the knitted fabric so as to constitute a knitting needle group and a transferring needle group. The transferring needle group is divided in half into a first transferring needle group and a second transferring needle group at an interval of 180 degrees, such that the first transferring needle group is attached to a fixed half dial and the second transferring needle group is attached to a movable half dial. The movable half dial is attached to the fixed half dial through hinge portions so as to be freely inverted with respect to the fixed half dial. It is preferable that the movable half dial is selectively set to an opened

state in which the fixed half dial and the movable half dial lie in the same plane, or a closed state in which a tip end of the second transferring needle group comes close to or is brought into contact with a tip end of the first transferring needle group such that the transferring needles of the first transferring needle group are continuous with the transferring needles of the second transferring needle group.

[0015] The first transferring needle group and the second transferring needle group are positioned such that the tip end of each of the transferring needles of the first transferring needle group and the tip end of each of the transferring needles of the second transferring needle group are deviated from each other in a radial direction of each of the half dials in the closed state. The tip end of each of the transferring needles of one of the first transferring needle group and the second transferring needle group has a housing groove for housing the tip end of each of the transferring needles of the other of them, such that the tip end of each of the transferring needles of one of the first transferring needle group and the second transferring needle group is housed in the housing groove of the tip end of each of the transferring needles of the other of them in the closed state. The transferring needles of the first transferring needle group are preferably continuous with the transferring needles of the second transferring needle group in an axial direction of the transferring needles. In this case, it is possible to surely connect the transferring needles of the first transferring needle group to the transferring needles of the second transferring needle group in the axial direction by the housing groove.

[0016] Before the final loops are transferred from the knitting needles to the transferring needles, each of the transferring sinkers is preferably inserted into the space between the adjacent knitting needles above the final loops of the knitted fabric and moved downward, so as to hold the final loops by a lower surface of the distal end portion of each of the transferring sinkers, in order to align the heights of the final loops before being transferred. In the case of the knitted fabric of the hosiery having a surplus portion such as a heel portion and a toe portion, even if the knitted fabric is sucked through the knitted-fabric drawing-down pipe in order to align the loops of the knitted fabric caught on the knitting needles, it is impossible to sufficiently draw the knitted fabric due to the loosening of the surplus portion, and therefore the loops of the knitted fabric do not align in some cases. In the case where the transferring sinkers are used to align the heights of the final loops in advance, it is possible to avoid disadvantages such as the loops being caught on the hooks of the knitting needles due to the misalignment of the loops. Additionally, it is possible to achieve an effect of surely engaging the final loops of the knitted fabric on the engagement portions of the transferring sinkers.

[0017] Preferably, after the final loops are transferred from the knitting needles to the transferring needles, the knitted fabric is moved to a sewing machine unit so as

to seam the final loops of the knitted fabric, and the fixed half dial is rotated in a circumferential direction thereof in conjunction with vertical movement of a sewing needle of the sewing machine unit. In this case, it is unnecessary to move the sewing machine unit along the final loops, and therefore the structure becomes simple. Further, it is preferable that each of the transferring needles of the fixed half dial has a sewing needle guide groove extending in the axial direction, and guides the sewing needle by the sewing needle guide groove in the vertical movement of the sewing needle. In this case, the sewing needle is surely guided to each of the final loops, and seaming is surely performed.

15 Effect of the Invention

[0018] According to the present invention, it is possible to surely transfer the knitted fabric, which is knitted by the circular knitting machine and has the surplus portion, from the knitting needles to the transferring needles. Additionally, it is possible to smoothly transfer the loops of the knitted fabric while preventing the loops of the knitted fabric from being caught on the hooks of the knitting needles or the like.

BRIEF DESCRIPTION OF DRAWINGS

[0019]

Fig. 1 is a perspective view of a circular knitting machine system of the present invention.

Fig. 2 is a plan view of the circular knitting machine system.

Fig. 3 is a vertical longitudinal sectional view showing a state that knitting with use of a circular knitting machine is completed.

Fig. 4 is a perspective view illustrating arrangement of transferring needles, transferring sinkers, knitting needles, and the like.

Fig. 5 is a perspective view of a knitted-fabric transferring apparatus as a whole.

Fig. 6 is a vertical longitudinal sectional view showing a state that the knitted-fabric transferring apparatus is positioned at a knitting position.

Fig. 7 is a perspective view of an exploded knitted-fabric transferring apparatus main body.

Fig. 8 is a perspective view of an exploded transferring needle unit.

Fig. 9 is a perspective view of the transferring needle unit in an opened state.

Fig. 10 is a perspective view of the transferring needle unit in a closed state.

Fig. 11 is a perspective view of an exploded transferring-sinker advancing/retreating mechanism.

Fig. 12 is a perspective view showing a transferring sinker as one example.

Fig. 13A is a perspective view of the transferring-sinker advancing/retreating mechanism in which

each of the transferring sinkers is in a retreated state. Fig. 13B is a perspective view of the transferring-sinker advancing/retreating mechanism in which each of the transferring sinkers is in an advanced state.

Fig. 14 is a perspective view illustrating a positional relationship among the knitting needles, the transferring needles, and the transferring sinkers.

Fig. 15 is a plan view illustrating a state that an upper mechanism of the circular knitting machine is opened and retreated above.

Fig. 16 is a vertical longitudinal sectional view showing a state that a knitted-fabric drawing-down pipe is moved upward after the upper mechanism of the circular knitting machine is retreated above.

Fig. 17 is a perspective view of the circular knitting machine system as a whole in a state that the knitted-fabric transferring apparatus main body is positioned at the knitting position.

Fig. 18 is a plan view of the circular knitting machine system as a whole in a state that the knitted-fabric transferring apparatus main body is positioned at the knitting position.

Fig. 19 is a vertical longitudinal sectional view showing a state that the transferring sinkers are located at the advanced position so as to align final loops of the knitted fabric.

Fig. 20 is a vertical longitudinal sectional view showing a state that the transferring sinkers are moved downward and the final loops of the knitted fabric are aligned.

Fig. 21 is a vertical longitudinal sectional view showing a state that the transferring needles are moved downward so as to be continuous with the knitting needles on a one-to-one basis in an axial direction thereof.

Fig. 22 is a side elevational view illustrating the transferring needle of a fixed half dial which is continuous with the knitting needle, and the transferring needle of a movable half dial which is continuous with the knitting needle, for comparison.

Fig. 23 is a vertical longitudinal sectional view showing a state that the transferring sinkers are located at the advanced position so as to transfer the knitted fabric from the knitting needles to the transferring needles, and push the final loops of the knitted fabric.

Fig. 24 is a transverse sectional view showing a state that the final loops of the knitted fabric are caught on the knitting needles.

Fig. 25 is a transverse sectional view showing a state that the final loops of the knitted fabric are pushed inward by the transferring sinkers.

Fig. 26 is a side elevational view showing the state that the final loops of the knitted fabric are pushed inward by the transferring sinkers.

Fig. 27 is a vertical longitudinal sectional view showing a state that the transferring sinkers are moved upward in order to transfer the knitted fabric from the

knitting needles to the transferring needles.

Fig. 28 is a vertical longitudinal sectional view showing a state that the knitted-fabric transferring apparatus main body and the knitted-fabric drawing-down pipe are moved upward.

Fig. 29 is a vertical longitudinal sectional view showing a state that a moving arm is rotated in order to pull out the knitted fabric from the knitted-fabric drawing-down pipe.

Fig. 30 is a vertical longitudinal sectional view showing a state that a turning pipe is moved downward in order to suck a lower end of the knitted fabric into the turning pipe.

Fig. 31 is a vertical longitudinal sectional view showing a state that the turning pipe is moved upward in order to turn the knitted fabric inside out.

Fig. 32 is a vertical longitudinal sectional view showing a state that an upper part of the turning pipe which turns the knitted fabric inside out is clamped by a clamping mechanism.

Fig. 33 is a vertical longitudinal sectional view showing a state that the knitted-fabric transferring apparatus main body is moved downward and the movable half dial is inverted by a movable-half-dial inversion driving section.

Fig. 34 is a vertical longitudinal sectional view showing a state that each of the transferring sinkers is moved downward and inserted into a space between the transferring needles in the movable half dial.

Fig. 35 is a vertical longitudinal sectional view showing a state that the transferring sinkers are moved upward in order to move the loops on the transferring needles of the movable half dial to the corresponding transferring needles of the fixed half dial.

Fig. 36 is a vertical longitudinal sectional view showing a state that the transferring sinkers are retreated above and the movable half dial returns to a default position.

Fig. 37 is a vertical longitudinal sectional view showing a state that the turning-pipe holder and the lower knitted-fabric holding member are moved upward such that the knitted fabric held by the fixed half dial is held against a half ring.

Fig. 38 is a vertical longitudinal sectional view showing a state that a sewing machine unit is set to a seaming position so as to seam the knitted fabric.

Fig. 39 is a perspective view of the transferring needle having a sewing needle guide groove formed on its outer end surface along an axial direction thereof.

Fig. 40 is a vertical longitudinal sectional view showing a state that the half ring is moved downward and the transferring needle unit is retreated above such that the knitted fabric seamed by a sewing machine is removed from the transferring needles.

Fig. 41 is a vertical longitudinal sectional view showing a state that a cutter is activated so as to cut sewing yarn after completion of the seaming.

Fig. 42 is a vertical longitudinal sectional view show-

ing a state that a turning rod is moved upward in order to turn the knitted fabric right side out and transfer the knitted fabric to a discharge unit.

Fig. 43 is a vertical longitudinal sectional view showing a state that the turning pipe is moved down after the knitted fabric which is turned inside out is discharged.

Fig. 44 is a vertical longitudinal sectional view showing a state that the knitted-fabric transferring apparatus main body returns to a default position.

Fig. 45 is a flowchart showing each process of a knitted-fabric transferring method.

DESCRIPTION OF THE INVENTION

[0020] As shown in Figs. 1 and 2, a circular knitting machine system 10 of the present invention includes a circular knitting machine 11, a knitted-fabric open-end seaming apparatus 12, and a knitted-fabric transferring apparatus 13. As shown in Fig. 3, the circular knitting machine 11 includes a crossbar 14, a yarn cutting section 15, a latch ring 16, a yarn guide section 17, a sinker bed 18, a knitting needle cylinder 19, a knitted-fabric drawing-down pipe 20, a yarn feeder (not shown in the drawing), and the like.

[0021] As shown in Fig. 4, at an upper end of the knitting needle cylinder 19, a lot of knitting needles 21 are arranged at a constant pitch in a circumferential direction of the knitting needle cylinder 19. The sinker bed 18 includes sinkers 25. Each of the sinkers 25 is capable of freely advancing and retreating in a radial direction of the knitting needle cylinder 19 in a space between the knitting needles 21 by cam driving. These components operate in conjunction with one another, and as well known, yarn is sequentially formed into loops in accordance with the knitting needles 21. Thereby, as shown in Fig. 3, the yarn is knitted into a tubular knitted fabric 27 as a sock in order of a cuff portion 27a, a leg portion 27b, a heel portion 27c, a foot portion 27d, and a toe portion 27e.

[0022] As shown in Fig. 1, a knitted-fabric open-end seaming apparatus 12 is provided at the side of the circular knitting machine 11. The knitted-fabric open-end seaming apparatus 12 includes a sewing machine unit 100, a knitted-fabric turning inside out unit 101, and a discharge unit 102. These units 100 to 102 operate in conjunction with one another, such that an edge of the open end of the knitted fabric 27 (see Fig. 3) is seamed. Thereafter, the knitted fabric 27 can be discharged into a product receiving box (not shown in the drawing) or the like.

[0023] As shown in Fig. 5, the knitted-fabric transferring apparatus 13 includes a knitted-fabric transferring apparatus main body 30, and a movement mechanism 31 for moving the knitted-fabric transferring apparatus main body 30. The movement mechanism 31 includes a vertically-moving rotary shaft 32 and a moving arm 33. The vertically-moving rotary shaft 32 is supported by a guide tube 36 so as to be movable in a vertical direction

and rotatable about a vertical axis. The moving arm 33 is fixed to an upper portion of the vertically-moving rotary shaft 32. The knitted-fabric transferring apparatus main body 30 is attached to a distal end of the moving arm 33.

5 The oscillation air cylinder 37 is mounted between the moving arm 33 and the guide tube 36. The oscillation air cylinder 37 makes the moving arm 33 rotate 90 degrees, for example, in a horizontal plane about the vertically-moving rotary shaft 32. Upon the rotation of the moving arm 33, the knitted-fabric transferring apparatus main body 30 is moved to an area above the knitting needle cylinder 19 of the circular knitting machine 11 (hereinafter referred to as knitting stage) as shown in Fig. 17, and moved to an area above a turning pipe 110 of the knitted-fabric open-end seaming apparatus 12 (hereinafter referred to as seaming stage) as shown in Fig. 1.

[0024] As shown in Fig. 5, an arm-vertically-moving first air cylinder 32a, an arm-vertically-moving second air cylinder 32b, and an arm-vertically-moving third air cylinder 32c are connected in series in this order from the bottom up at a lower end of the vertically-moving rotary shaft 32. Upon one of or two or more of these air cylinders 32a to 32c being selectively driven, the vertically-moving rotary shaft 32 moves in the vertical direction, and the moving arm 33 is set to a position at the height necessary for a series of processes.

[0025] As shown in Fig. 6, the knitted-fabric transferring apparatus main body 30 includes a transferring needle unit 40 and a transferring sinker unit 41. The transferring needle unit 40 includes a fixed half dial 43 and a movable half dial 44 each of which holds the transferring needles 34, and a transferring needle holding cylinder 45 which holds the fixed half dial 43 and the movable half dial 44. The transferring needle unit 40 is moved in the vertical direction above the knitting needle cylinder 19 by the moving arm 33 (see Fig. 5), such that the knitted fabric 27 held by the knitting needles 21 is transferred from the knitting needles 21 to the transferring needles 34 of the fixed half dial 43 and the movable half dial 44.

[0026] The transferring needle holding cylinder 45 is attached to a transferring apparatus base 51 through a bearing 50 in a rotatable manner. As shown in Fig. 5, one end of the moving arm 33 is fixed to the transferring apparatus base 51. As shown in Fig. 6, the transferring needle holding cylinder 45 is horizontally divided into an upper holding cylinder 45a and a lower holding cylinder 45b, and a transferring needle rotary gear 52 is fixed between the upper holding cylinder 45a and the lower holding cylinder 45b. As shown in Fig. 7, the transferring needle rotary gear 52 is coordinated with a drive gear 53b of a motor 53. Upon rotation of the motor 53, the transferring needle rotary gear 52 is rotated, such that each of the half dials 43 and 44 is rotated through the transferring needle holding cylinder 45. The motor 53, the transferring needle rotary gear 52, the transferring needle holding cylinder 45, and the like constitute a rotation mechanism 106. As shown in Fig. 40, at the time of seaming the final loops 26 (see Fig. 24) of the knitted fabric 27 by the sew-

ing machine unit 100, the rotation mechanism 106 makes the fixed half dial 43 rotate intermittently in conjunction with vertical movement of a sewing needle 107, such that the sewing needle 107 is surely inserted into each of the final loops 26. Thereby, sewing yarn 108 is passed through each of the final loops 26, and seaming (also referred to as linking or looping) can be performed on a single stitch basis. Incidentally, looper needles operating in cooperation with the sewing needle 107 are not shown in the drawing in this embodiment. Further, the number of skeins of sewing yarn 108 is not limited to one, and two or more skeins of sewing yarn 108 may be used.

[0027] As shown in Fig. 8, the fixed half dial 43 has transferring needle holding grooves 43b formed on an outer circumferential surface of the half dial main body 43a, and the transferring needles 34 are set in the transferring needle holding grooves 43b and held from above by a holder 43c. The movable half dial 44 has the same structure as that of the fixed half dial 43, and has a half dial main body 44a, transferring needle holding grooves 44b for holding transferring needles 34, and a holder 44c. Thereby, a first transferring needle group is attached to the fixed half dial 43, and a second transferring needle group is attached to the movable half dial 44. The movable half dial 44 is attached to the fixed half dial 43 such that the movable half dial 44 can rotate or invert 180 degrees with respect to the fixed half dial 43 through hinge portions 46. The holder 43c of the fixed half dial 43 is fixed to the transferring needle holding cylinder 45.

[0028] As shown in Fig. 9, normally, the transferring needles 34 of the fixed half dial 43 and the transferring needles 34 of the movable half dial 44 are alternately arranged in a circumferential direction of the dials 43 and 44, i.e., they are in an opened state. In this state, the knitted fabric 27 is transferred from the knitting needles 21 to the transferring needles 34 as shown in Figs. 19 to 21 and 23 to 25. As shown in Fig. 10, when the movable half dial 44 is inverted and joined to the fixed half dial 43, each of the half dials 43 and 44 comes into a closed state. In this closed state, as shown in Fig. 33, a tip end of each of the transferring needles 34 of the fixed half dial 43 comes into contact with and is connected to a tip end of each of the transferring needles 34 of the movable half dial 44. Accordingly, the final loops 26 corresponding to one half of the open end of the knitted fabric 27 held by the transferring needles 34 of the movable half dial 44 and the final loops 26 corresponding to the other half of the open end of the knitted fabric 27 held by the transferring needles 34 of the fixed half dial 43 are respectively joined together. Thereby, the knitted fabric 27, in which the final loops 26 held by the transferring needles 34 of the movable half dial 44 and the final loops 26 held by the transferring needles 34 of the fixed half dial 43 are respectively joined together as described above, is transferred to the transferring needles 34 of the fixed half dial 43 (see Fig. 35), and thereafter the seaming is performed by the sewing machine unit 100, as shown in Fig. 38.

[0029] According to this embodiment, for the purpose

of surely connecting the transferring needles 34 in the closed state, a radius of the movable half dial 44 for arranging the transferring needles 34 is slightly larger than a radius of the fixed half dial 43 for arranging the transferring needles 34. Therefore, as shown by Z1 corresponding to the transferring needles 34 displayed in an enlarged manner in Fig. 10, when the movable half dial 44 is closed, the transferring needles 34 of the fixed half dial 43 are in a shifted state with respect to the transferring needles 34 of the movable half dial 44 in a radial direction of the fixed half dial 43. In the shifted state, the tip end of each of the transferring needles 34 of the movable half dial 44 has a tip-end housing groove 34a corresponding to a position at which the tip end of each of the transferring needles 34 of the fixed half dial 43 is located. The tip end of each of the transferring needles 34 of the fixed half dial 43 is inserted into the corresponding tip-end housing groove 34a. Since the transferring needles 34 of the fixed half dial 43 are arranged so as to be slightly shifted from the transferring needles 34 of the movable half dial 44 in the radial direction of the half dials 43 and 44 when the movable half dial 44 is inverted as described above, it is possible to connect the transferring needles 34 of the fixed half dial 43 to the transferring needles 34 of the movable half dial 44 more surely in comparison with the case where the tip ends of the transferring needles 34 of the fixed half dial 43 come face-to-face with the tip ends of the transferring needles 34 of the movable half dial 44 so as to be continuous with them.

[0030] As shown in Fig. 8, the transferring needle holding cylinder 45 has insertion holes 45c each extending in the vertical direction, and a lock shaft 56 is disposed so as to be movable in the vertical direction through each of the insertion holes 45c. A lower end of each of the lock shafts 56 enters a locking groove 44d of the movable half dial 44, so as to regulate inversion of the movable half dial 44. A lock ring 57 is fixed to an upper end of the lock shafts 56.

[0031] As shown in Fig. 7, a lock cover 55 for the movable half dial 44 is attached to the transferring needle holding cylinder 45 so as to cover the transferring needle rotary gear 52. The lock cover 55 has lock cylinders 55a and stoppers 55b. The lock ring 57 is moved in the vertical direction by the lock cylinders 55a. When the lock ring 57 is moved downward, the lower end of each of the lock shafts 56 enters the locking groove 44d (see Fig. 8), so as to regulate inversion of the movable half dial 44. The lock cylinders 55a lift up the lock ring 57 until the lock ring 57 comes in contact with the stoppers 55b, and stop. Thereby, the lower end of each of the lock shafts 56 is released from the locking groove 44d, and regulation of inversion of the movable half dial 44 is canceled.

[0032] A half-ring vertically-moving cylinder 58 is attached to an upper end of the transferring needle holding cylinder 45 so as to be movable in the vertical direction. A half ring 60 is fixed to the half-ring vertically-moving cylinder 58 through the vertically-moving shafts 59. Each of the vertically-moving shafts 59 is horizontally divided,

and attached to the transferring needle holding cylinder 45 so as to be movable in the vertical direction. As shown in Fig. 6, the half-ring vertically-moving cylinder 58 consists of an inner cylinder 58a and an outer cylinder 58b, and the inner cylinder 58a and the outer cylinder 58b are configured to be rotatable about a central axis of the vertically-moving cylinder 58. As shown in Fig. 7, a cylinder attachment board 61 is attached to the lock cover 55 through stays 61a above the outer cylinder 58b. A half-ring lowering first air cylinder 62a and a half-ring lowering second air cylinder 62b are attached between the cylinder attachment board 61 and the outer cylinder 58b. The half-ring lowering first air cylinder 62a or the half-ring lowering second air cylinder 62b is selectively driven, and thereby the half ring 60 is moved downward from a first position at which the half ring 60 is retreated upward (see Figs. 36 to 38) to a second position at which the knitted fabric 27 seamed by the sewing machine unit 100 is removed from the transferring needles (see Fig. 40) or a third position at which the sewing yarn 108 is cut after the knitted fabric 27 is seamed (see Fig. 41). Upon downward movement of the half ring 60, the sewing yarn 108 is cut away from the seamed knitted fabric 27.

[0033] The transferring needle rotary gear 52, the motor 53, the half ring 60 for holding the open end of the knitted fabric 27 at the time of seaming the knitted fabric 27, a vertically-moving mechanism 68 of the half ring 60, and an inversion locking mechanism 69 of the movable half dial 44 operate in conjunction with one another. Thus, one half of the open end of the knitted fabric 27 is overlapped with the other half of the open end of the knitted fabric 27 at the seaming stage in the knitted-fabric open-end seaming apparatus 12 as described later, and then the knitted fabric 27 is seamed with use of the sewing yarn 108 and the sewing yarn 108 is cut away from the knitted fabric 27.

[0034] As shown in Fig. 7, the transferring sinker unit 41 includes a transferring-sinker advancing/retreating mechanism 70 and a transferring-sinker vertically-moving mechanism 71 for moving the transferring-sinker advancing/retreating mechanism 70 upward and downward in the vertical direction. As shown in Fig. 11, the transferring-sinker advancing/retreating mechanism 70 includes a bed 72, a base 73, transferring sinkers 49, a sinker belt 75, a cam holding ring 76, a cam 77, a cap 78, a rotary ring 79, set screws 74, and a transferring-sinker advancing/retreating air cylinder 80 in this order from the bottom up. The bed 72 is attached to the base 73 having the shape of a ring.

[0035] The number of the transferring sinkers 49 is equal to the number of the knitting needles 21. The transferring sinkers 49 are inserted into radial grooves 72a of the bed 72, and radially arranged in a radial direction of the bed 72, so as to be held in a movable manner. As shown in Fig. 12, each of the transferring sinkers 49 includes a transferring sinker main body 49a having the shape of a belt plate, a distal end portion 49b formed at an inner end of the transferring sinker main body 49a,

and a projection 49c that projects upward from an outer end of the transferring sinker main body 49a. The distal end portion 49b has a tapered portion 49d and is formed to have an acute angle. An engagement claw 49e is formed at an upper portion of the tapered portion 49d, and protrudes toward the distal end of the transferring sinker main body 49a. An engagement portion 49f is formed between the tapered portion 49d and the engagement claw 49e. Each of the distal end portion 49b, the tapered portion 49d, and the engagement claw 49e is made thinner than the transferring sinker main body 49a. Further, the thickness of the transferring sinker main body 49a is the same as that of a space between the adjacent knitting needles 21. Incidentally, in the case where the thickness of the transferring sinker main body 49a is the same as the space between the adjacent knitting needles 21, there is room for the transferring sinker main body 49a to enter the space between the adjacent knitting needles 21 and moves in the space. In other words, the thickness of the transferring sinker main body 49a is approximately the same as the space between the adjacent knitting needles 21, and the thickness of the transferring sinker main body 49a is not quite the same as the space between the adjacent knitting needles 21 in a state that the transferring sinker main body 49a cannot advance or retreat in the space between the adjacent knitting needles 21. A belt groove 49g is formed on an outer end surface of each of the transferring sinkers 49. As shown in Fig. 11, the sinker belt 75 made of rubber or coil spring is inserted into each of the belt grooves 49g. The sinker belt 75 biases the transferring sinkers 49 to the inside.

[0036] The cam 77 consists of cam bodies 77a divided in a circumferential direction thereof, and the cam bodies 77a are connected to each other with use of set screws 74 to have a ring shape as a whole. Each of the cam bodies 77a is nipped between the cam holding ring 76 and the cap 78, so as to be movable in a radial direction of the cap 78. The cap 78 has guide grooves 78a for guiding the cam bodies 77a in an approximately radial direction. The number of the guide grooves 78a is twice as that of the cam bodies 77a. The rotary ring 79 has cam grooves 79a arranged in a direction intersecting with the radial direction.

[0037] Each of the set screws 74 penetrates through the cam groove 79a and the guide groove 78a, and screwed to the corresponding cam body 77a. The rotary ring 79 is held by the cap 78 in a rotatable manner. The rotary ring 79 has a projected portion 79b that projects toward outside. The base 73 is provided with a bracket portion 73b. The bracket portion 73b extends from the base 73 and is used for the attachment of a proximal end of the transferring-sinker advancing/retreating air cylinder 80. The transferring-sinker advancing/retreating air cylinder 80 is attached to the projected portion 79b and the bracket portion 73b.

[0038] Since the transferring sinkers 49 are biased by the sinker belt 75 toward the inside, the projection 49c

of each of the transferring sinkers 49 is brought into contact with an outer circumferential surface of the cam 77. A rod 80a of the transferring-sinker advancing/retreating air cylinder 80 moves in and out, such that the rotary ring 79 rotates at a predetermined angle.

[0039] As shown in Fig. 13A, in a state that the rod 80a of the transferring-sinker advancing/retreating air cylinder 80 protrudes, each of the set screws 74 is located at an outer end of the cam groove 79a. Thereby, a diameter of the cam 77 (see Fig. 11) becomes large, and each of the transferring sinkers 49 is retreated, namely, comes into a retreated state.

[0040] In contrast, as shown in Fig. 13B, in a state that the rod 80a of the transferring-sinker advancing/retreating air cylinder 80 is retracted, each of the set screws 74 is located at an inner end of the cam groove 79a. Thereby, the diameter of the cam 77 becomes small, and each of the transferring sinkers 49 is advanced by being biased toward the inside by the sinker belt 75 and comes into an advanced state.

[0041] As shown in Fig. 14, when each of the transferring sinkers 49 is in the advanced state, each of the transferring sinkers 49 is inserted into the space between the adjacent knitting needles 21 from outside to inside in the knitting needle cylinder 19 in the radial direction. A top portion of the distal end portion 49b on each side surface is obliquely cut, such that the distal end portion 49b gradually becomes thinner toward the distal end thereof in comparison with the transferring sinker main body 49a. Therefore, it is possible to surely insert each of the transferring sinkers 49 into the space between the adjacent knitting needles 21. Further, after each of the transferring sinkers 49 is inserted into the space between the adjacent knitting needles 21, the transferring sinker main body 49a is located at the space between the adjacent knitting needles 21, it is possible to guide the knitting needles 21 in the circumferential direction. Incidentally, the distal end portion 49b including the engagement claw 49e may not be necessarily formed to be gradually thinner. Instead, the distal end portion 49b including the engagement claw 49e may have a constant thickness thinner than the transferring sinker main body 49a.

[0042] As shown in Fig. 7, the transferring-sinker vertically-moving mechanism 71 includes transferring-sinker vertically-moving air cylinders 71a, a transferring-sinker-lowering first air cylinder 71b, a transferring-sinker-lowering second air cylinder 71c, a transferring-sinker elevating/transferring air cylinder 71d, and a cylinder attachment board 71e. Each of the transferring-sinker vertically-moving air cylinders 71a is mounted between the transferring apparatus base 51 and the base 73 of the transferring-sinker advancing/retreating mechanism 70, so as to adjust the distance between the bases 51 and 73. An operating point of each of the transferring-sinker-lowering first air cylinder 71b, the transferring-sinker-lowering second air cylinder 71c, and the transferring-sinker elevating/transferring air cylinder 71d, which are fixed to the transferring apparatus base 51, is provided to the

cylinder attachment board 71e. The air cylinders 71a to 71d are selectively driven, and thereby the transferring-sinker advancing/retreating mechanism 70 can be lowered to the first position (see Fig. 6), the second position (see Fig. 27), the third position (see Fig. 19), and a fourth position (see Fig. 20). The position of the transferring-sinker advancing/retreating mechanism 70 is the highest when the transferring-sinker advancing/retreating mechanism 70 is located at the first position. The height becomes lower from the first position to fourth position in this order. It is possible to move each of the transferring sinkers 49 in the vertical direction within a predetermined range by switching the position of the transferring-sinker advancing/retreating mechanism 70 among the first, second, third, and fourth positions.

[0043] The transferring-sinker advancing/retreating mechanism 70 and the transferring-sinker vertically-moving mechanism 71 are used such that the components operate in conjunction with one another, and thereby the knitted fabric 27 on the knitting needle cylinder 19 can be transferred to the transferring needles 34. Further, after the knitted fabric 27 is transferred to the transferring needles 34, the movable half dial 44 is inverted in the knitted-fabric open-end seaming apparatus 12, so that the final loops 26 of one half of the open end and the final loops 26 of the other half of the open end to be seamed are overlapped with each other, and the overlapped final loops 26 are seamed by the sewing machine unit 100. Thus, a sock is completed.

[0044] As shown in Fig. 40, the sewing machine unit 100 includes a sewing machine main body 103, a movement mechanism 104 for setting the sewing machine main body 103 to the open end of the toe portion, a toe-open-end holding mechanism 105 for nipping and holding the open end of the toe portion in the vertical direction, and a rotation mechanism 106 for rotating the open end of the toe portion.

[0045] As shown in Fig. 31, the knitted-fabric turning inside out unit 101 includes the turning pipe 110, a lower pipe vertically-moving mechanism 111 into which a lower end of the turning pipe 110 is inserted and which moves in the vertical direction, a turning-pipe clamping mechanism 112, a turning rod 113 (see Figs. 42 and 43), and a turning-rod vertically-moving mechanism (not shown in the drawing).

[0046] The structure and operation of each component are described hereinbelow by referring to an operation procedure of the circular knitting machine system 10. Fig. 3 illustrates a longitudinal section of the knitting stage just after the completion of the circular knitting. Note that, in each of the longitudinal sections hereinbelow, only the cross section (end surface) is illustrated in order to avoid complication of the drawings, and members located behind are omitted (not shown in the drawings). In the knitted fabric 27 just after the completion of the circular knitting, from which the yarn is cut away by the yarn cutting section 15, each of the final loops 26 is caught on the knitting needle 21 (see Fig. 24) and housed in the knitted-

fabric drawing-down pipe 20. An upper mechanism containing the yarn cutting section 15, the latch ring 16, and the yarn guide section 17 is attached to the crossbar 14. The crossbar 14 oscillates in the vertical direction by a not-shown air cylinder. Due to the oscillation, as shown in Figs. 2 and 3, the upper mechanism is displaced between a knitting position in which the latch ring 16 and the like face the knitting needle cylinder 19 of the circular knitting machine 11 and a retreated position in which the latch ring 16 and the like are retreated upward from the knitting position as shown in Figs. 15 and 16.

[0047] In a state shown in Fig. 3, the knitted-fabric drawing-down pipe 20 is connect to a suction blower through a not-shown valve, and the knitted fabric 27 is sucked downward in the knitted-fabric drawing-down pipe 20. The knitted-fabric drawing-down pipe 20 is configured to move in the vertical direction by a plurality of air cylinders at three stages including an upper stage, a middle stage, and a lower stage, although not shown in the drawings. Upon upward rotation of the crossbar 14, the yarn cutting section 15, the latch ring 16, and the yarn guide section 17 are moved to the retreated position (see Fig. 16).

[0048] As shown in Fig. 16, a sinker cam 18a and a rubber sinker cam (not shown in the drawing) on the sinker bed 18 come into the operation state, each of the sinkers 25 moves toward the outside between the adjacent knitting needles 21 in the radial direction of the knitting needle cylinder 19, and an engagement claw of each of the sinkers 25 moves away from the knitting needle 21. Thereby, the engagement of the knitted fabric 27 by the engagement claw is canceled. Next, the knitting needles 21 move upward to a level at which knitting is not performed, and the knitting needles 21 protrude upward from the knitting needle cylinder 19 at the maximum level. Further, the knitted-fabric drawing-down pipe 20 is moved upward and set to the upper stage. Thereby, the final loops 26 of the knitted fabric 27 are moved to the vicinity of latch needles 21a of the knitting needles 21 (see Fig. 26). Next, the knitting needle cylinder 19 is rotated, such that the knitting needles 21 and the transferring needles 34 have a positional relationship corresponding to each other, and then the rotation of the knitting needle cylinder 19 is stopped. Thereby, the knitting needle cylinder 19 is locked by a not-shown locking device so as not to be unnecessarily rotated. Thereafter, the transferring-sinker-lowering first air cylinder 71b and the transferring-sinker-lowering second air cylinder 71c shown in Fig. 7 extend, and a stopper for determining a position to which the transferring sinkers 49 are lowered is prepared.

[0049] The oscillation air cylinder 37 is operated in a direction that a rod thereof is contracted from the state shown in Fig. 15, such that the moving arm 33 is rotated. Then, the knitted-fabric transferring apparatus main body 30 moves to the knitting stage located above the knitting needle cylinder 19 as shown in Figs. 17 and 18, and a state shown in Fig. 6 appears. Next, the arm-vertically-moving first air cylinder 32a and the arm-vertically-moving

second air cylinder 32b shown in Fig. 5 are contracted, and the transferring needles 34 are moved downward from the position shown in Fig. 6, and stopped at a position 10 mm above the transferring position as shown in Fig. 19. Further, the suction by the knitted-fabric drawing-down pipe 20 is stopped. Next, the transferring-sinker vertically-moving air cylinder 71a (see Fig. 7) comes into a non-operation state (i.e., free state), and the transferring-sinker advancing/retreating mechanism 70 moves downward by its weight to the height to which the transferring-sinker-lowering first air cylinder 71b extends as shown in Fig. 19. Then, each of the transferring sinkers 49 is switched from the retreated state shown in Fig. 13A to the advanced state shown in Fig. 13B by the transferring-sinker advancing/retreating mechanism 70.

[0050] Thereafter, as shown in Fig. 20, the knitted-fabric drawing-down pipe 20 moves downward to the middle stage. Further, the transferring-sinker-lowering first air cylinder 71b is contracted, and the transferring-sinker advancing/retreating mechanism 70 moves downward to the height to which the transferring-sinker-lowering second air cylinder 71c extends. Due to the downward movement of the transferring-sinker advancing/retreating mechanism 70, the transferring sinkers 49 in the advanced state draw the knitted fabric 27 downward, and the final loops 26 are aligned at a certain position (i.e., the same horizontal level) in the vertical direction. Thereby, the engagement claw 49e of each of the transferring sinkers 49 is always brought into contact with the corresponding final loop 26 at a certain position, and it is possible to surely engage the final loops 26 by the transferring sinkers 49.

[0051] Next, each of the transferring sinkers 49 moves to the retreated position, as shown in Fig. 21. Further, the transferring-sinker-lowering second air cylinder 71c (see Fig. 7) is contracted, and each of the transferring sinkers 49 is moved downward to the height at which the transferring-sinker advancing/retreating mechanism 70 is brought into contact with a sinker cap 18b. Further, the arm-vertically-moving third air cylinder 32c (see Fig. 5) is contracted. Thereby, the tip end of each of the transferring needles 34 comes close to or comes in contact with the rear surface of the corresponding knitting needle 21, as shown in Fig. 22.

[0052] Next, the state in which the rod of the transferring-sinker advancing/retreating air cylinder 80 protrudes as shown in Fig. 13A comes into a state in which the rod of the transferring-sinker advancing/retreating air cylinder 80 is retracted as shown in Fig. 13B. Thereby, each of the transferring sinkers 49 is switched from the retreated position to the advanced position. Thereby, as shown in Fig. 26, the final loops 26 are engaged by the engagement portions 49f of the transferring sinkers 49.

[0053] Fig. 24 illustrates a traverse section of the knitted fabric 27 at the vicinity of the knitting needles 21 in a state that the final loops 26 are caught on the knitting needles 21. Fig. 25 illustrates a traverse section of the knitted fabric 27 at the vicinity of the knitting needles 21

in a state that each of the transferring sinkers 49 is inserted into the space between the adjacent knitting needles 21 from outside to inside in the radial direction. Fig. 26 is a side elevational view showing a state that each of the transferring sinkers 49 is inserted into the space between the adjacent knitting needles 21. Each of the transferring sinkers 49 is inserted into the space between the adjacent knitting needles 21 from outside to inside, and thereby a connecting portion 26b of the adjacent final loops 26, which is caught on the knitting needle 21, is pushed to the inside in the radial direction by the engagement claw 49e of the distal end portion 49b of each of the transferring sinkers 49. Consequently, as shown in Fig. 25, each of the final loops 26 caught on the knitting needle 21 is stretched to the outside in the radial direction, such that a gap G1 is formed between the final loop 26 and an inner loop 26a preceding the final loop 26. When the knitted fabric 27 is lifted up and moved from the knitting needles 21 to the transferring needles 34, each of the final loops 26 is not engaged by the tip end of the transferring needle 34, and the knitted fabric 27 can be smoothly moved due to the existence of the gap G1.

[0054] As shown in Fig. 22, at the transferring position where each of the transferring needles 34 moves downward so as to be continuous with the corresponding knitting needle 21 in the vertical direction, an outer distal end surface of each of the transferring needles 34 is in contact with or close to an inner rear surface of the corresponding knitting needle 21. This is because the radius of the movable half dial 44 for arranging the transferring needles 34 is slightly larger than the radius of the fixed half dial 43 for arranging the transferring needles 34. Accordingly, when each of the knitting needles 21 comes close to the corresponding transferring needle 34 in a state that both the fixed half dial 43 and the movable half dial 44 are in the opened state, a clearance appears between each of the transferring needles 34 of the fixed half dial 43 and the corresponding knitting needle 21, because the space between the adjacent transferring needles 34 of the fixed half dial 43 is different from the space between the adjacent transferring needles 34 of the movable half dial 44, and the radius of the fixed half dial 43 for arranging the transferring needles 34 is smaller than the radius of the movable half dial 44 for arranging the transferring needles 34. However, as shown in Fig. 26, since the final loops 26 of the knitted fabric 27 are pushed to the inside in the radial direction by the transferring sinkers 49, each of the knitting needles 21 is slightly bent toward the inside such that the rear surface of the knitting needle 21 comes in contact with the tip end of the transferring needle 34, and the appearance of the slight clearance does not matter in particular. Accordingly, the knitting needles 21 and the transferring needles 34 are approximately integrated together in the vertical direction, and it becomes possible to surely transfer the final loops 26 of the knitted fabric 27 from the knitting needles 21 to the transferring needles 34.

[0055] Incidentally, in Fig. 26, the tip end of each of the transferring needles 34 is in close contact with and integrated with the rear surface of the corresponding knitting needle 21. However, alternatively, the rear surface of the knitting needle 21 may be cut obliquely so as to have a tapered shape, such that the tip end of each of the transferring needles 34 is brought into contact with the tapered rear surface of the corresponding knitting needle 21 or comes close to the tapered rear surface of the corresponding knitting needle 21 with a clearance therebetween. In the case where the tip end of each of the transferring needles 34 is made close to the tapered rear surface of the corresponding knitting needle 21, the clearance between the tip end of each of the transferring needles 34 and the tapered rear surface of the corresponding knitting needle 21 is set to be smaller than the thickness of the yarn, for example, less than 1/4 of the thickness of the yarn, and thus it is possible to prevent the final loop 26 from being engaged by the clearance between the knitting needle 21 and the transferring needle 34.

[0056] Next, as shown in Fig. 27, the transferring-sinker elevating/transferring air cylinder 71d extends, and the knitted fabric 27 is lifted up to the upper portions of the transferring needles 34 by the transferring sinkers 49. Thereby, in the state that the final loops 26 of the knitted fabric 27 are inserted into the transferring needles 34, it is possible to prevent the final loops 26 from being dropped from the transferring sinkers 49 such that the knitted fabric 27 is surely held by the transferring needles 34 due to the existence of the transferring sinkers 49.

[0057] Next, the arm-vertically-moving first air cylinder 32a to the arm-vertically-moving third air cylinder 32c (see Fig. 5) are extended, and as shown in Fig. 28, the transferring apparatus base 51 returns to the upper stage. Further, the knitted-fabric drawing-down pipe 20 is moved upward to the upper stage. Next, after rotation lock of the knitting needle cylinder 19 is canceled, the knitting needle cylinder 19 is rotated, and the knitting needles 21 are moved downward to a float level at which the knitting needles 21 are hidden by the sinkers 25. Thereby, in the following process, even when the moving arm 33 is oscillated so as to pull out the knitted fabric 27 from the knitted-fabric drawing-down pipe 20, the knitted fabric 27 never come in contact with the knitting needles 21.

[0058] Next, the oscillation air cylinder 37 (see Fig. 5) is moved in a direction that the rod of the oscillation air cylinder 37 extends, and the moving arm 33 starts to rotate toward the knitted-fabric open-end seaming apparatus 12 as shown in Fig. 29, and reaches the position shown in Fig. 2. Next, the knitted-fabric drawing-down pipe 20 is positioned at the lower stage. Then, as shown in Fig. 3, the crossbar 14 is oscillated from the retreated position to the knitting position, and the yarn cutting section 15, the latch ring 16, and the yarn guide section 17 are set to the knitting position, and another knitted fabric 27 starts to be knitted.

[0059] As shown in Fig. 30, a suction switching valve (not shown in the drawings) is opened, and suction is

performed through the turning pipe 110. Next, the arm-vertically-moving first air cylinder 32a to the arm-vertically-moving third air cylinder 32c (see Fig. 5) are contracted, and the knitted-fabric transferring apparatus main body 30 is moved to the lower stage. Then, the suction switching valve (not shown in the drawings) comes into the closed state, and the suction through the turning pipe 110 is stopped.

[0060] As shown in Fig. 31, a turning-pipe holder 109 is elevated, and concurrently the turning pipe 110 is elevated, such that the turning pipe 110 is passed through the knitted fabric 27. Accordingly, the knitted fabric 27 is turned inside out. Next, as shown in Fig. 32, after a vertically-moving air cylinder 112a of the turning-pipe clamping mechanism 112 extends and moves downward, a clamping air cylinder 112b operates, so as to hold the turning pipe 110. Then, only the turning-pipe holder 109 moves downward. Next, after each of the transferring sinkers 49 is moved to the retreated position, the transferring-sinker vertically-moving air cylinder 71a is contracted, and each of the transferring sinkers 49 is retreated upward.

[0061] Next, as shown in Fig. 33, a movable-half-dial inversion driving section 85 is moved from the retreated position to a position at which the movable-half-dial inversion driving section 85 is operable by the movable half dial 44. Further, the lock cylinder 55a of the lock cover 55 is stretched, and the locking of the movable half dial 44 is canceled. The movable-half-dial inversion driving section 85 includes an inversion pin receiving section 85a into which an inversion pin 44e for inverting the movable half dial 44 is inserted. Upon rotation of the movable-half-dial inversion driving section 85 by 180 degrees, the movable half dial 44 is inverted. Upon operation of the movable-half-dial inversion driving section 85, each of the transferring needles 34 of the movable half dial 44 is brought into contact with the corresponding transferring needle 34 of the fixed half dial 43 such that each of the transferring needles 34 of the movable half dial 44 and the corresponding transferring needle 34 of the fixed half dial 43 are aligned in a line. Next, the inversion locking mechanism 69 operates such that the movable half dial 44 remains in the closed state. Thereafter, the movable-half-dial inversion driving section 85 returns to the retreated position.

[0062] As shown in Fig. 34, after the transferring-sinker vertically-moving air cylinder 71a extends so as to move each of the transferring sinkers 49 downward, the transferring-sinker advancing/retreating mechanism 70 comes into the advanced state, and an upper end of the distal end portion of each of the transferring sinkers 49 enters a lower end of the corresponding final loop 26 caught on the transferring needle 34 of the movable half dial 44. Next, as shown in Fig. 35, the transferring-sinker elevating/transferring air cylinder 71d extends, and thereby the final loops 26 on the transferring needles 34 of the movable half dial 44 are lifted up, and moved to the transferring needles 34 of the fixed half dial 43.

[0063] As shown in Fig. 36, after the transferring sinkers 49 are moved to the retreated position, the transferring-sinker vertically-moving air cylinder 71a is contracted, and the transferring sinkers 49 are retreated upward. Next, the movable-half-dial inversion driving section 85 is elevated again, and the inversion locking mechanism 69 comes into the non-operation state, and the locking of the movable half dial 44 for preventing inversion of the movable half dial 44 is canceled. Thereafter, the movable half dial 44 is returned to the non-inversion state by the movable-half-dial inversion driving section 85, and the lock cylinder 55a of the lock cover 55 is contracted. Thus, the movable half dial 44 comes into the opened state at which the movable half dial 44 is away from the fixed half dial 43, and is locked again. Thereafter, the movable-half-dial inversion driving section 85 is moved downward to the retreated position.

[0064] As shown in Fig. 37, the turning-pipe holder 109 and a lower knitted-fabric holding member 115 move upward, and hold the knitted fabric 27 against the half ring 60.

[0065] As shown in Fig. 38, the motor 53 (see Fig. 7) rotates the transferring needle rotary gear 52, such that a seaming starting portion of the knitted fabric 27 is moved to the position at which the sewing needle 107 is located. Thereafter, the sewing-machine advancing/retreating air cylinder 104a is extended, and the sewing machine main body 103 is set to a seaming position. Then, the sewing machine main body 103 is driven, and the motor 53 is driven in conjunction with the operation of the sewing needle 107. Thereby, the final loops 26 are seamed on a single stitch basis by the sewing needle 107.

[0066] As shown in Fig. 39, a sewing needle guide groove 34b with a V-shaped cross section, a semicircular cross section, or a circular cross section is formed on an external surface of each of the transferring needles 34 in the radial direction of the fixed half dial 43, so as to extend in the axial direction of the transferring needle 34. Further, the lower end (tip end) of each of the transferring needles 34 has an inclined surface 34c which is inclined inwardly, and a flat surface 34d which is parallel to the axial direction of the transferring needle 34. The sewing needle guide groove 34b is opened on the inclined surface 34c. Therefore, the sewing needle 107 enters the sewing needle guide groove 34b and moves downward, such that the tip end of the sewing needle 107 is surely guided into each of the final loops 26 held by the corresponding transferring needle 34. Accordingly, the seaming can be performed surely performed for each final loop 26. A tip end 34e of each of the transferring needles 34 has a triangular pyramid shape so as to be sharp.

[0067] As shown in Fig. 40, after the seaming, the half-ring lowering first air cylinder 62a is extended, and the arm-vertically-moving first air cylinder 32a is extended. Then, each of the transferring needles 34 is lifted up by 20 mm, for example, and the seamed final loops 26 are removed from the transferring needles 34. At the time of the removal, the knitted fabric 27 remains to be held be-

tween the lower knitted-fabric holding member 115 and the half ring 60. Thereafter, the sewing machine main body 103 makes 10 yarn chains, for example, using the sewing yarn 108.

[0068] As shown in Fig. 41, the half-ring lowering second air cylinder 62b is extended, and the position of the knitted fabric 27 held between the lower knitted-fabric holding member 115 and the half ring 60 is moved downward. Thereafter, the cutter advancing/retreating air cylinder 120 operates in the extending direction, and a cutter 121 is inserted into an upper part of the yarn chain made using the sewing yarn 108. Next, a cutter vertically-moving air cylinder 122 is extended so as to set the cutter 121 to a position for cutting the yarn chain. Next, the cutter advancing/retreating air cylinder 120 is contracted, and the cutter 121 is retreated. Thereby, the yarn chain is cut. Thereafter, the cutter vertically-moving air cylinder 122 is contracted, and the cutter 121 is returned to a default position. Next, the sewing-machine advancing/retreating air cylinder 104a is contracted, such that the sewing machine main body 103 is set to the retreated position.

[0069] Next, as shown in Fig. 42, a discharge-port-side suction switching valve (not shown in the drawing) comes into an opened state, and suction through the discharge unit 102 by the turning pipe 110 is performed. Next, the lower knitted-fabric holding member 115 moves downward to the retreated position, and the turning-pipe holder 109 also moves to the lowest stage once. Thereafter, the turning rod 113 moves upward together with the turning-pipe holder 109, so as to lift up the knitted fabric 27 within the turning pipe 110. Thereby, the knitted fabric 27 is inverted such that the right side of the knitted fabric 27 come to the outside again, and the knitted fabric 27 is discharged to the product receiving box (not shown in the drawings) through a discharge tube 102 of the discharge unit 102 shown in Fig. 1. Thereafter, the discharge-port-side suction switching valve (not shown in the drawing) comes into the closed state, and the suction through the discharge tube 102a is canceled. Further, the half-ring lowering first air cylinder 62a and the half-ring lowering second air cylinder 62b are contracted, such that the half ring 60 is retreated upward. Then, the turning-pipe holder 109 is further moved upward to the upper stage.

[0070] Next, as shown in Fig. 43, the clamping air cylinder 112b is contracted, and the holding of the turning pipe 110 by the turning-pipe clamping mechanism 112 is changed over to the holding of the turning pipe 110 by the turning-pipe holder 109. Thereafter, the turning-pipe holder 109 is moved downward together with the turning rod 113 and the turning pipe 110, and set to the lower stage.

[0071] Next, the vertically-moving air cylinder 112a of the turning-pipe clamping mechanism 112 shown in Fig. 43 is contracted, and a clamping pipe 112c is retreated upward. Further, the arm-vertically-moving second air cylinder 32b and the arm-vertically-moving third air cyl-

inder 32c operate in the extending direction, and the moving arm 33 is set to the upper stage. At the upper stage, the moving arm 33 is movable in a horizontal plane.

[0072] The operations described above are repeatedly performed, and after the knitted fabric 27 is knitted by the circular knitting machine 11, the knitted fabric 27 is conveyed by the knitted-fabric transferring apparatus 13 to the knitted-fabric open-end seaming apparatus 12. After the open end of the toe portion is closed, the knitted fabric 27 is discharged to the product receiving box through the discharge unit 102. Then, when the open end of the toe portion is closed by the knitted-fabric open-end seaming apparatus 12, the next knitted fabric 27 is knitted by the circular knitting machine 11, and therefore it is possible to efficiently produce the knitted fabric 27 such as hosiery.

[0073] In this embodiment, in particular, a knitted-fabric transferring method for transferring the knitted fabric 27 from the knitting needle cylinder 19 of the circular knitting machine 11 to the knitted-fabric transferring apparatus 13 in order to close one end of the knitted fabric 27 knitted by the circular knitting machine 11 includes a transfer preparation process ST1, a knitted-fabric transferring apparatus moving process ST2, a knitted-fabric loop alignment process ST3, a loop gap forming process ST4, a knitted-fabric transferring process ST5, a knitted-fabric moving process ST6, a knitted-fabric turning inside out process ST7, a toe-portion-open-end joining process ST8, a toe-portion-open-end seaming process ST9, a knitted-fabric turning right-side out process ST10, a knitted-fabric discharge process ST11, and an apparatus restitution process ST12, as shown in Fig. 45.

[0074] In the transfer preparation process ST1, as shown in Figs. 3 and 16, the upper mechanism of the circular knitting machine 11 is moved from the knitting position to the retreated position with respect to the knitted fabric 27 knitted by the circular knitting machine 11, the final loops 26 (see Fig. 26) of the knitted fabric 27 held by the knitting needles 21 of the circular knitting machine 11 are moved to be positioned under the latch needles 21a of the knitting needles 21, and the knitting needle cylinder 19 of the circular knitting machine 11 is stopped at a fixed position.

[0075] In the knitted-fabric transferring apparatus moving process ST2, as shown in Fig. 6, the knitted-fabric transferring apparatus 13 for catching and transferring the final loops 26 of the knitted fabric 27 is moved to be positioned immediately above the circular knitting machine 11. In the knitted-fabric loop alignment process ST3, as shown in Fig. 20, the transferring sinkers 49 of the knitted-fabric transferring apparatus 13 are brought into contact with the knitted fabric 27 and moved downward, so as to align the height of each of the final loops 26 of the knitted fabric 27 at a fixed position in the vertical direction. In the loop gap forming process ST4, the transferring needles 34 of the knitted-fabric transferring apparatus 13 are moved to the height at which the transferring needles 34 are brought into contact with the back of the

hooks of the knitting needles 21 as shown in Fig. 23, and each of the final loops 26 of the knitted fabric 27 between the adjacent knitting needles 21 is held at the engagement portion 49f of each of the transferring sinkers 49 as shown in Fig. 26, and concurrently, each of the final loops 26 is pushed to the center of the knitting needle cylinder 19 so as to form the gap G1 between each of the final loops 26 and the back of the corresponding knitting needle 21. In the knitted-fabric transferring process ST5, as shown in Fig. 27, each of the transferring sinkers 49 is moved to the height above the hook of the corresponding knitting needle 21, so as to transfer the final loops 26 of the knitted fabric 27 to the transferring needles 34. Incidentally, instead of moving the transferring sinkers 49, the transferring needles 34 may be lowered to the height at which the final loops 26 are held by the transferring sinkers 49, and then the knitted-fabric transferring apparatus 13 as a whole may be lifted up, such that the final loops 26 are transferred from the knitting needles 21 to the transferring needles 34.

[0076] In the knitted-fabric moving process ST6, as shown in Figs. 28 to 30, the knitted fabric 27 is transferred by the knitted-fabric transferring apparatus 13 from the knitting stage to the seaming stage.

[0077] In the knitted-fabric turning inside out process ST7, as shown in Figs. 31 and 32, the turning pipe 110 is inserted into the knitted fabric 27, so as to turn the knitted fabric 27 inside out.

[0078] In the toe-portion-open-end joining process ST8, after the transferring needles 34 of the movable half dial 44 and the transferring needles 34 of the fixed half dial 43 are joined together as shown in Fig. 33, the final loops 26 on the transferring needles 34 of the movable half dial 44 are transferred to the transferring needles 34 of the fixed half dial 43 by the transferring sinkers 49 of the transferring sinker unit 41 as shown in Fig. 34.

[0079] In the toe-portion-open-end seaming process ST9, as shown in Fig. 38, the overlapped final loops 26 on the transferring needles 34 of the fixed half dial 43 are seamed using the sewing yarn 108 for each of the final loops 26 (for each stitch). Concurrently, each of the final loops 26 of the knitted fabric 27 is fed one by one by the rotation mechanism 106 of the fixed half dial 43 in conjunction with the vertical movement of the sewing needle 107, and each of the final loops 26 is surely seamed on a single stitch basis using the sewing yarn 108. Further, in the toe-portion-open-end seaming process ST9, as shown in Fig. 39, the sewing needle 107 is guided in accordance with the vertical movement of the sewing needle 107 by the sewing needle guide groove 34b of each of the transferring needles 34, and therefore it is possible to surely pass the sewing needle 107 into each of the final loops 26.

[0080] In the knitted-fabric turning right-side out process ST10, as shown in Fig. 42, the turning rod 113 is inserted into the knitted fabric 27, and thereby the knitted fabric 27 is turned right side out within the turning pipe 110.

[0081] In the knitted-fabric discharge process ST11, as shown in Fig. 42, the knitted fabric 27, which is turned right side out within the turning pipe 110, is sucked and discharged through the discharge tube 102a of the discharge unit 102 into the product receiving box (not shown in the drawings) disposed outside the circular knitting machine 11, as shown in Fig. 1.

[0082] In the apparatus restitution process ST12, as shown in Figs. 43 and 44, each operation component returns to its default position, and stands ready until the next knitted fabric 27 is completed.

[0083] Further, in the above embodiment, at the time of seaming the final loops 26, the sewing yarn 108 is passed through each of the final loops 26 once. However, alternatively, the sewing yarn 108 may be passed through each of the final loops 26 two or more times. Further, in the case where the sewing yarn 108 is passed through an area corresponding to the loop at which the closing of the final loops 26 starts and the following some loops and the loop at which the closing of the final loops 26 ends and the preceding some loops two or more times, it is possible to enhance the portion of the knitted fabric 27 closed by the seaming. Furthermore, the area through which the sewing yarn 108 is passed two or more times is not limited to the above, and may be appropriately determined. Further, the sewing yarn 108, which is passed through the inner loops 26a, may be changed for every two or more pitches, for example. For example, the loop through which the sewing yarn 108 is passed once and the loop through which the sewing yarn 108 is passed twice may alternate. Alternatively, every some pitches, the sewing yarn 108 is passed through the loop two or more times.

[0084] Although the present invention has been fully described by way of the preferred embodiments thereof with reference to the accompanying drawings, various changes and modifications will be apparent to those having skill in this field. Therefore, unless otherwise these changes and modifications depart from the scope of the present invention, they should be construed as included therein.

Claims

1. A knitted-fabric transferring method for a circular knitting machine, for transferring a knitted fabric (27) knitted by a circular knitting machine (11) from knitting needles (21) of a knitting-needle cylinder (19) of the circular knitting machine to transferring needles (34), to close one end of the knitted fabric, the knitted-fabric transferring method comprising the steps of:

advancing the transferring needles and the knitting needles relative to each other in an axial direction of the knitting needles such that the transferring needles and the knitting needles are continuous with each other;

- inserting a transferring sinker (49) into a space between the adjacent knitting needles of the knitting-needle cylinder from outside to inside in a radial direction of the knitting-needle cylinder, so as to push final loops (26) of the knitted fabric caught on the knitting needles to an inside of the knitting-needle cylinder by an engagement portion (49f) of a distal end portion (49b) of each of the transferring sinkers, such that a gap (G) is formed between an internal surface of each of the knitting needles and an inner loop preceding each of the final loops; and moving the transferring sinkers from the knitting needles to the transferring needles in the axial direction of the knitting needles, so as to transfer the final loops from the knitting needles to the transferring needles by the transferring sinkers.
2. The knitted-fabric transferring method for a circular knitting machine as defined in claim 1, wherein each of the transferring sinkers includes a transferring sinker main body (49a) having the shape of a belt plate, the distal end portion having a tapered portion (49d) so as to be formed to have an acute angle, and the engagement portion formed at the tapered portion and engaged by the final loop, and each of the distal end portion and the engagement portion is thinner than the transferring sinker main body, and the thickness of the transferring sinker main body is the same as the space between the adjacent knitting needles.
 3. The knitted-fabric transferring method for a circular knitting machine as defined in claim 1 or 2, wherein the knitting needles and the transferring needles are arranged at a constant pitch in a circumferential direction of the knitted fabric so as to constitute a knitting needle group and a transferring needle group, the transferring needle group is divided in half into a first transferring needle group and a second transferring needle group at an interval of 180 degrees, such that the first transferring needle group is attached to a fixed half dial (43) and the second transferring needle group is attached to a movable half dial (44), and the movable half dial is attached to the fixed half dial through hinge portions (46) so as to be freely inverted with respect to the fixed half dial, and the movable half dial is selectively set to an opened state in which the fixed half dial and the movable half dial lie in the same plane, or a closed state in which a tip end of the second transferring needle group comes close to or is brought into contact with a tip end of the first transferring needle group such that the transferring needles of the first transferring needle group are continuous with the transferring needles of the second transferring needle group.
 4. The knitted-fabric transferring method for a circular knitting machine as defined in claim 3, wherein the first transferring needle group and the second transferring needle group are positioned such that the tip end of each of the transferring needles of the first transferring needle group and the tip end of each of the transferring needles of the second transferring needle group are deviated from each other in a radial direction of each of the half dials in the closed state, and the tip end of each of the transferring needles of one of the first transferring needle group and the second transferring needle group has a housing groove (34a) for housing the tip end of each of the transferring needles of the other of them, such that the tip end of each of the transferring needles of the one of the first transferring needle group and the second transferring needle group is housed in the housing groove of the tip end of each of the transferring needles of the other of them, and the first transferring needle group is continuous with the second transferring needle group in an axial direction of the transferring needles.
 5. The knitted-fabric transferring method for a circular knitting machine as defined in any one of claims 1 to 4, wherein before the final loops are transferred from the knitting needles to the transferring needles, each of the transferring sinkers is inserted into the space between the adjacent knitting needles above the final loops of the knitted fabric and moved downward, so as to hold the final loops by a lower surface of the distal end portion of each of the transferring sinkers, in order to align heights of the final loops before being transferred.
 6. The knitted-fabric transferring method for a circular knitting machine as defined in any one of claims 3, 4, or 5 according to claim 3 or 4, wherein after the final loops are transferred from the knitting needles to the transferring needles, the knitted fabric is moved to a sewing machine unit (100) so as to seam the final loops of the knitted fabric, and the fixed half dial is rotated in a circumferential direction thereof in conjunction with vertical movement of a sewing needle (107) of the sewing machine unit.
 7. The knitted-fabric transferring method for a circular knitting machine as defined in claim 6, wherein each of the transferring needles of the fixed half dial has a sewing needle guide groove (34b) extending in the axial direction, and guides the sewing needle by the sewing needle guide groove in the vertical movement of the sewing needle.
 8. A knitted-fabric transferring apparatus for a circular knitting machine, for transferring a knitted fabric (27) knitted by a circular knitting machine (11) from knitting needles (21) of a knitting-needle cylinder (19) of

the circular knitting machine to transferring needles (34), to close one end of the knitted fabric, the knitted-fabric transferring apparatus comprising:

- a transferring needle holding cylinder (45), which is disposed above the knitting-needle cylinder so as to be vertically movable along a center line of the knitting-needle cylinder and has the transferring needles arranged at a constant pitch in a circumferential direction thereof, the transferring needles coming close to internal surfaces of the knitting needles in a state that the transferring needle holding cylinder moves downward, such that the transferring needles and the knitting needles are continuous with each other in an axial direction thereof; transferring sinkers (49) each of which is disposed in a space between the adjacent knitting needles of the knitting-needle cylinder so as to freely advance or retreat from outside to inside in a radial direction of the knitting-needle cylinder and has an engagement portion (49f), the transferring sinkers pushing final loops (26) of the knitted fabric caught on the knitting needles to an inside of the knitting-needle cylinder by the engagement portions in a state that the transferring sinkers are advanced into the knitting-needle cylinder, such that a gap (G) is formed between an internal surface of each of the knitting needles and an inner loop preceding each of the final loops; and
 - a transferring-sinker vertically-moving mechanism (71) for moving the transferring sinkers from the knitting needles to the transferring needles in the axial direction of the knitting needles in a state that the transferring needles and the knitting needles are continuous with each other.
9. The knitted-fabric transferring apparatus for a circular knitting machine as defined in claim 8, wherein each of the transferring sinkers includes a transferring sinker main body (49a) having the shape of a belt plate, the distal end portion having a tapered portion (49d) so as to be formed to have an acute angle, and the engagement portion formed at the tapered portion and engaged by the final loop, and each of the distal end portion and the engagement portion is thinner than the transferring sinker main body, and the thickness of the transferring sinker main body is the same as the space between the adjacent knitting needles.
10. The knitted-fabric transferring apparatus for a circular knitting machine as defined in claim 8 or 9 further comprising:
- a transferring needle group including the transferring needles arranged at a constant pitch in

a circumferential direction of the knitted fabric so as to correspond to the knitting needles of the knitting-needle cylinder, the transferring needle group being divided in half into a first transferring needle group and a second transferring needle group at an interval of 180 degrees;

a fixed half dial (43) to which the first transferring needle group is attached;

a movable half dial (44) to which the second transferring needle group is attached; and

hinge portions (46) through which the movable half dial is attached to the fixed half dial so as to be freely inverted with respect to the fixed half dial, the movable half dial being selectively set to an opened state in which the fixed half dial and the movable half dial lie in the same plane, or a closed state in which a tip end of the second transferring needle group of the movable half dial comes close to or is brought into contact with a tip end of the first transferring needle group of the fixed half dial such that the transferring needles of the first transferring needle group are continuous with the transferring needles of the second transferring needle group.

11. The knitted-fabric transferring apparatus for a circular knitting machine as defined in claim 10, wherein the first transferring needle group and the second transferring needle group are positioned such that the tip end of each of the transferring needles of the first transferring needle group and the tip end of each of the transferring needles of the second transferring needle group are deviated from each other in a radial direction of each of the half dials in the closed state, and
- the tip end of each of the transferring needles of one of the first transferring needle group and the second transferring needle group has a housing groove (34a) for housing the tip end of each of the transferring needles of the other of them in the closed state.
12. The knitted-fabric transferring apparatus for a circular knitting machine as defined in any one of claims 8 to 11, wherein before the final loops are transferred from the knitting needles to the transferring needles, each of the transferring sinkers is inserted into the space between the adjacent knitting needles above the final loops of the knitted fabric and moved downward, so as to hold the final loops by a lower surface of the distal end portion of each of the transferring sinkers, in order to align heights of the final loops before being transferred.
13. The knitted-fabric transferring apparatus for a circular knitting machine as defined in any one of claims 10, 11, or 12 according to claim 10 or 11 further comprising:

a movement mechanism (104) for moving the knitted fabric to a sewing machine unit (100) so as to seam the final loops of the knitted fabric after the final loops are transferred from the knitting needles to the transferring needles; and
a rotation mechanism (106) for rotating the fixed half dial in a circumferential direction in conjunction thereof with vertical movement of a sewing needle (107) of the sewing machine unit.

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- 14.** The knitted-fabric transferring apparatus for a circular knitting machine as defined in claim 13, wherein each of the transferring needles of the fixed half dial has a sewing needle guide groove (34b) extending in the axial direction, and guides the sewing needle by the sewing needle guide groove in the vertical movement of the sewing needle.

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FIG.1

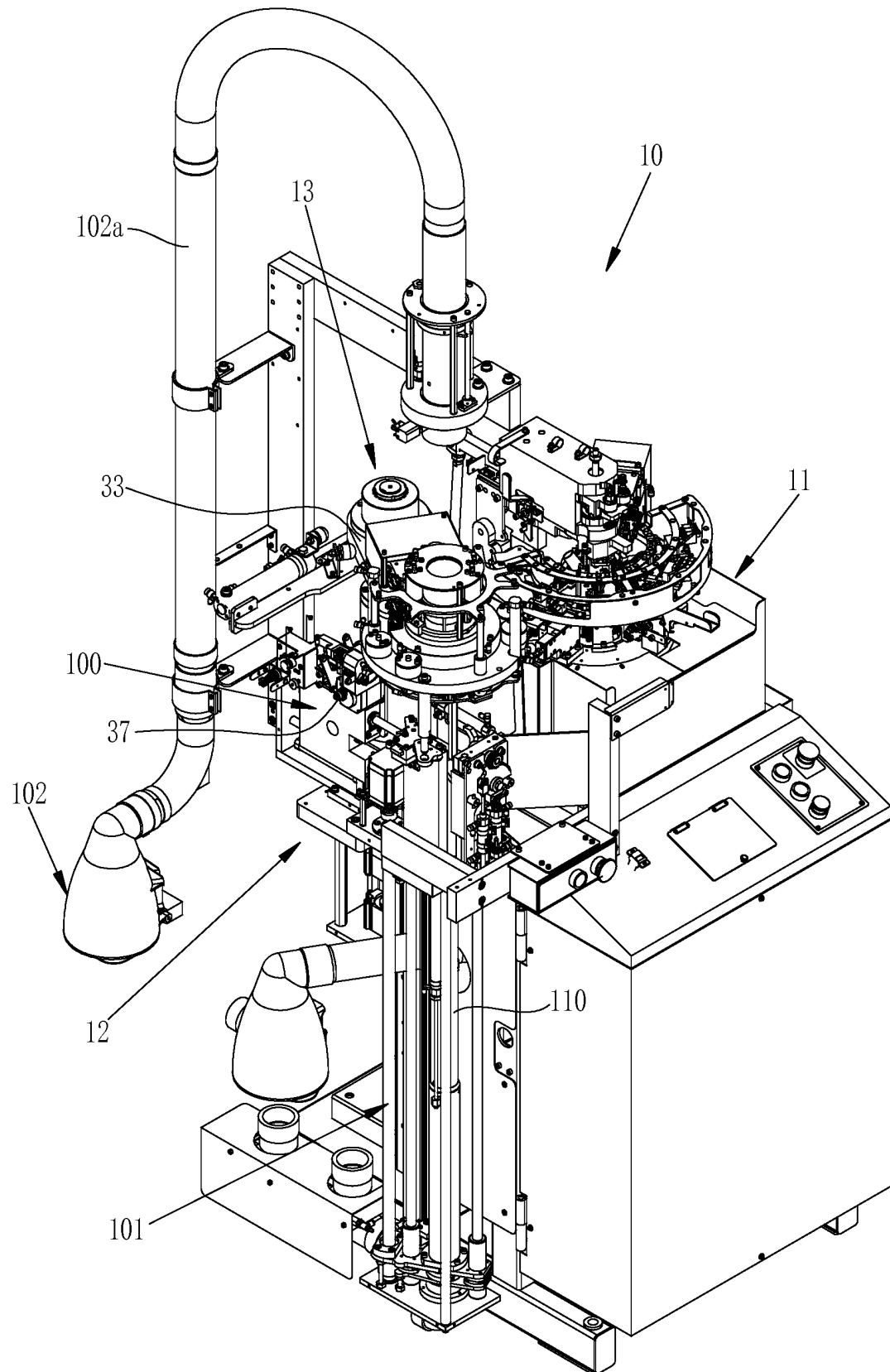


FIG.2

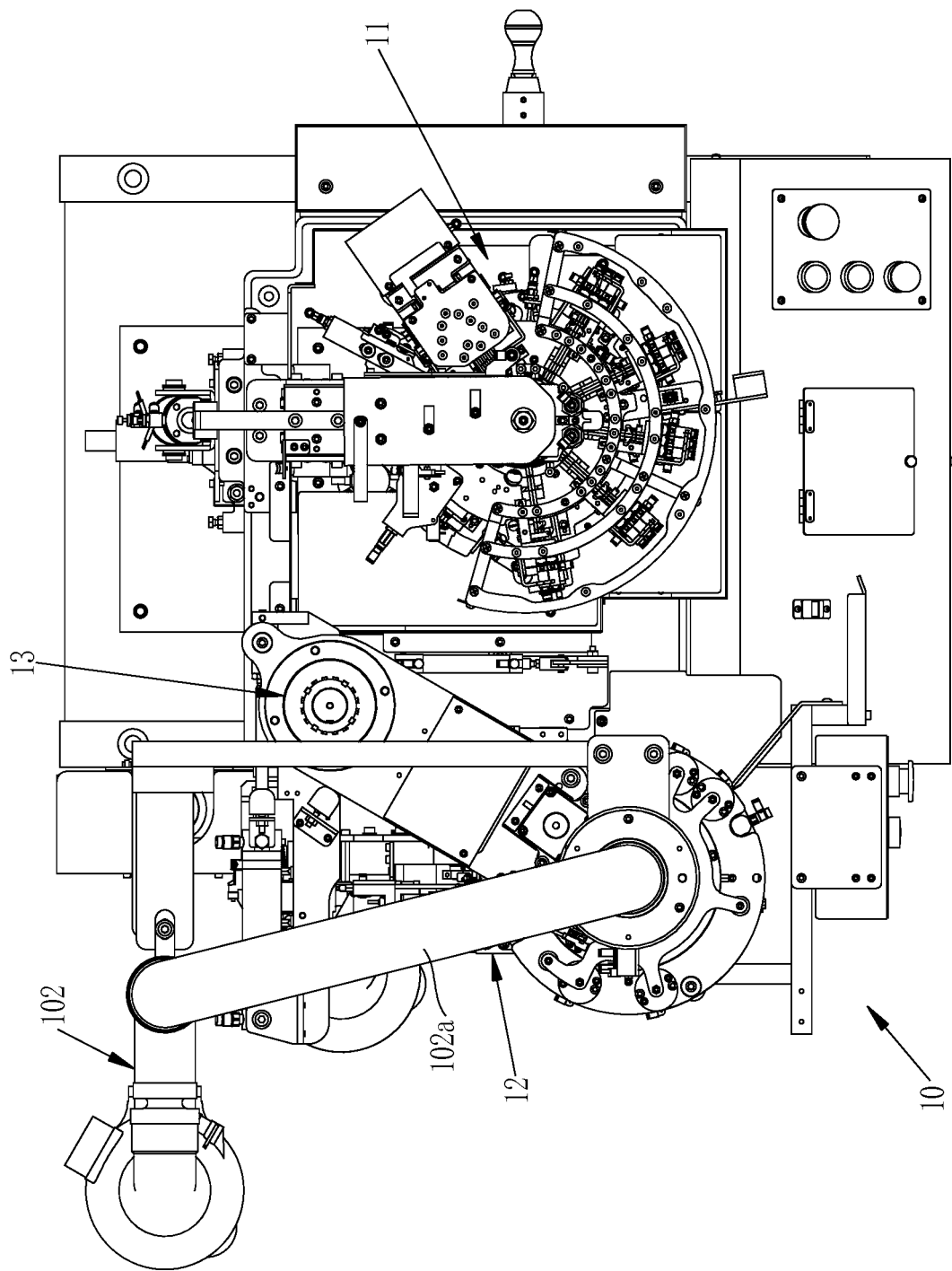


FIG.3

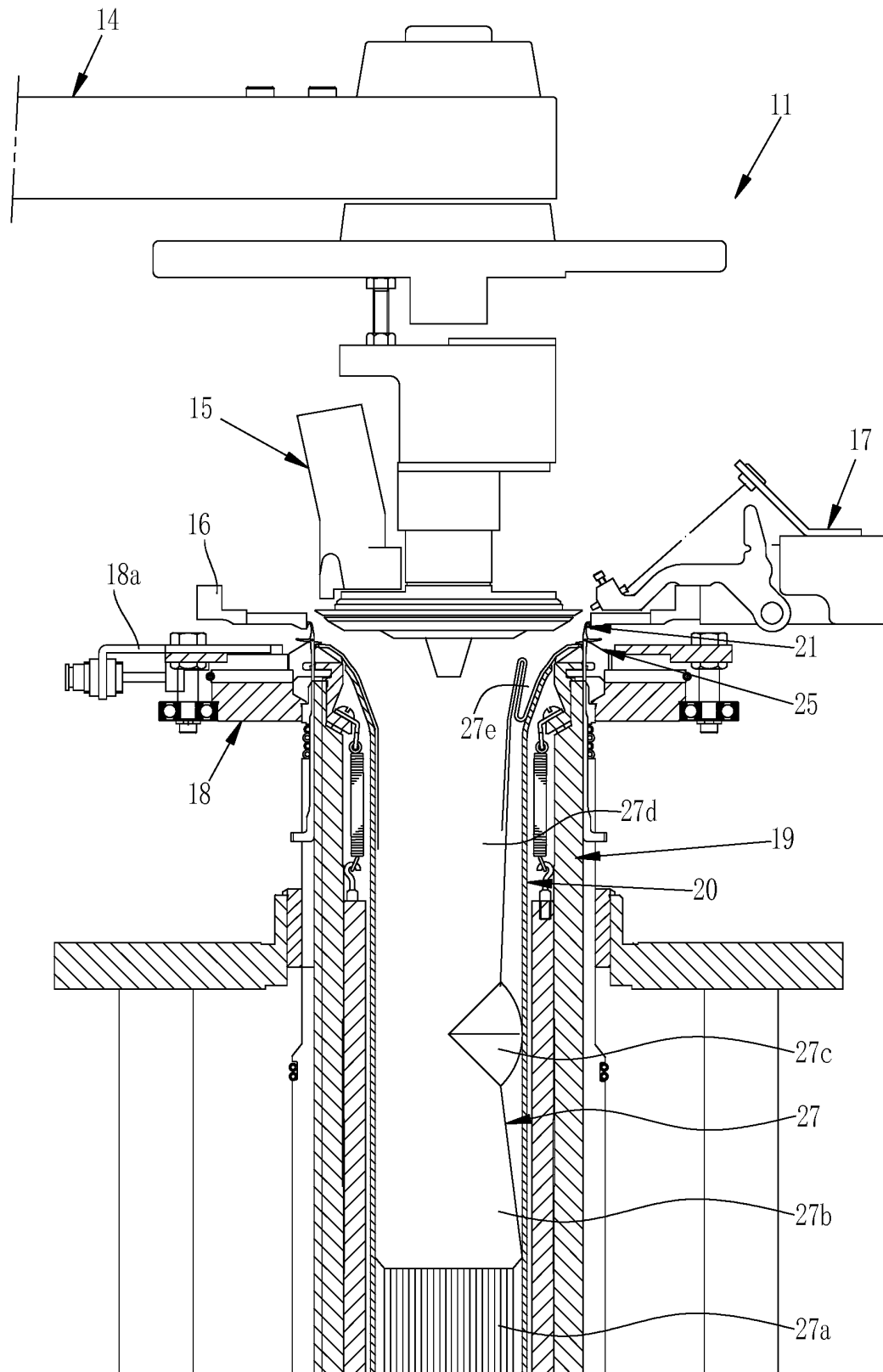


FIG.4

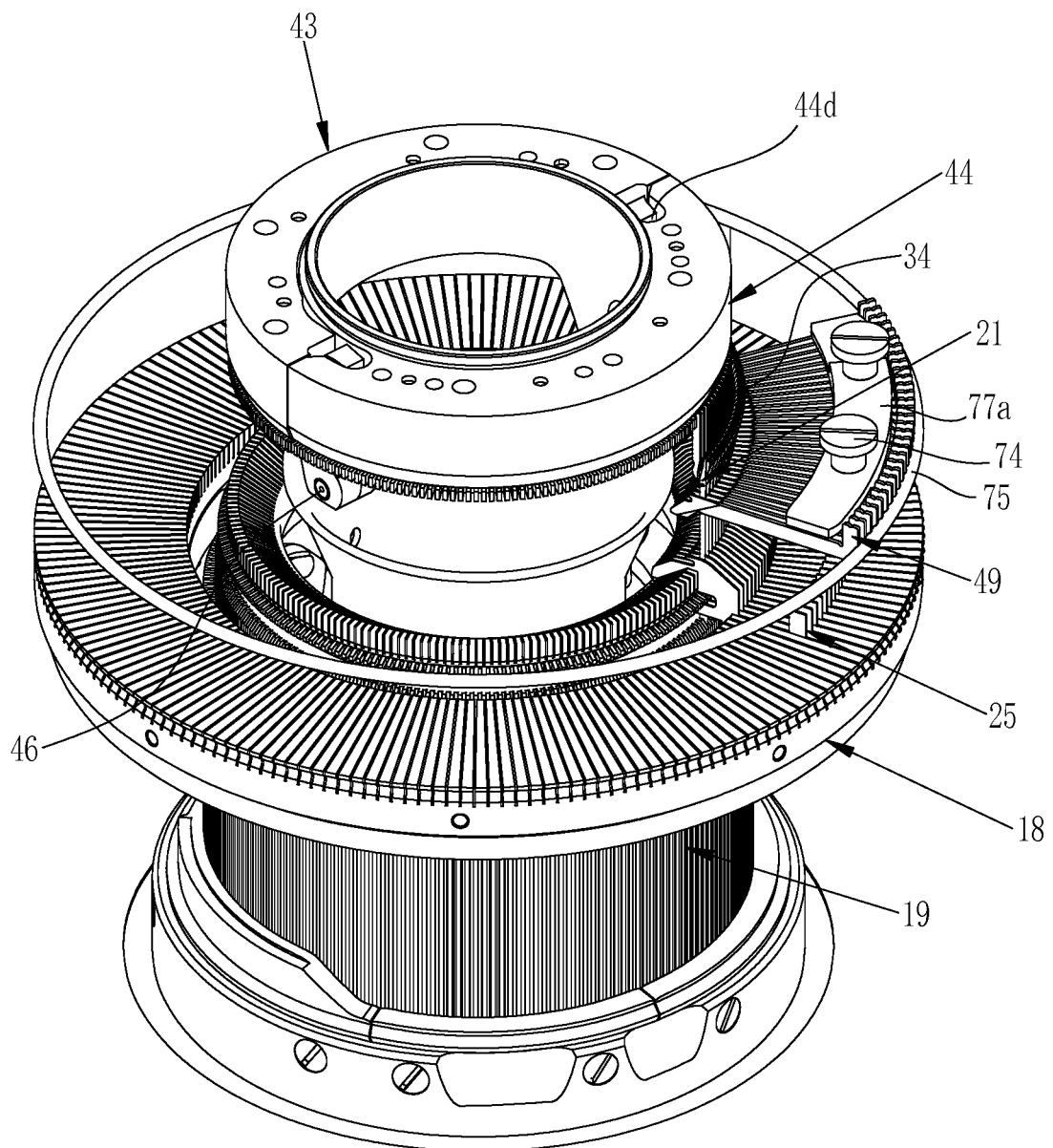


FIG.5

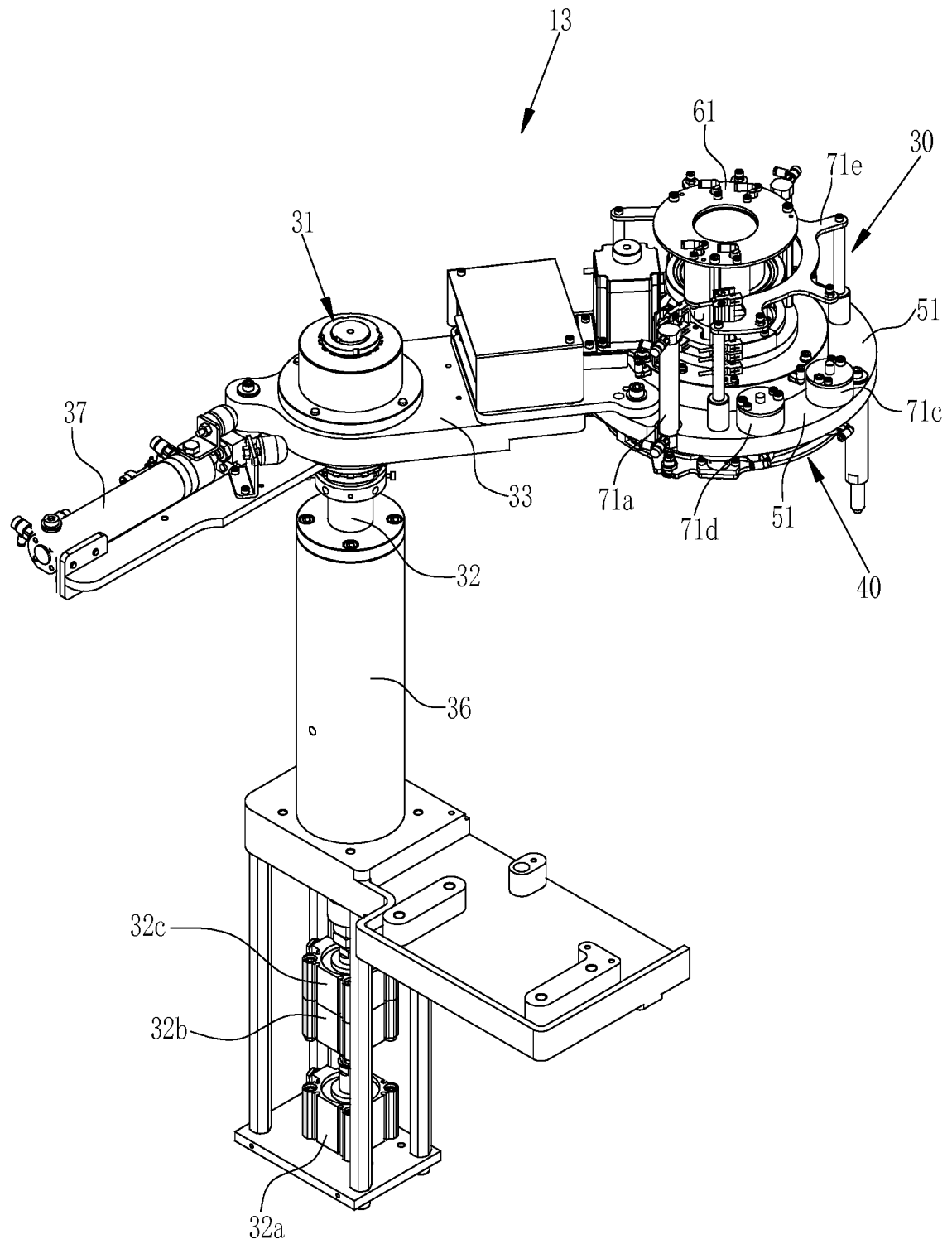


FIG.6

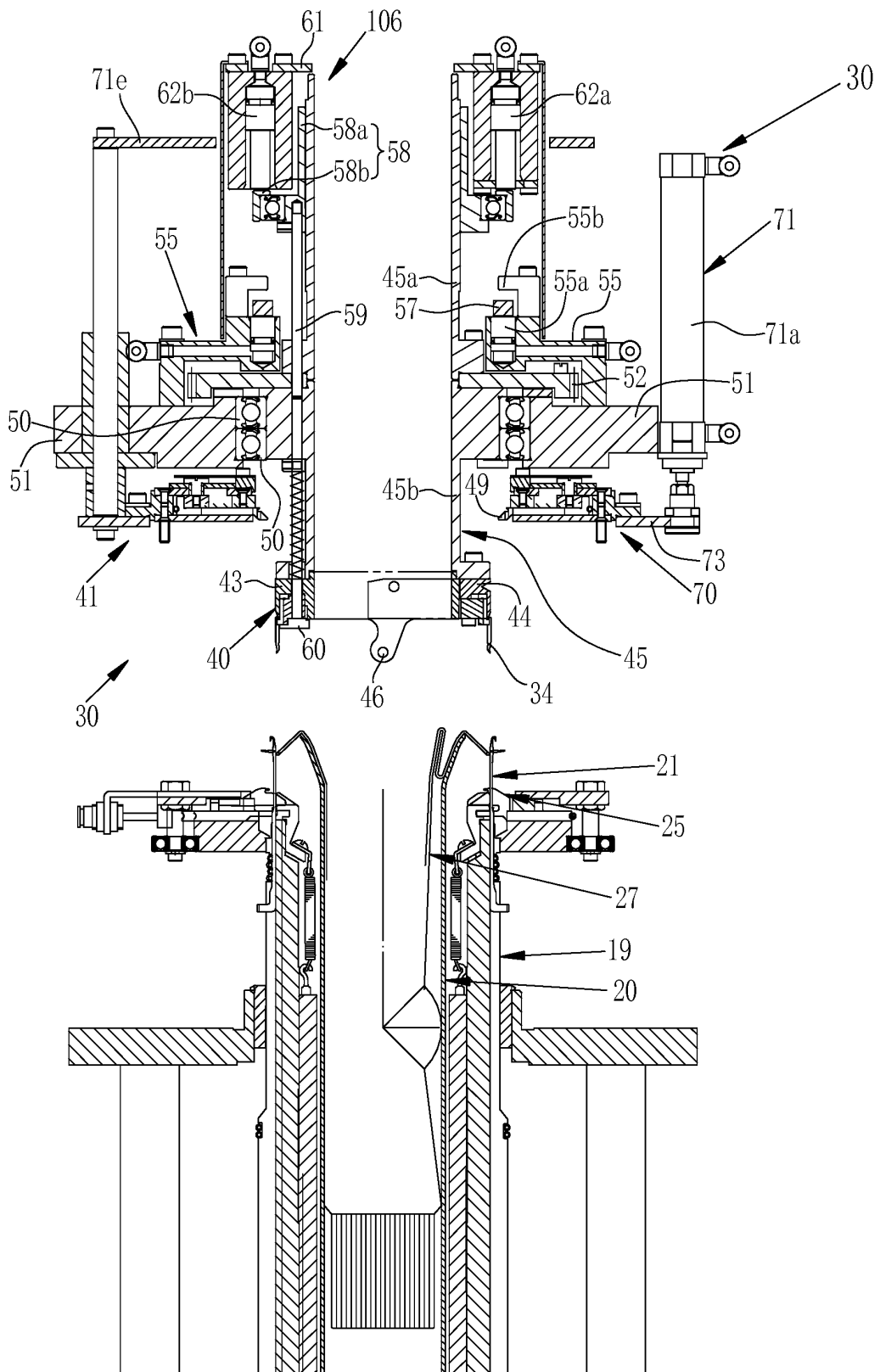


FIG.7

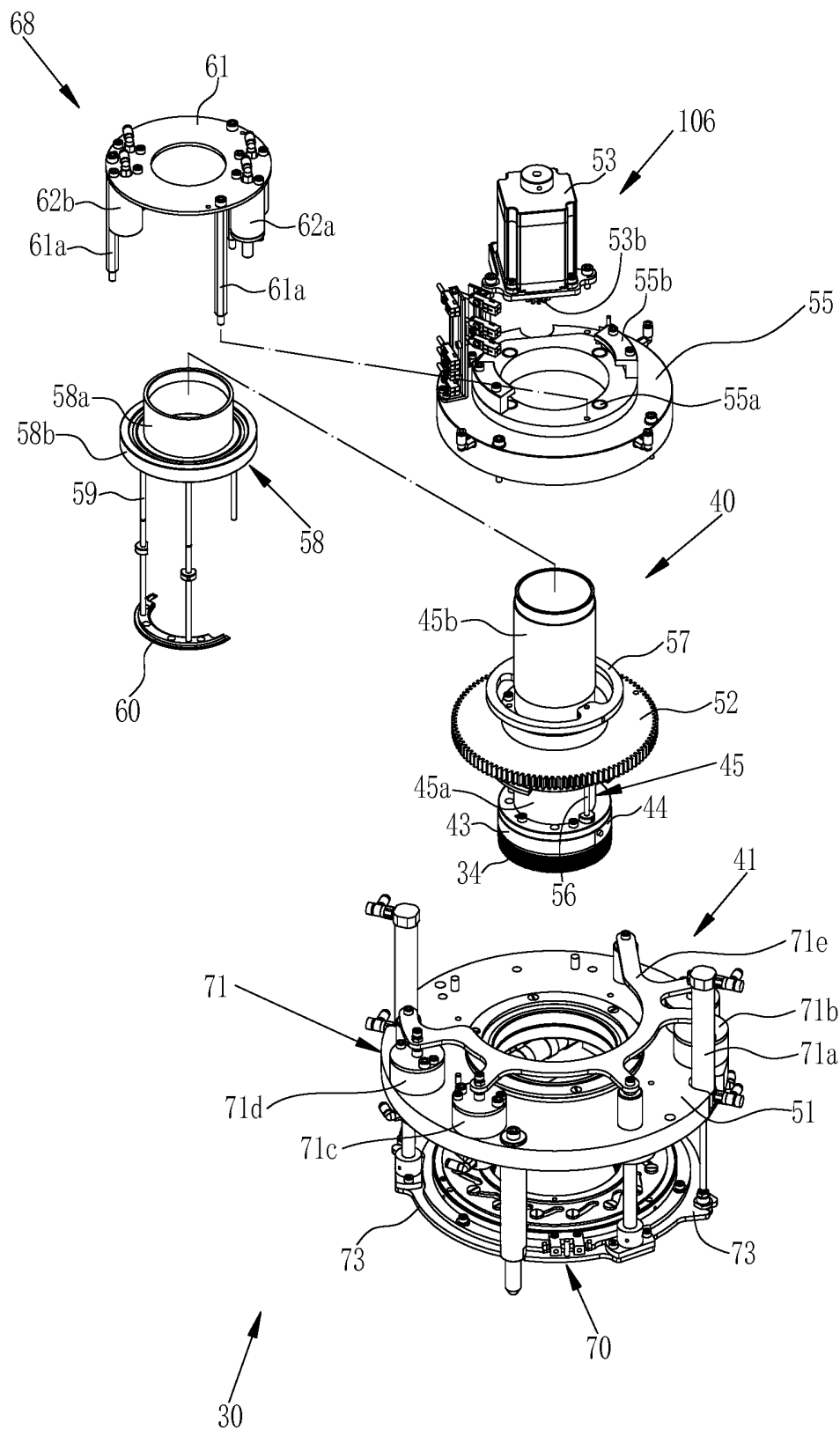


FIG.8

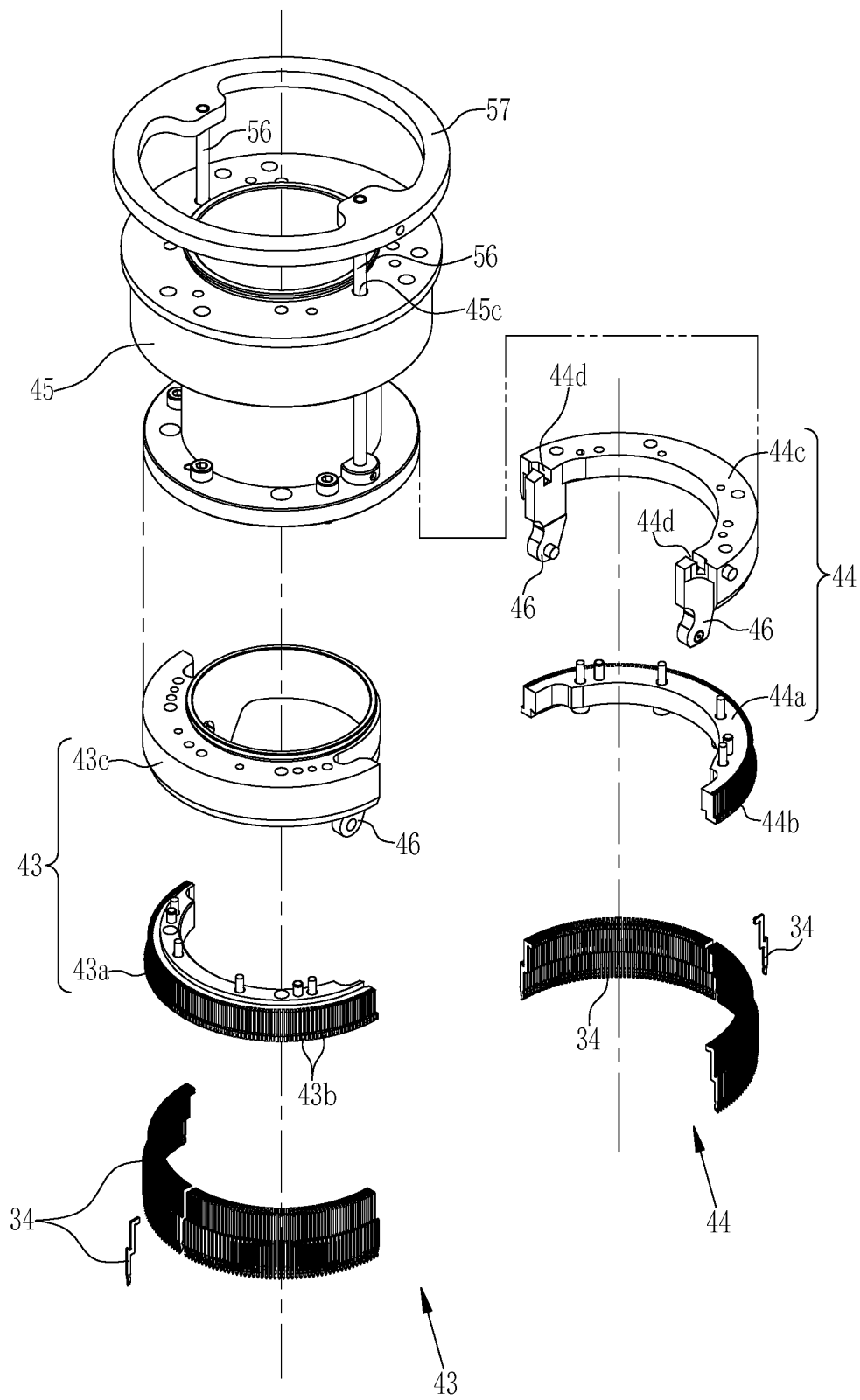


FIG.9

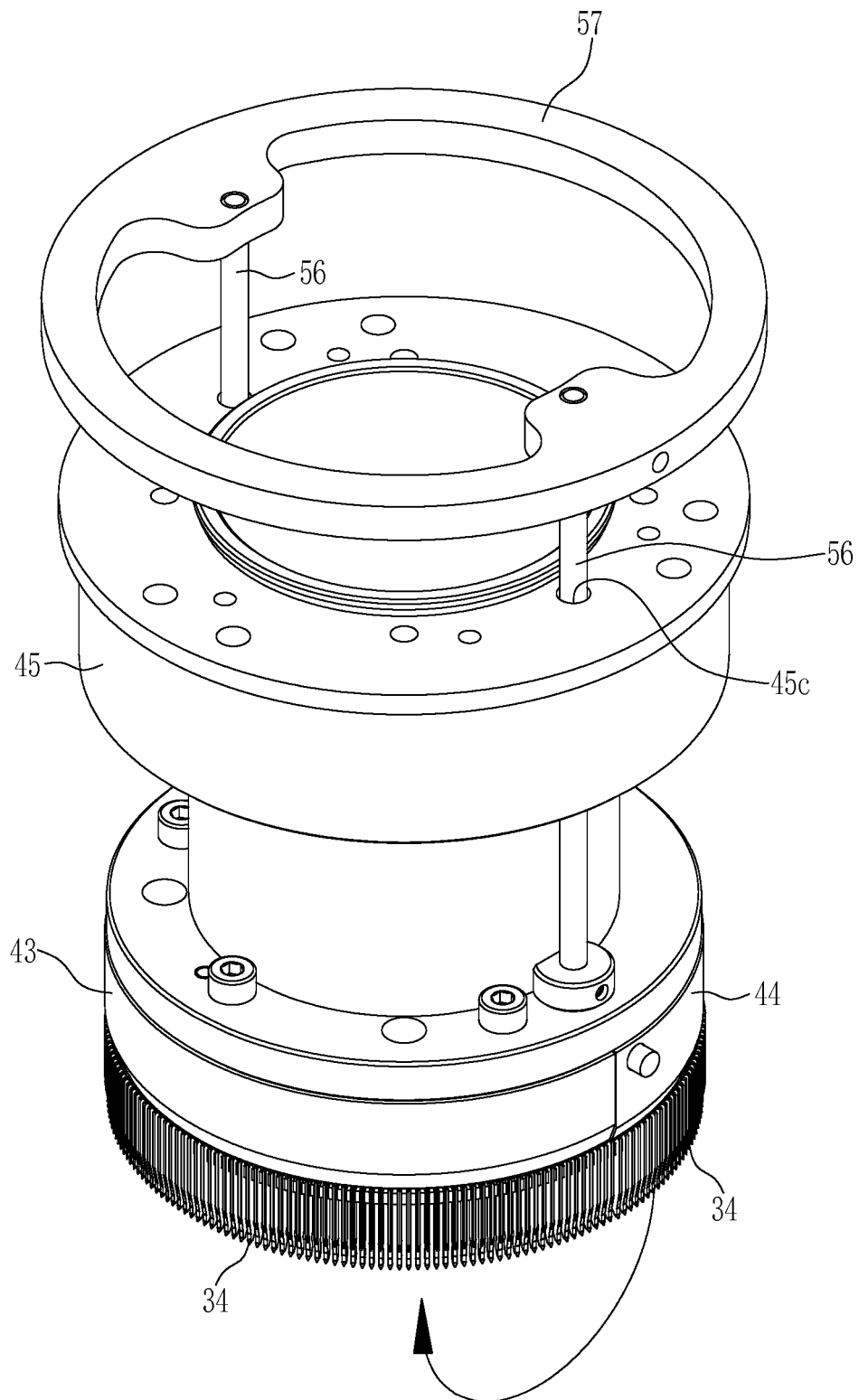


FIG.10

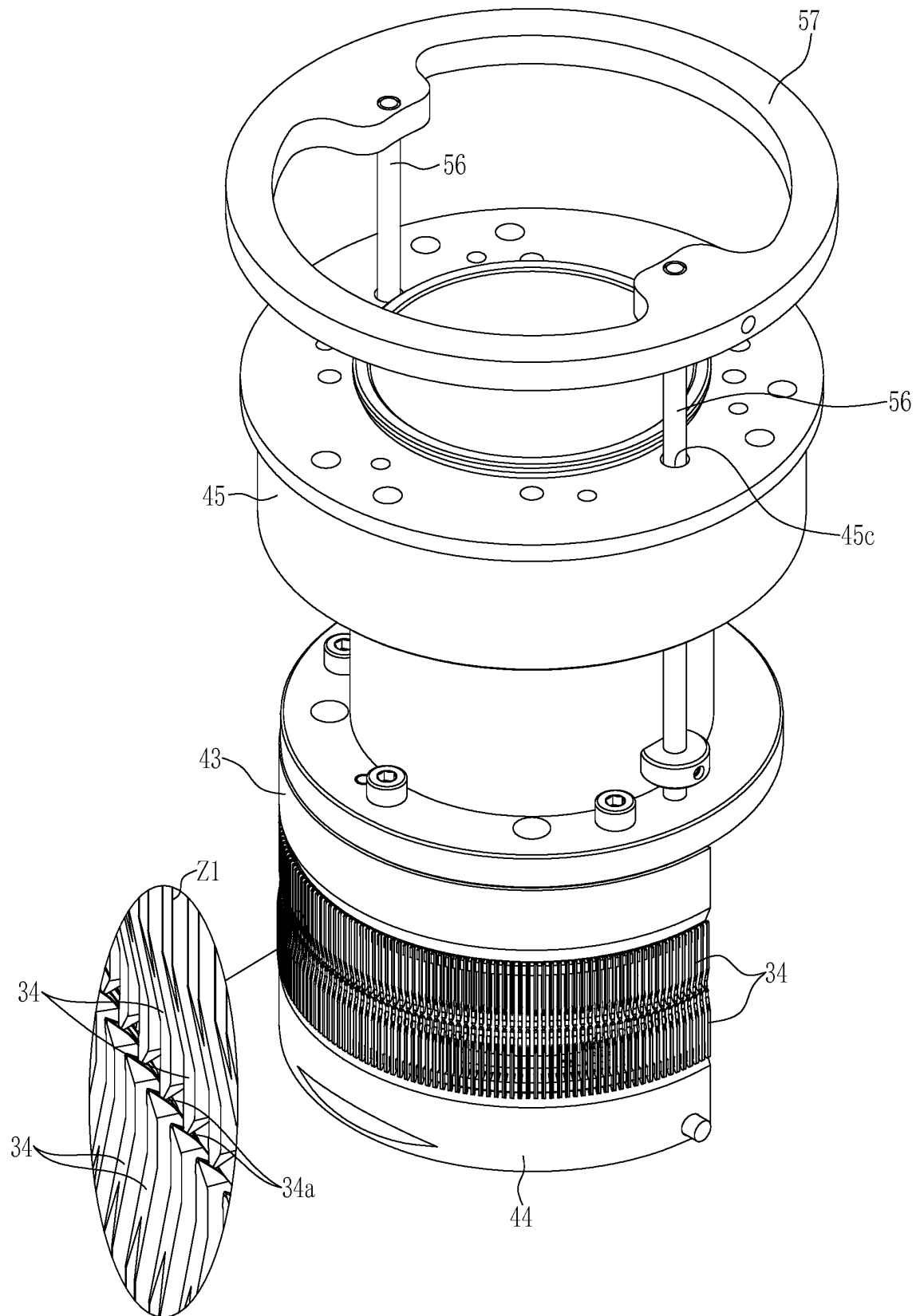


FIG.11

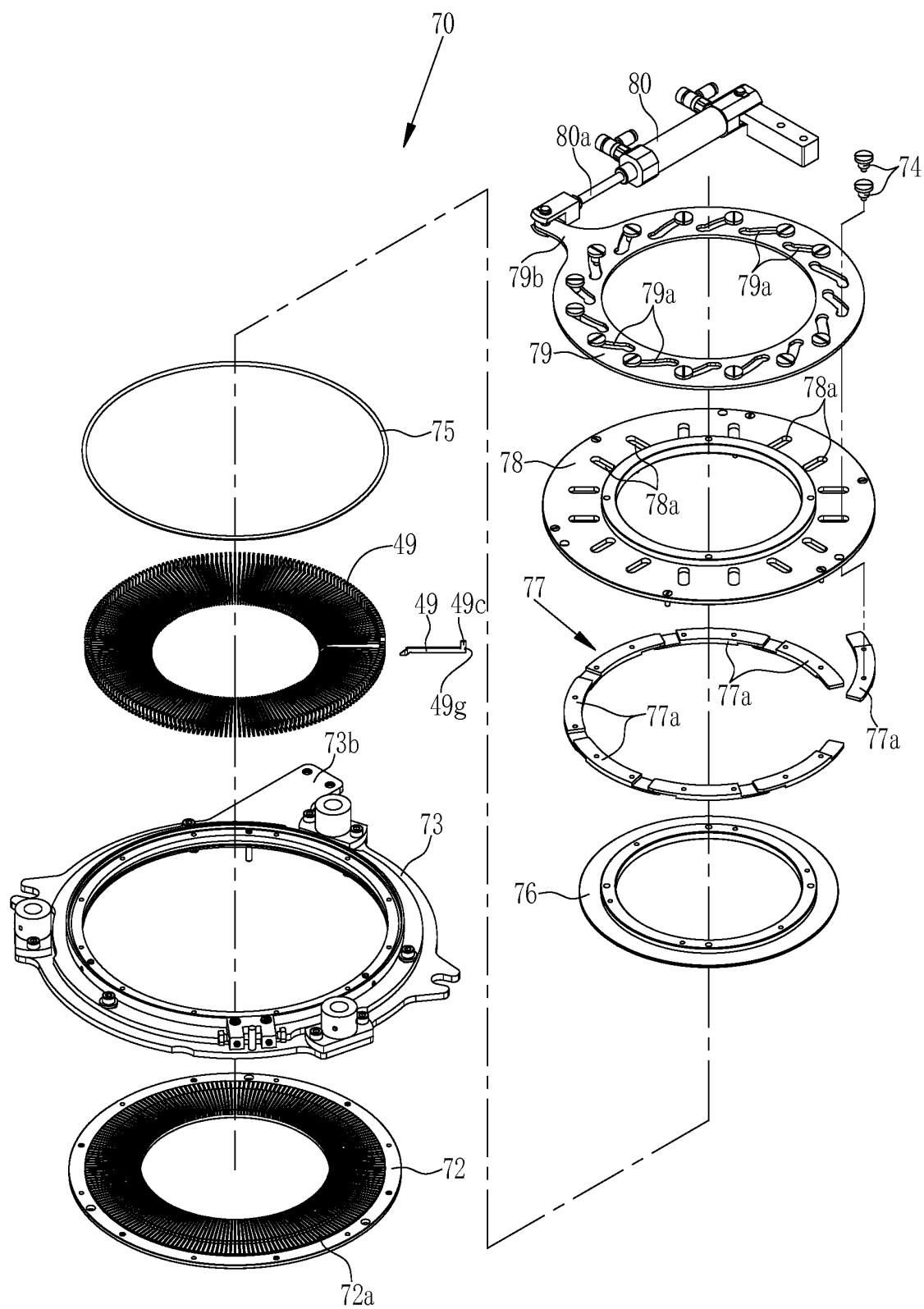


FIG.12

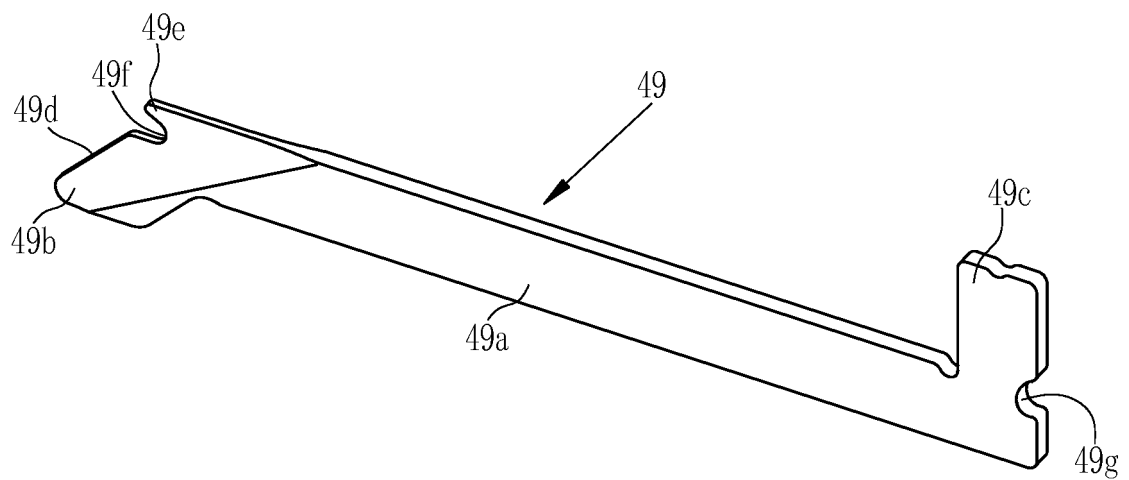


FIG.13A

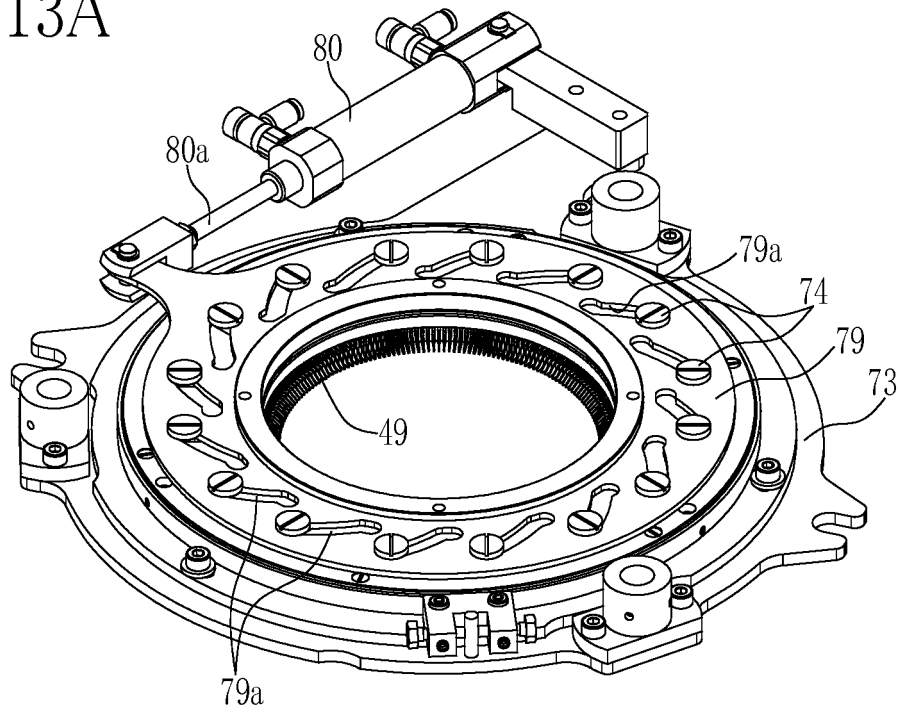


FIG.13B

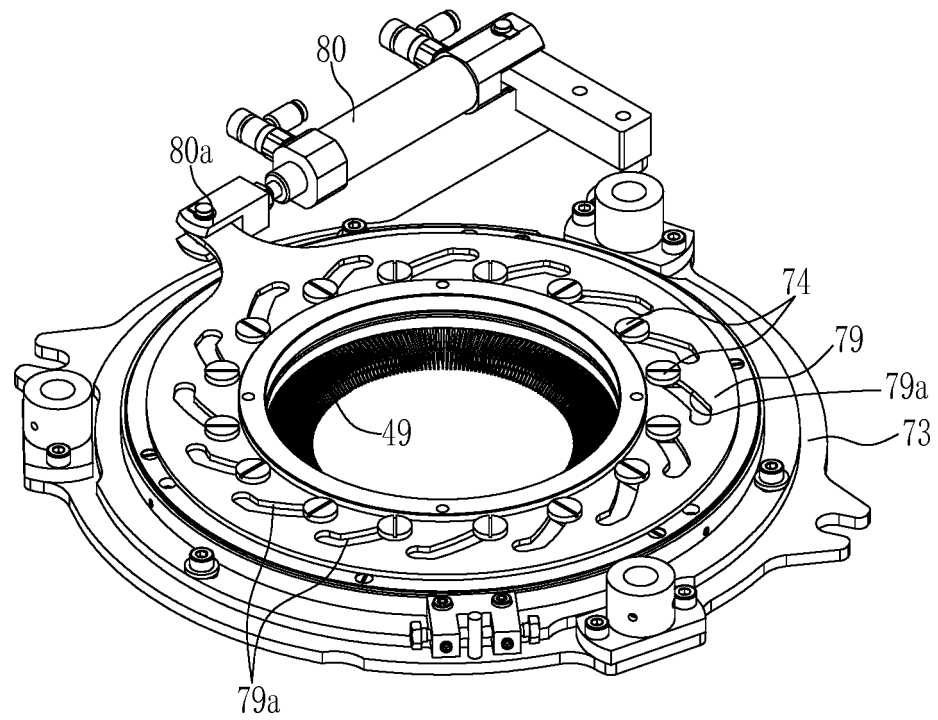


FIG.14

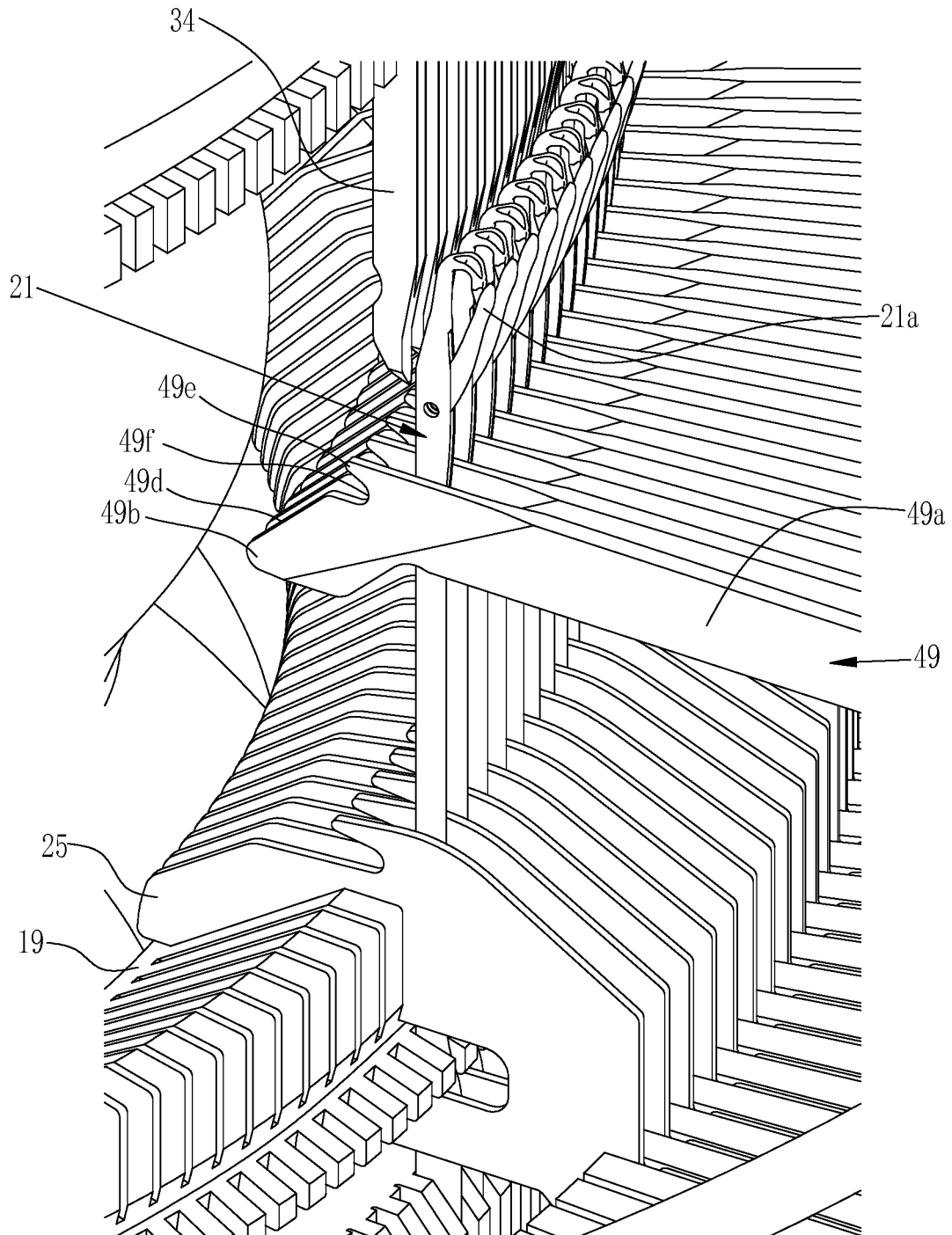


FIG.15

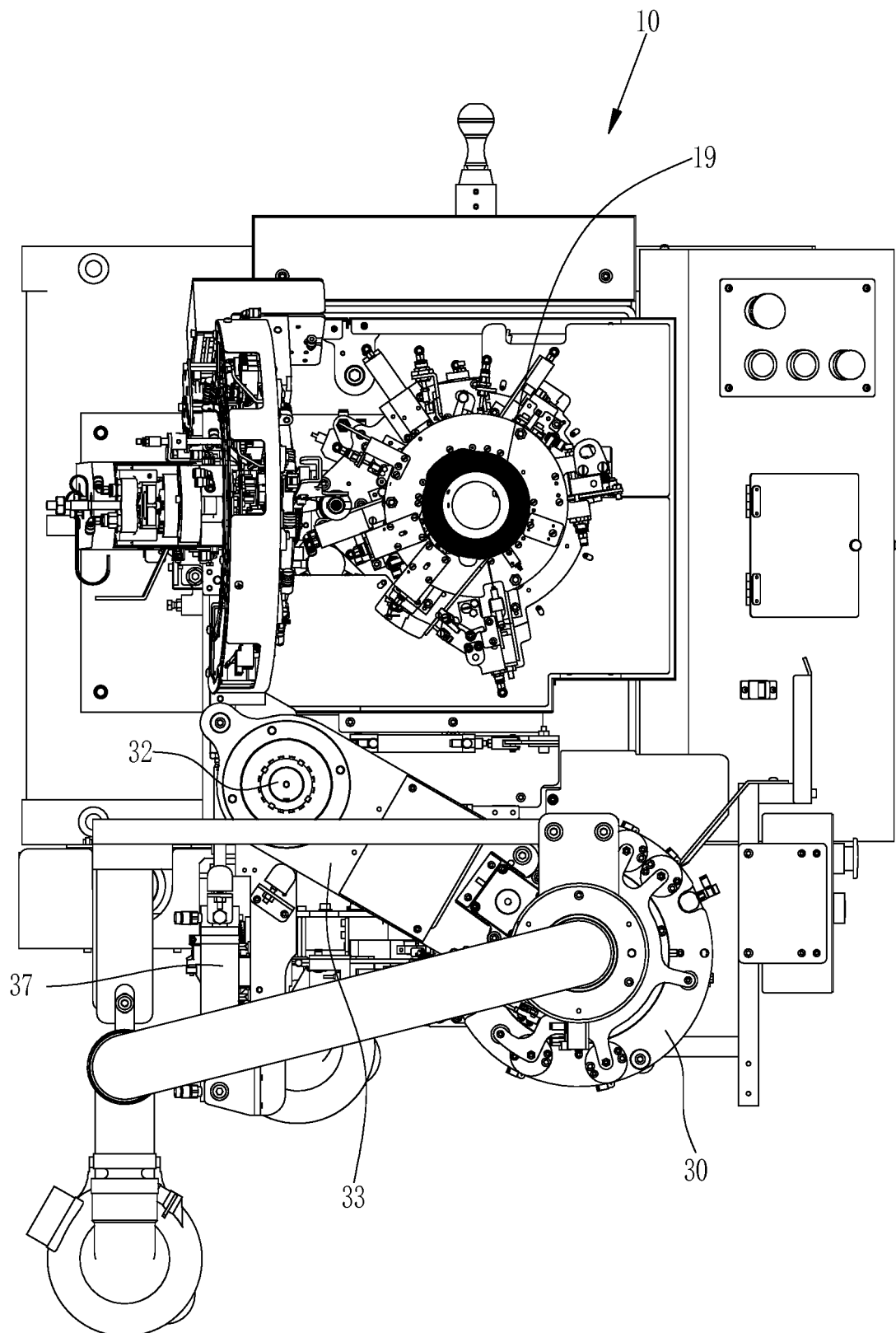


FIG.16

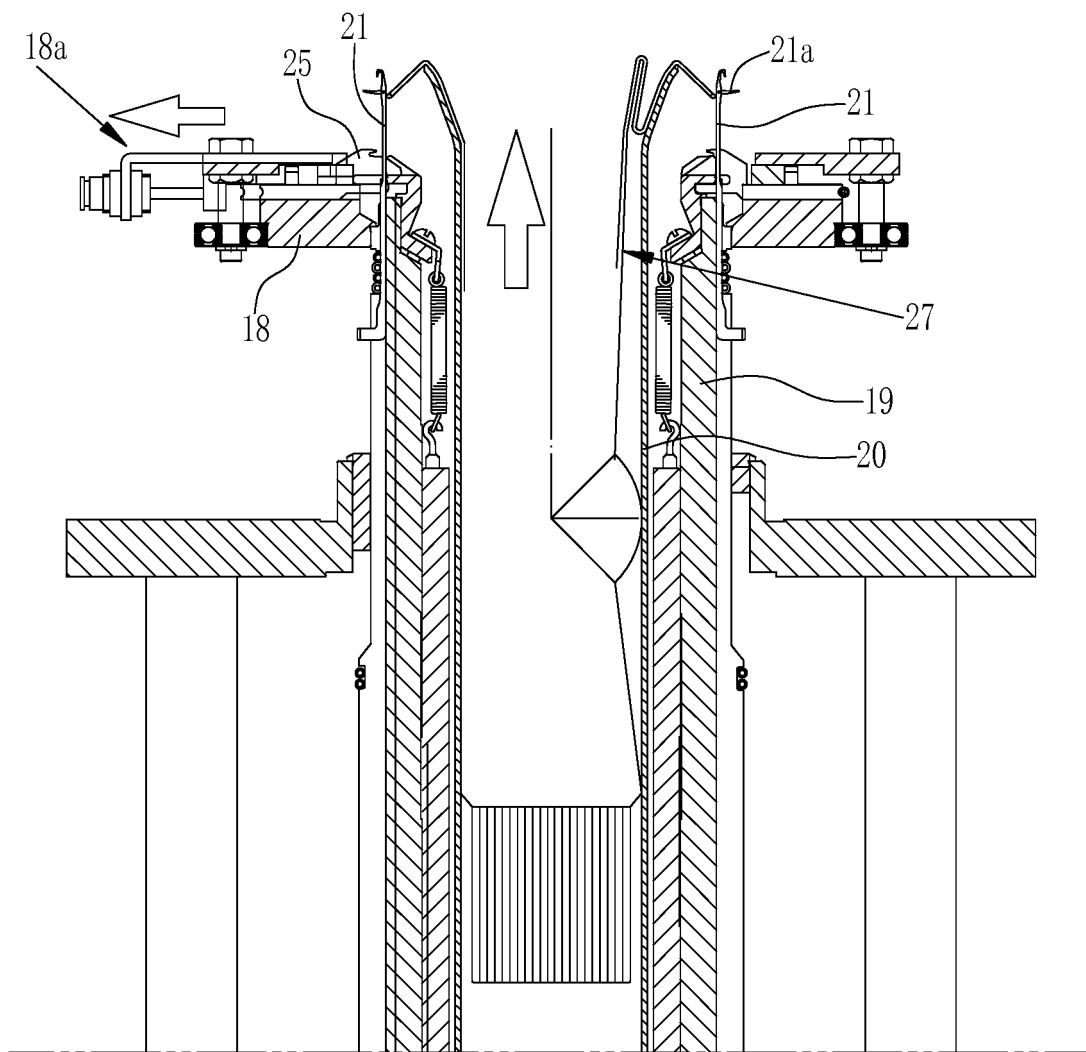


FIG.17

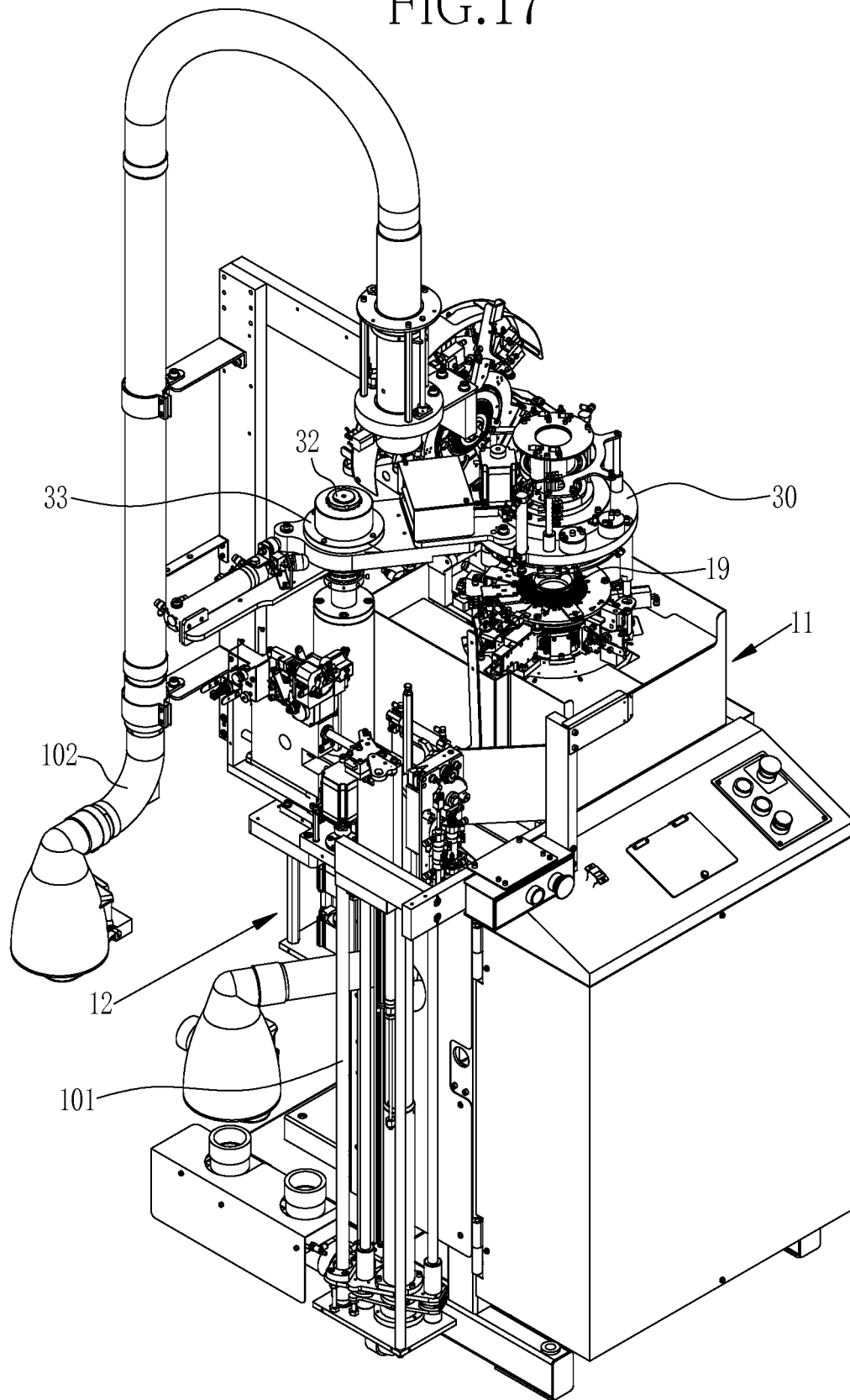


FIG.18

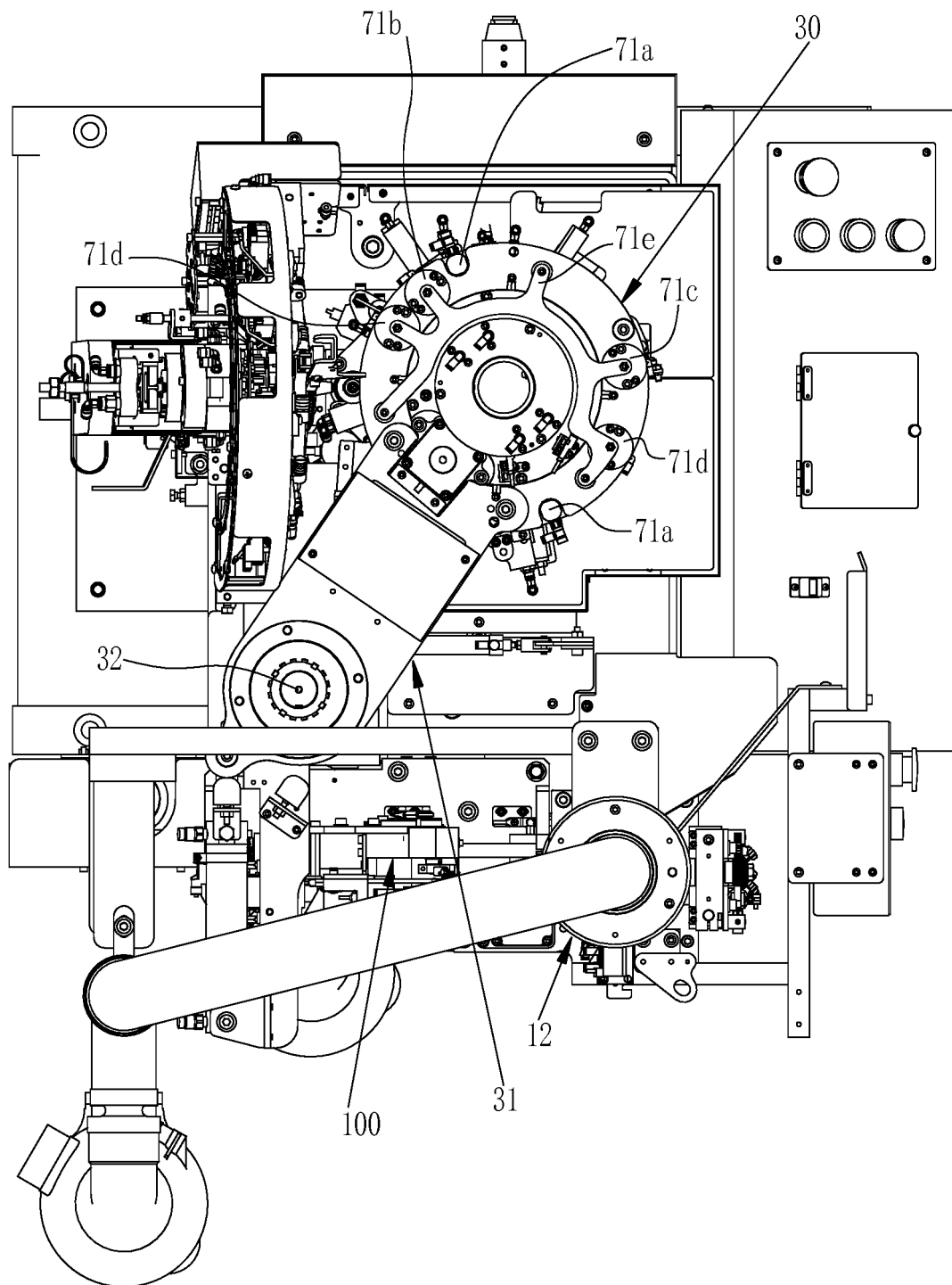


FIG.19

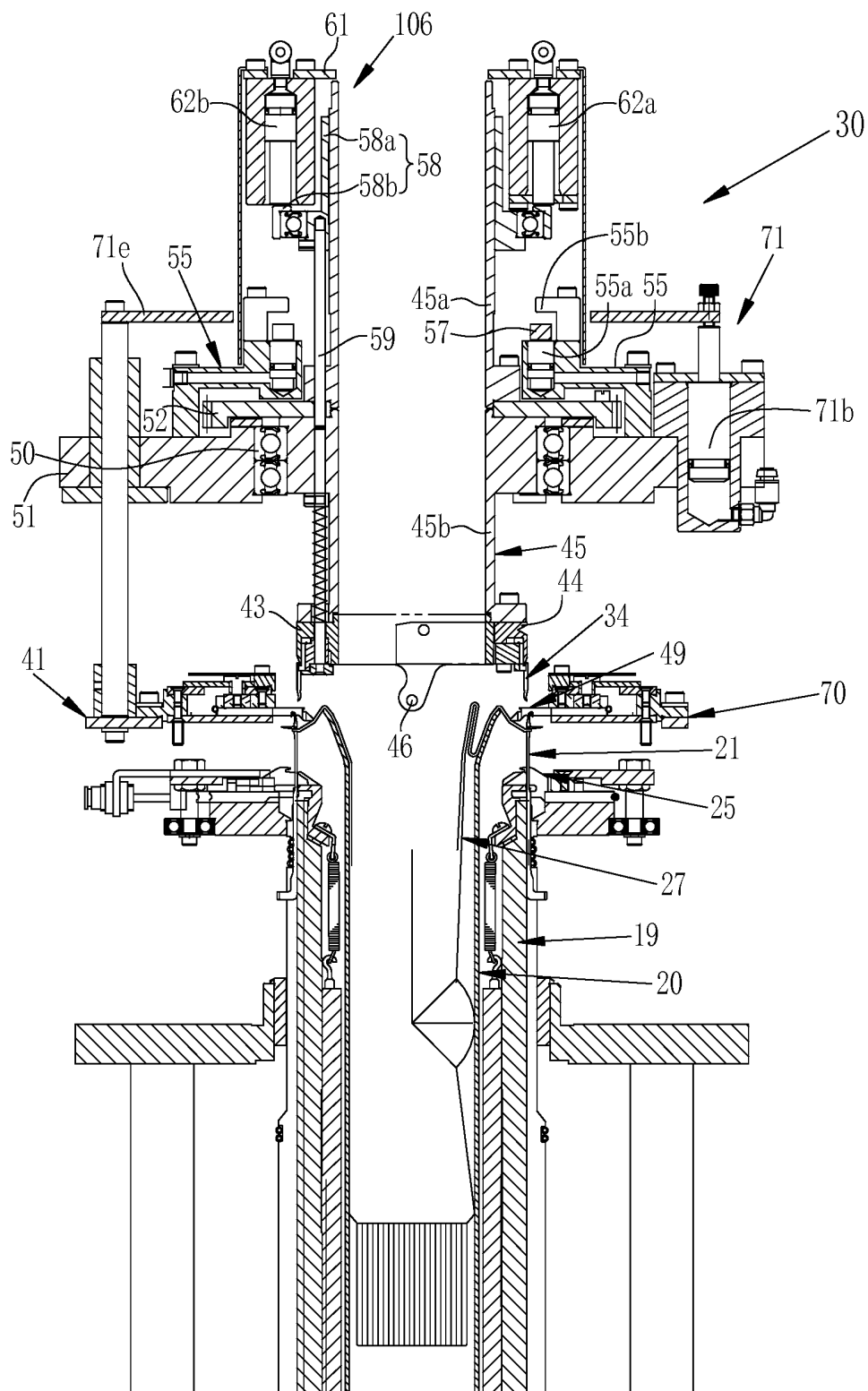


FIG.21

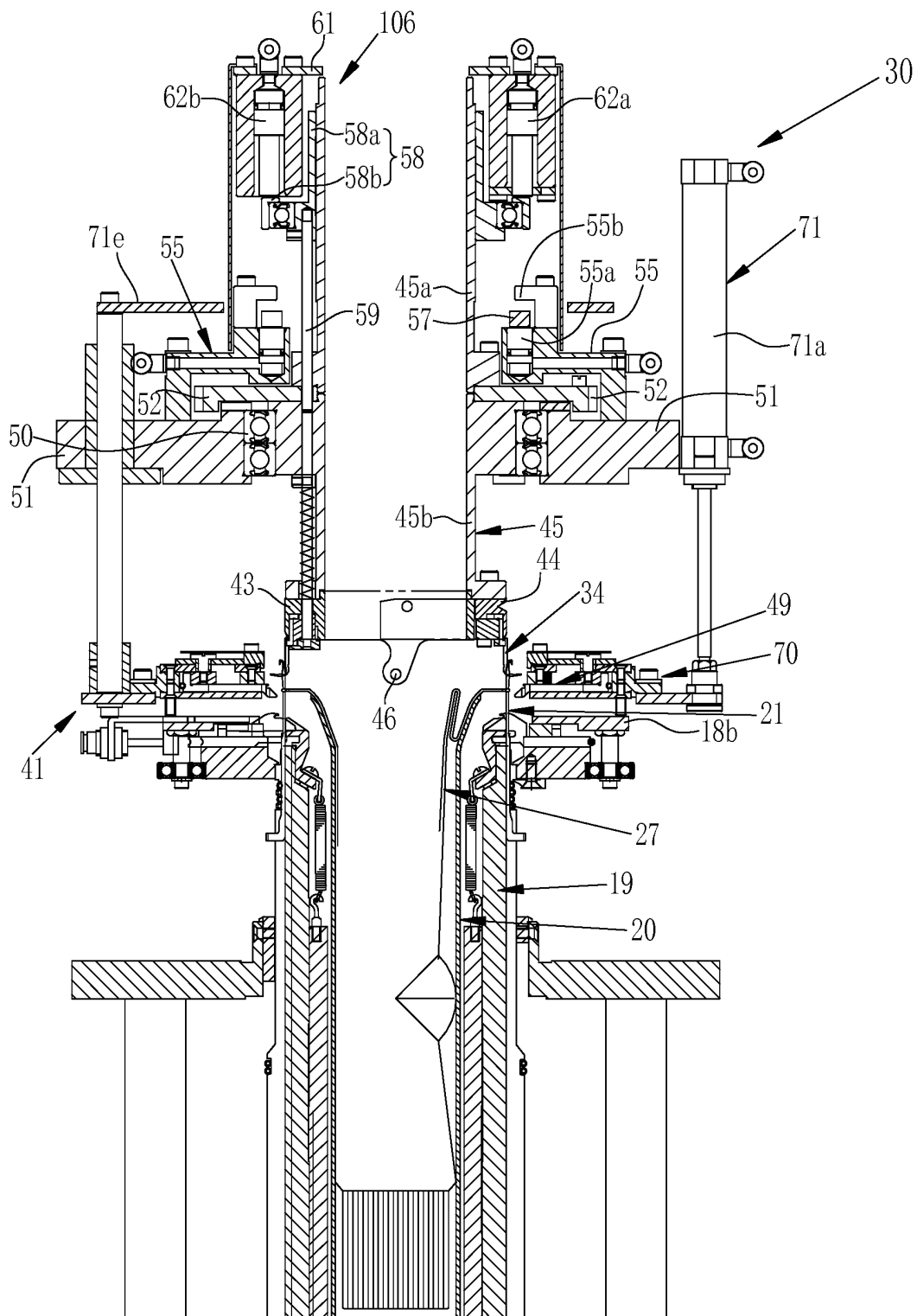


FIG.22

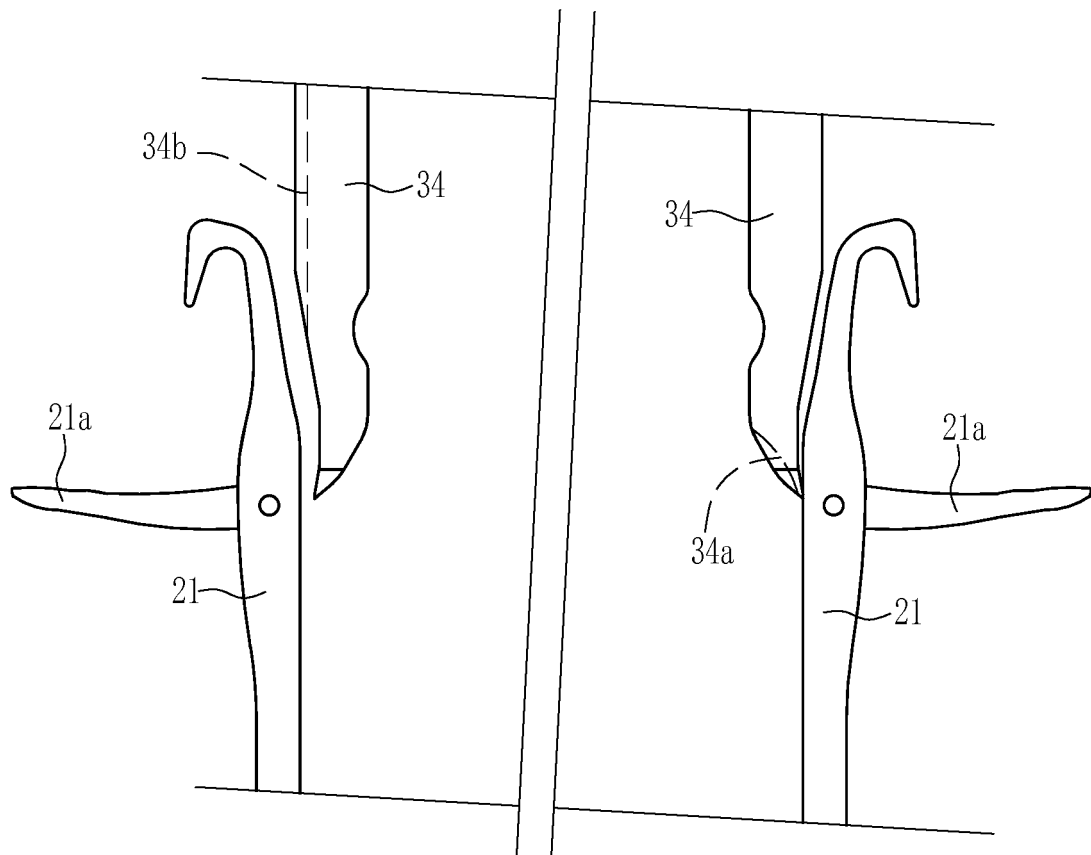


FIG.23

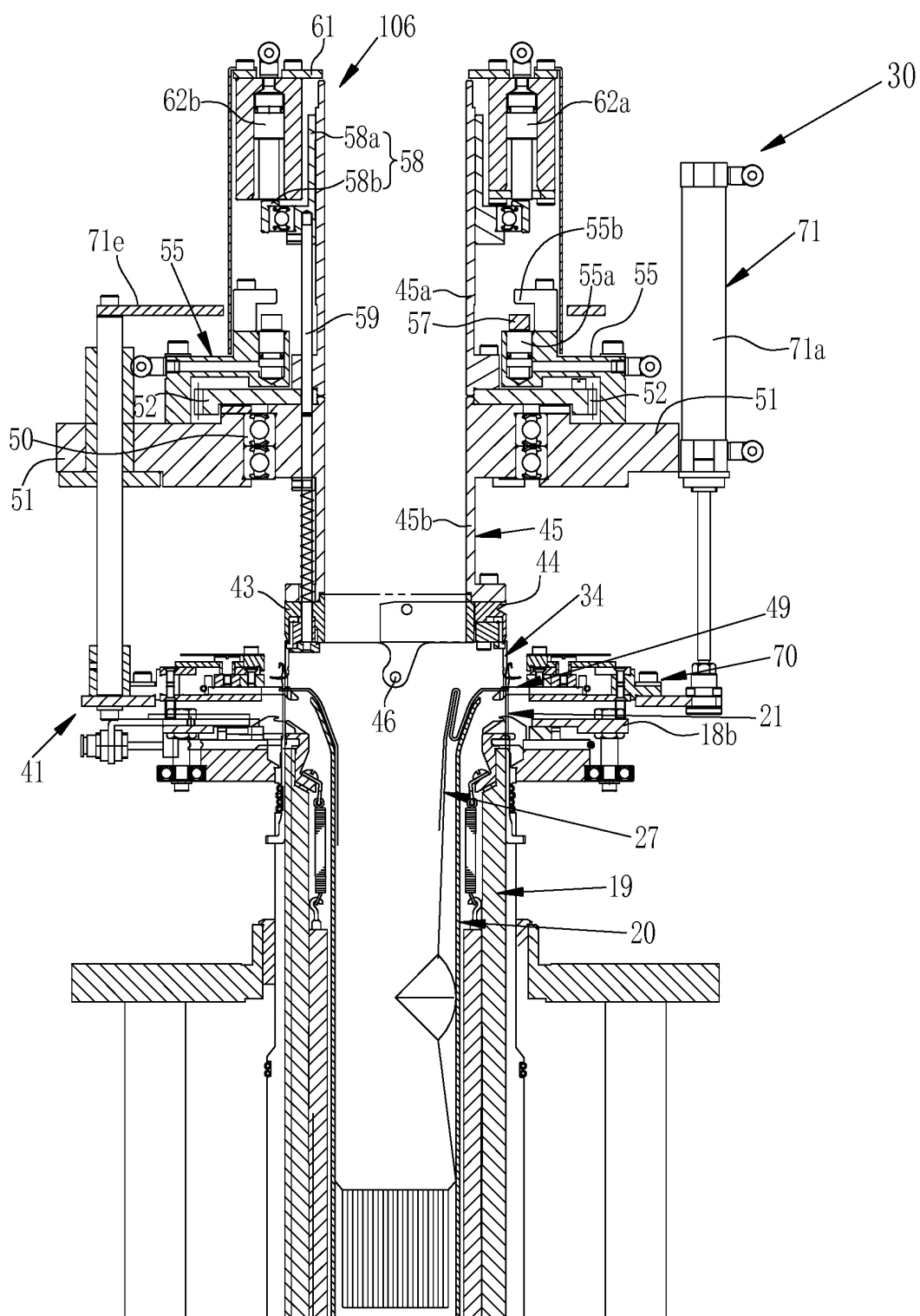


FIG.24

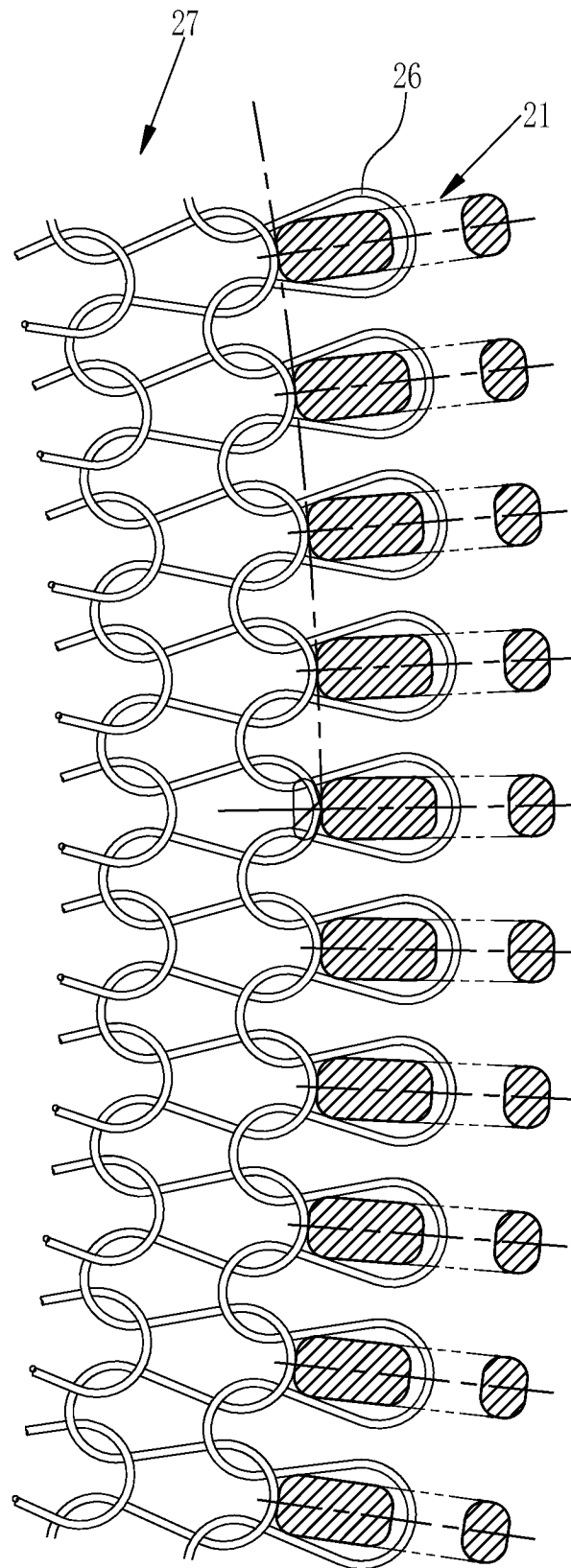


FIG.25

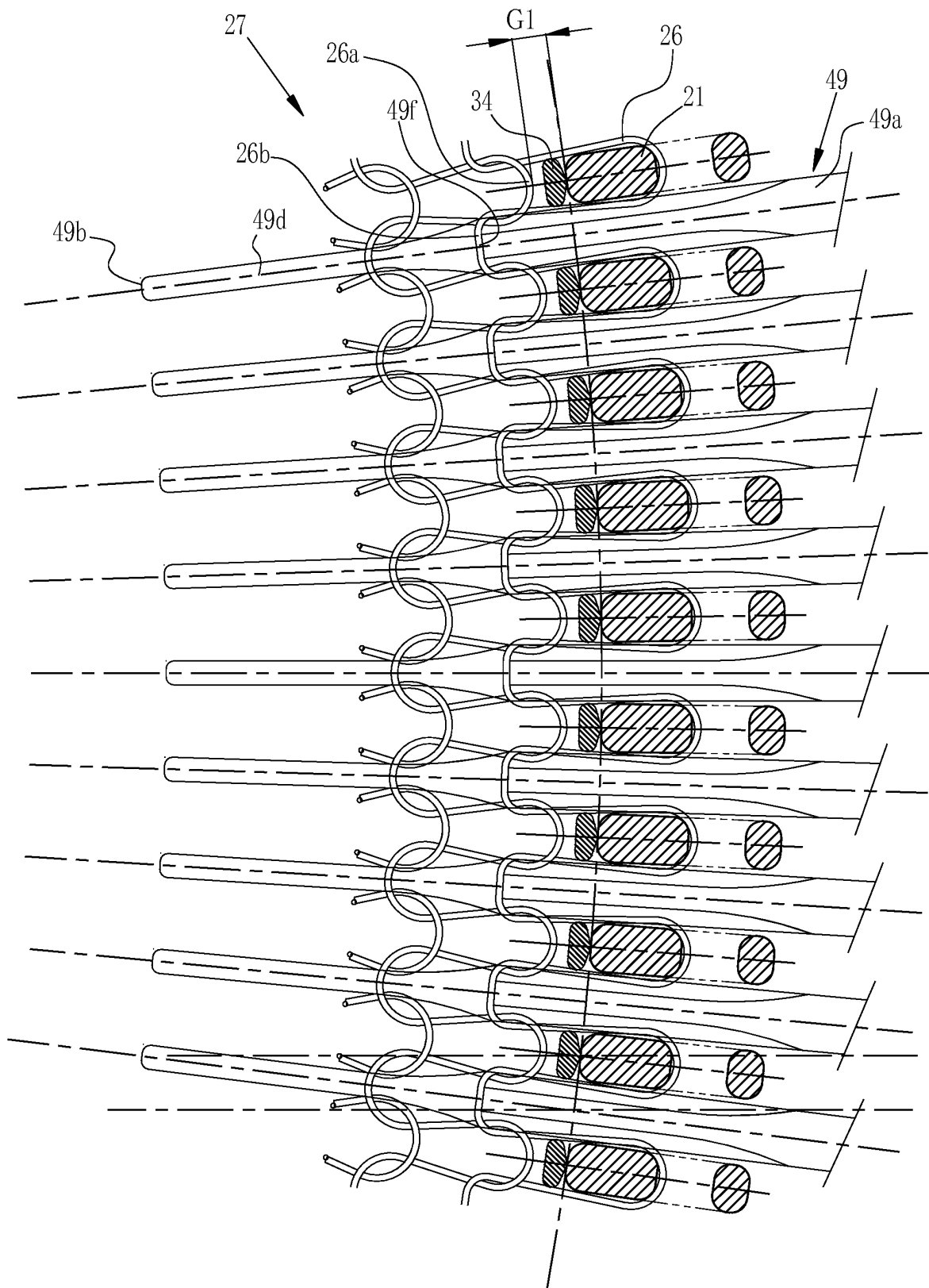


FIG.26

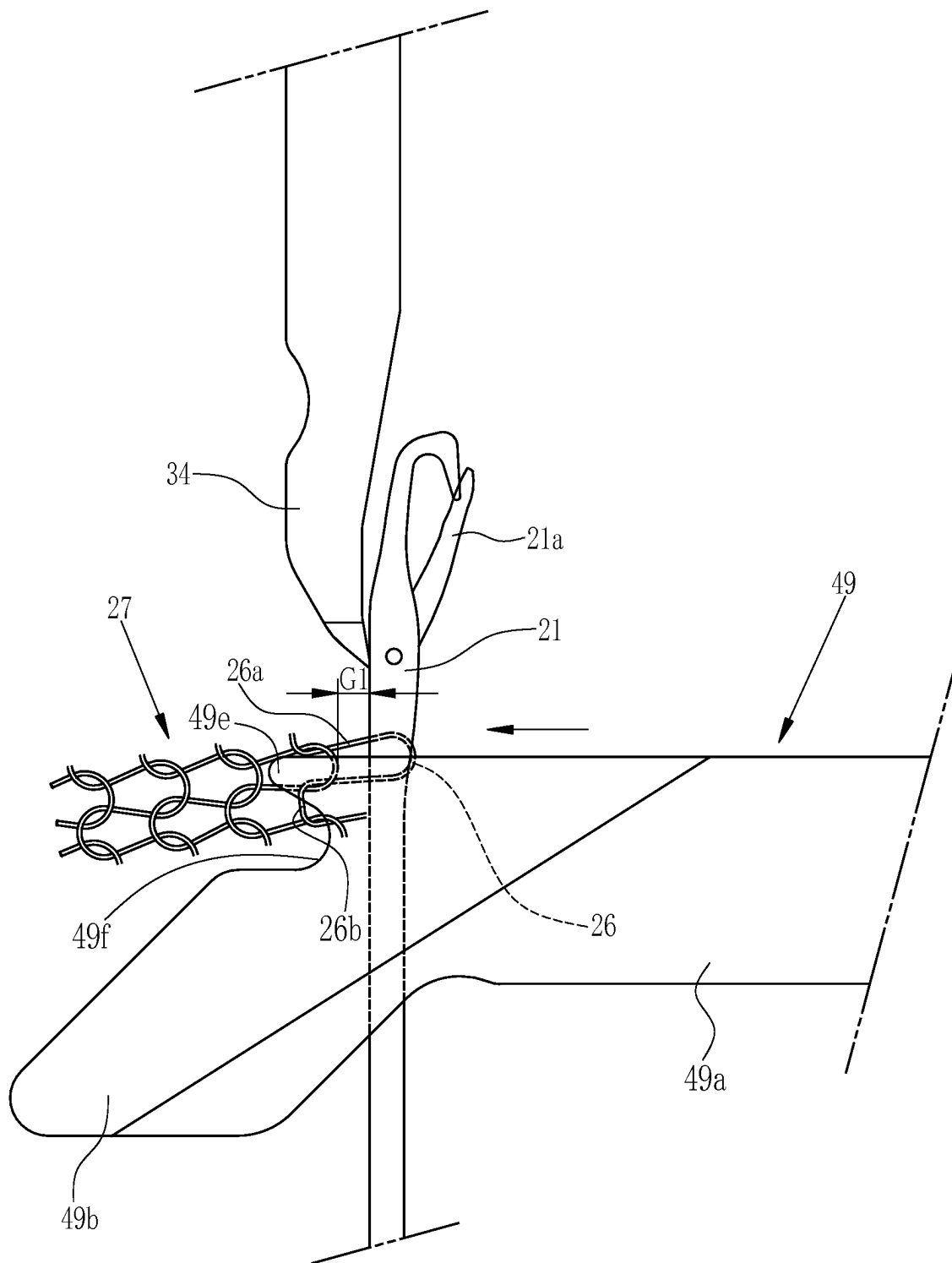


FIG.27

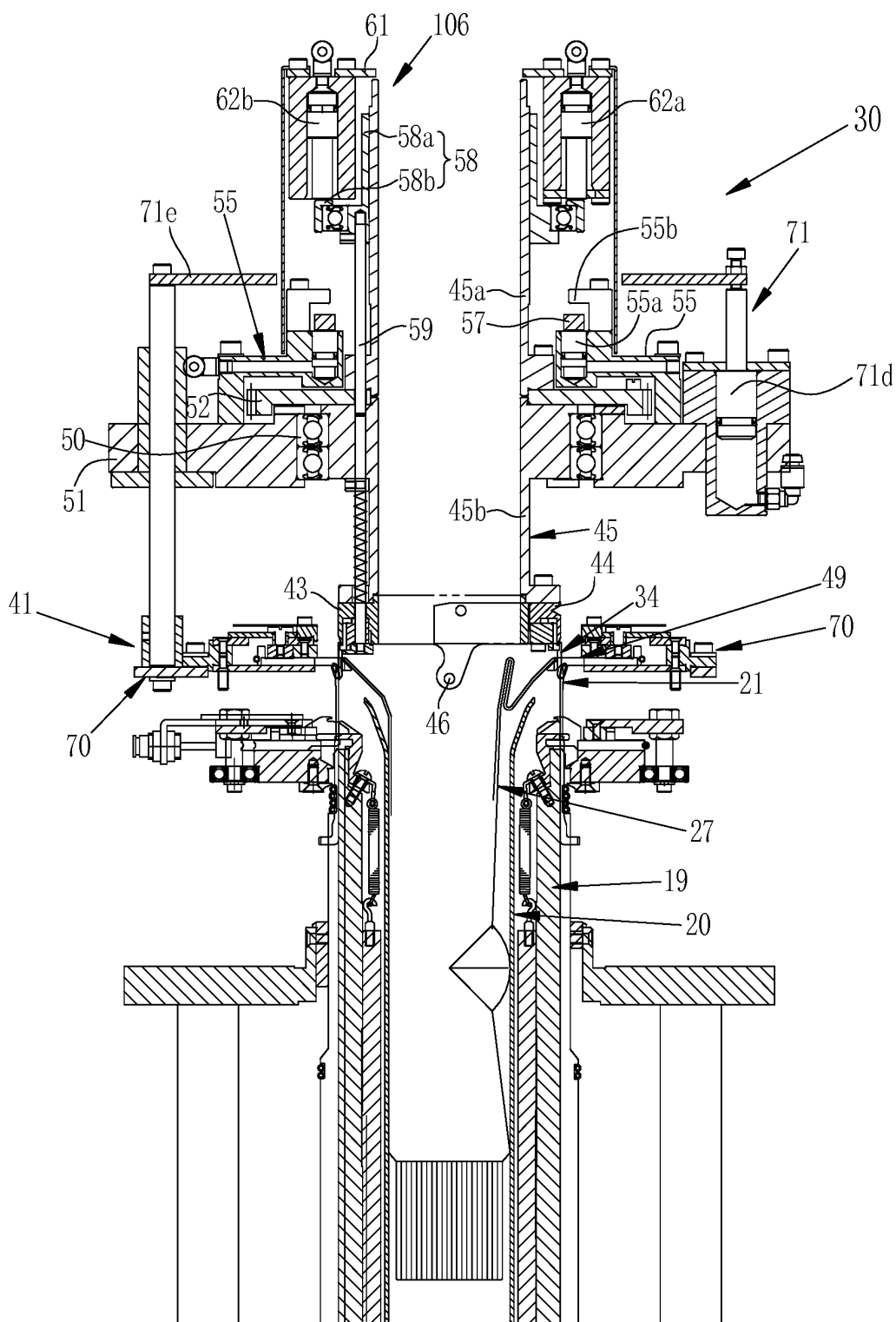


FIG.28

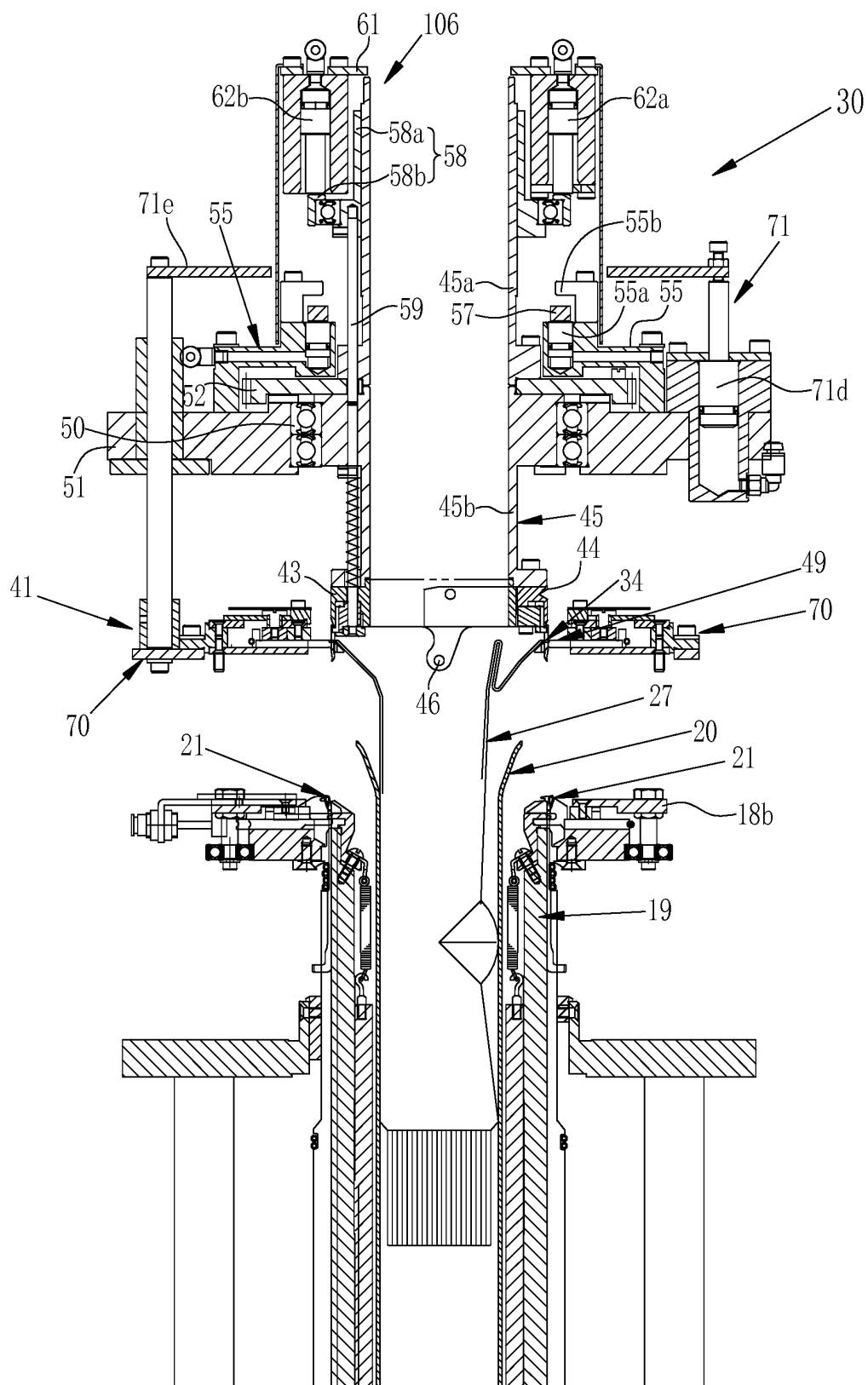


FIG.29

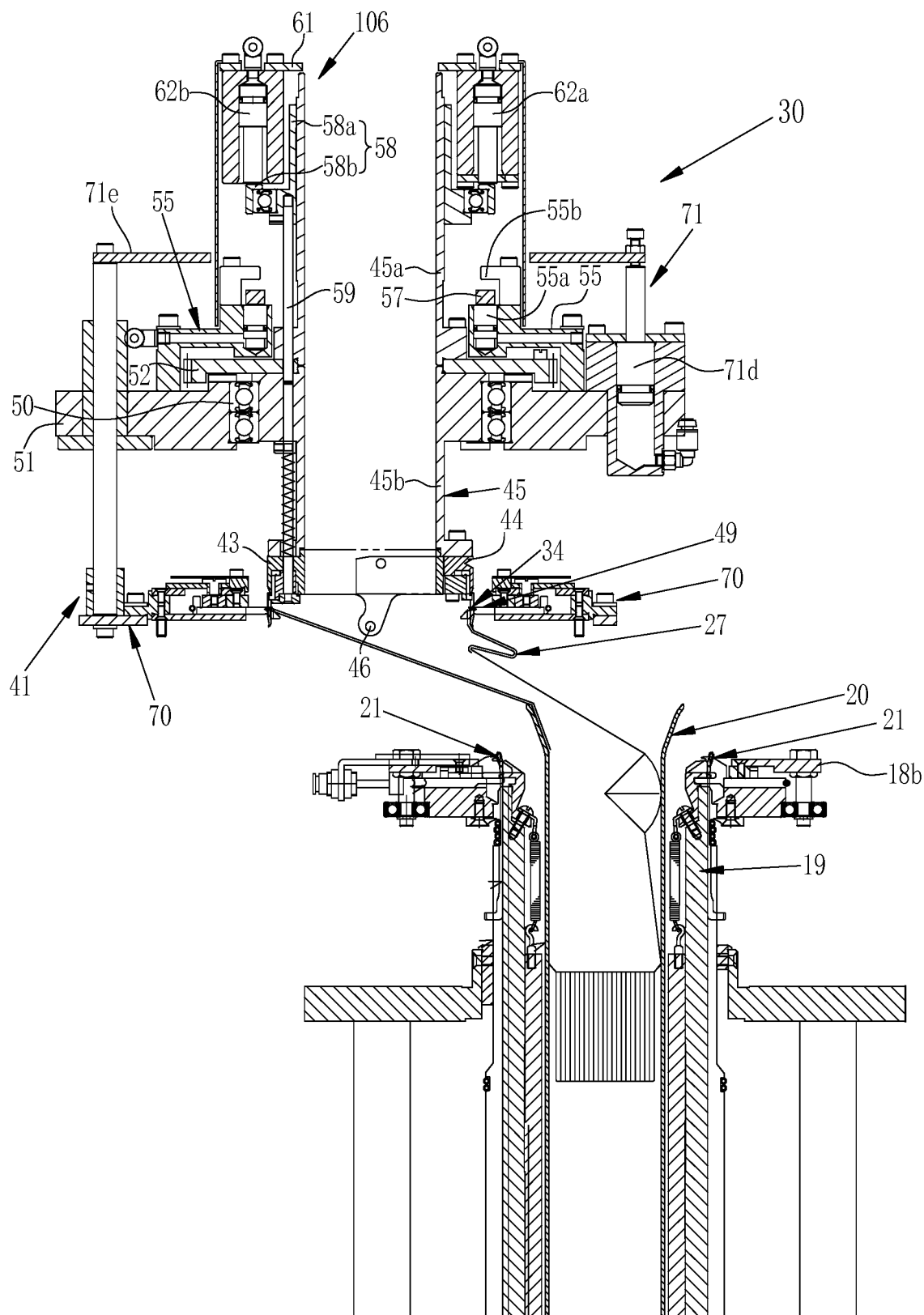


FIG.30

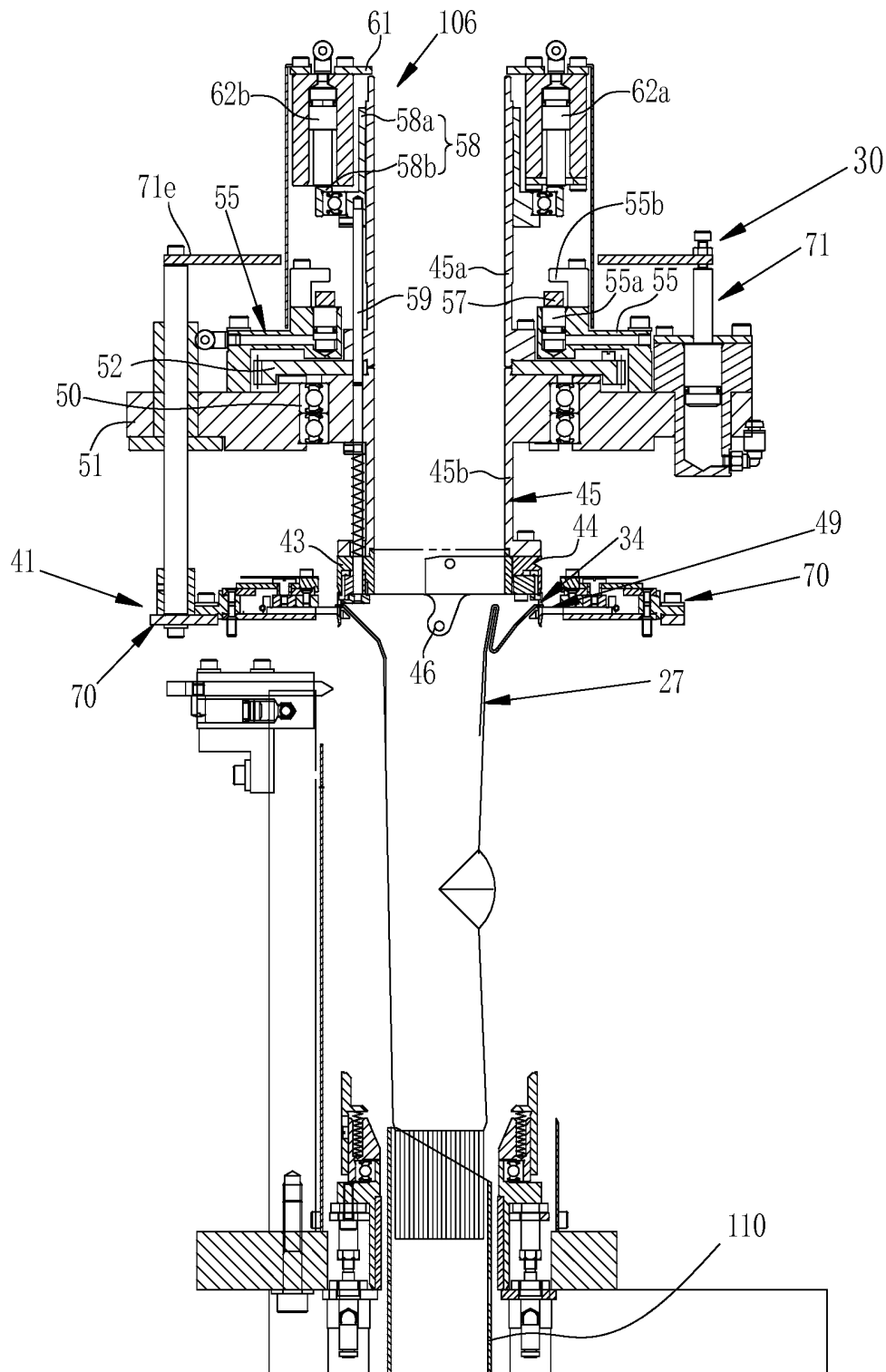


FIG.31

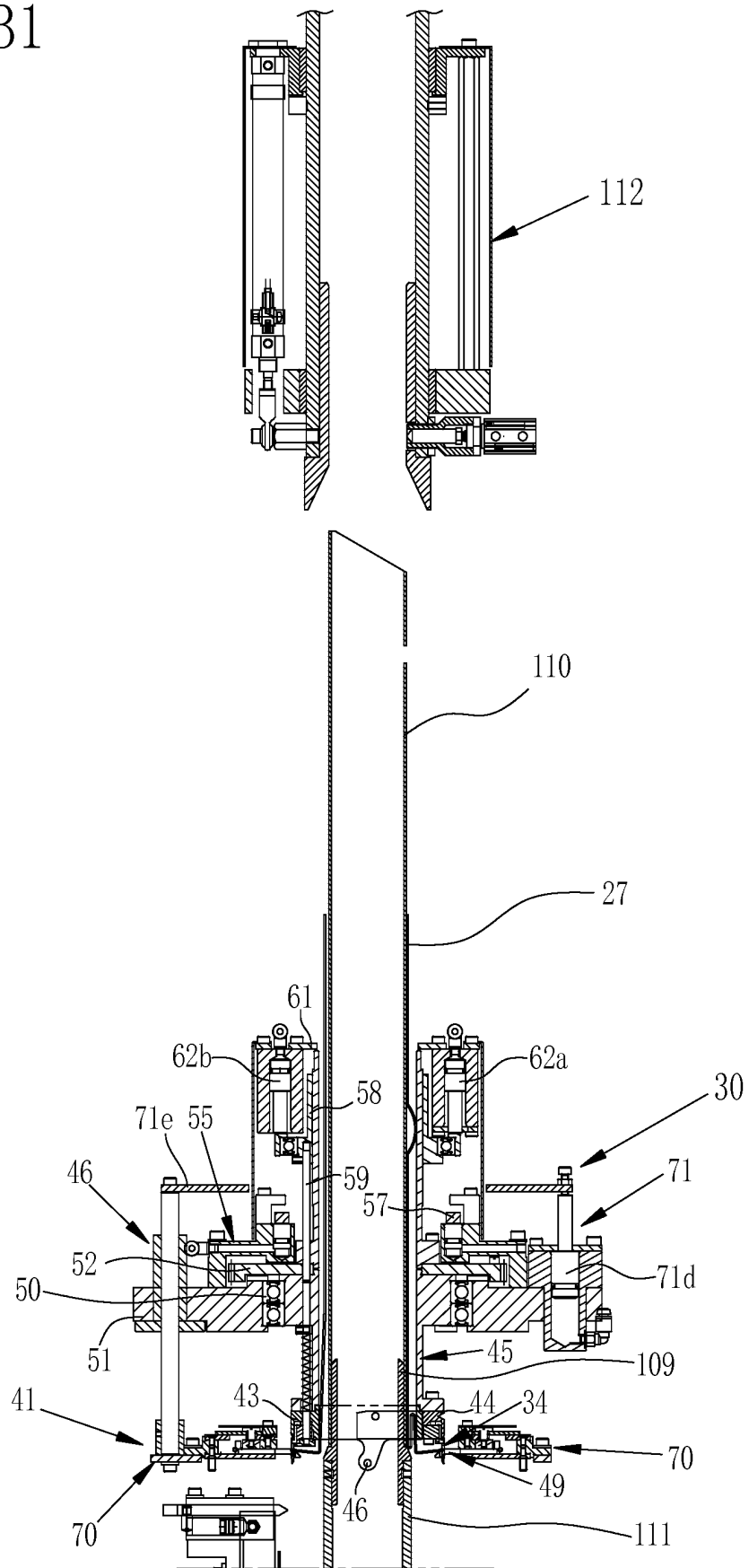


FIG.32

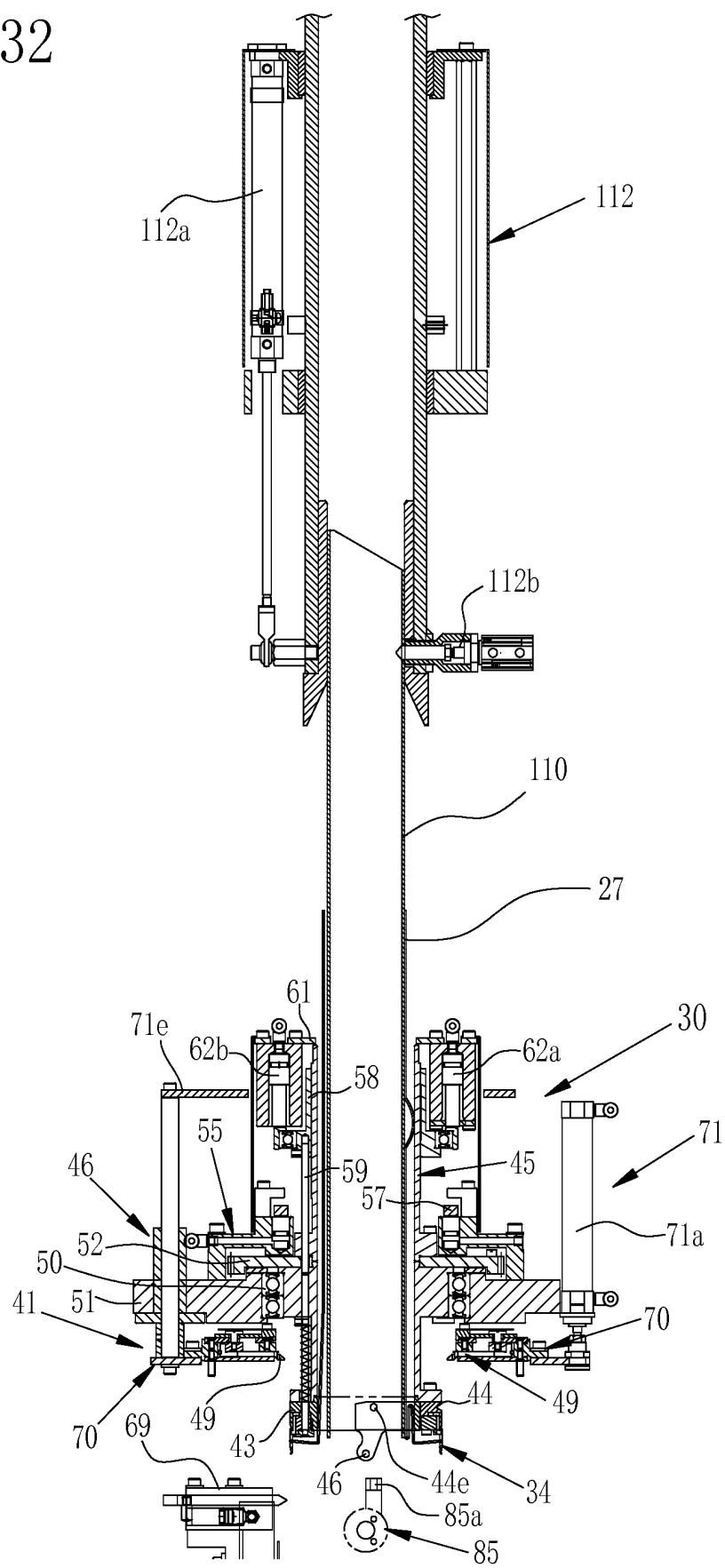


FIG.33

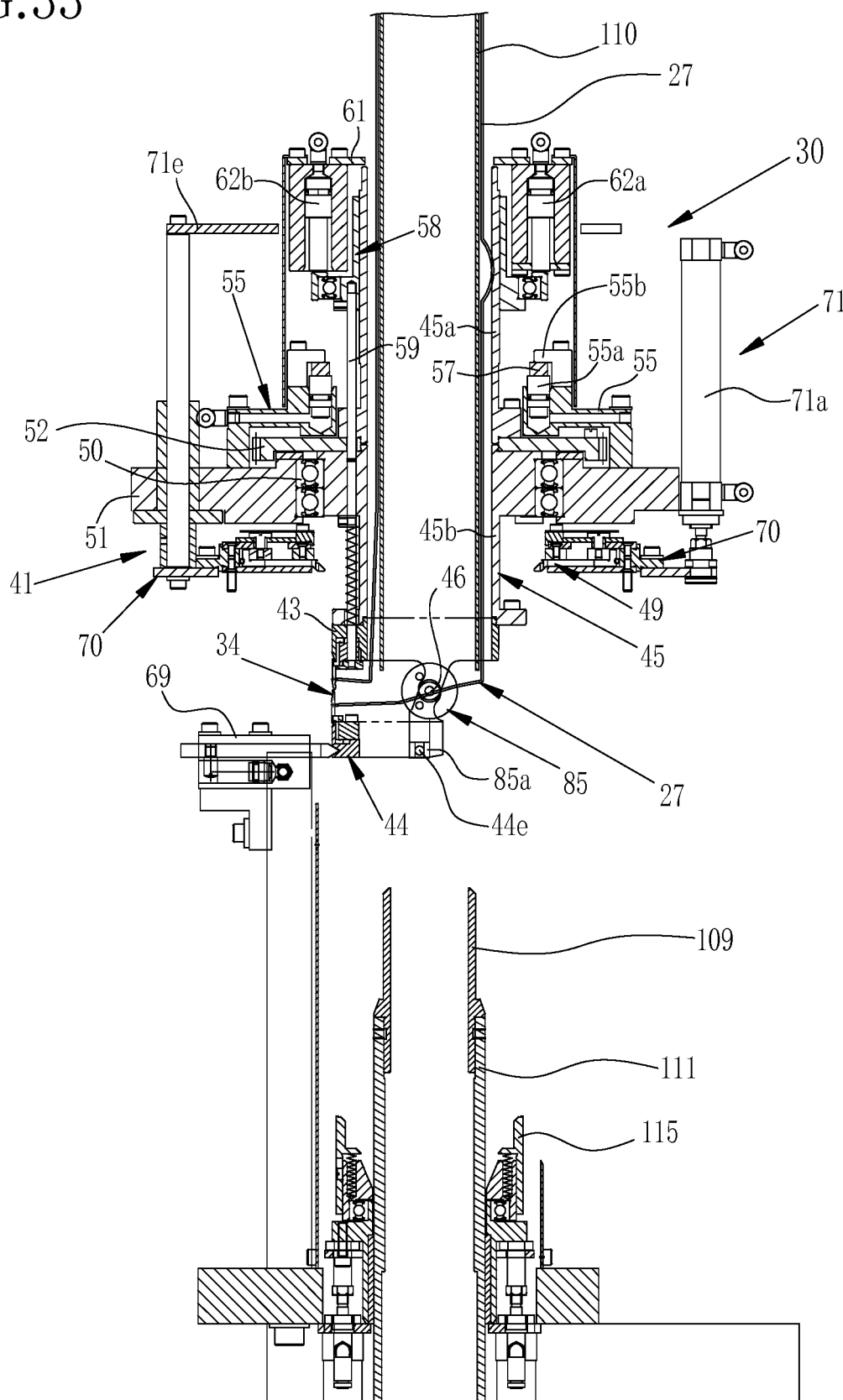


FIG.34

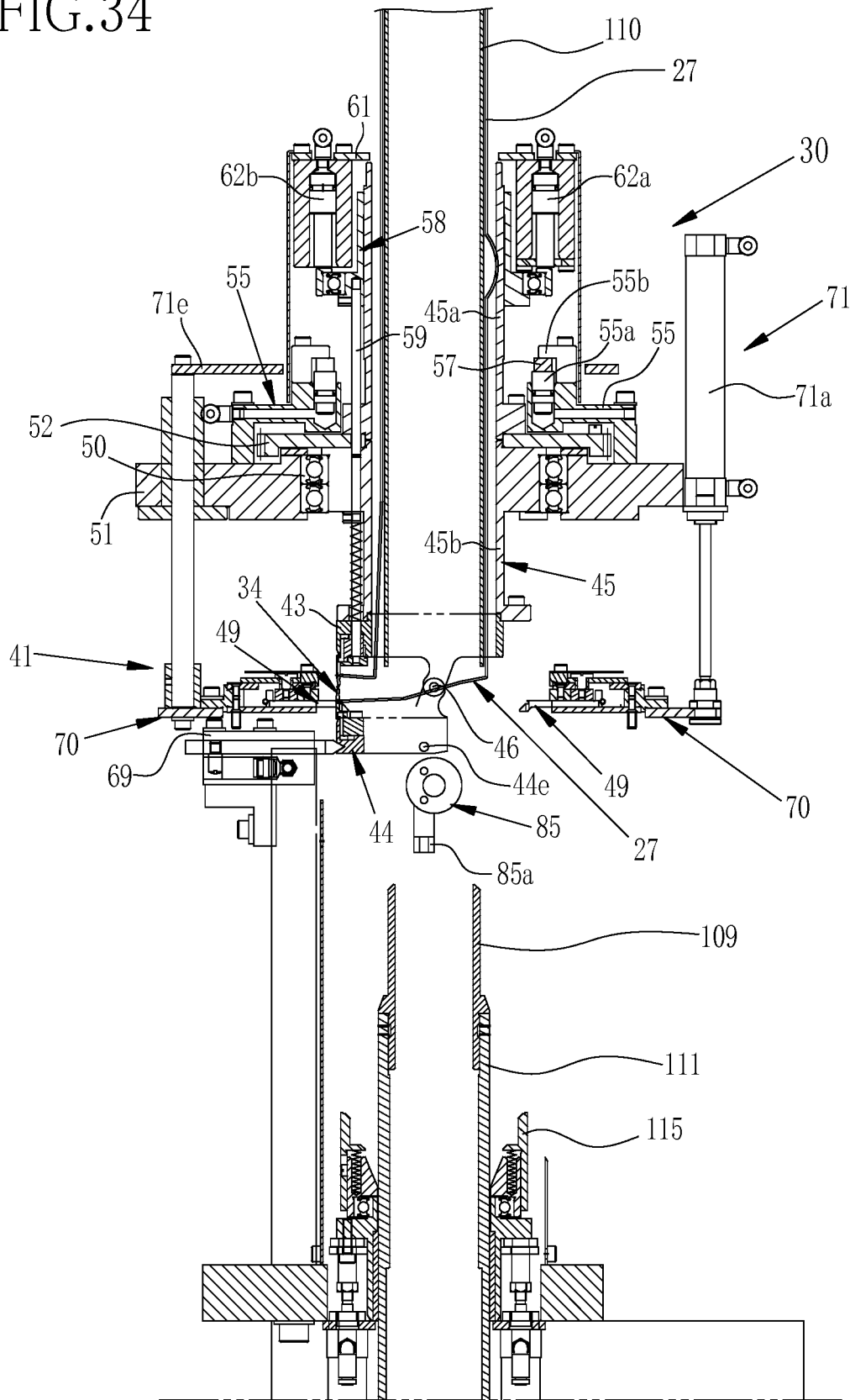


FIG.35

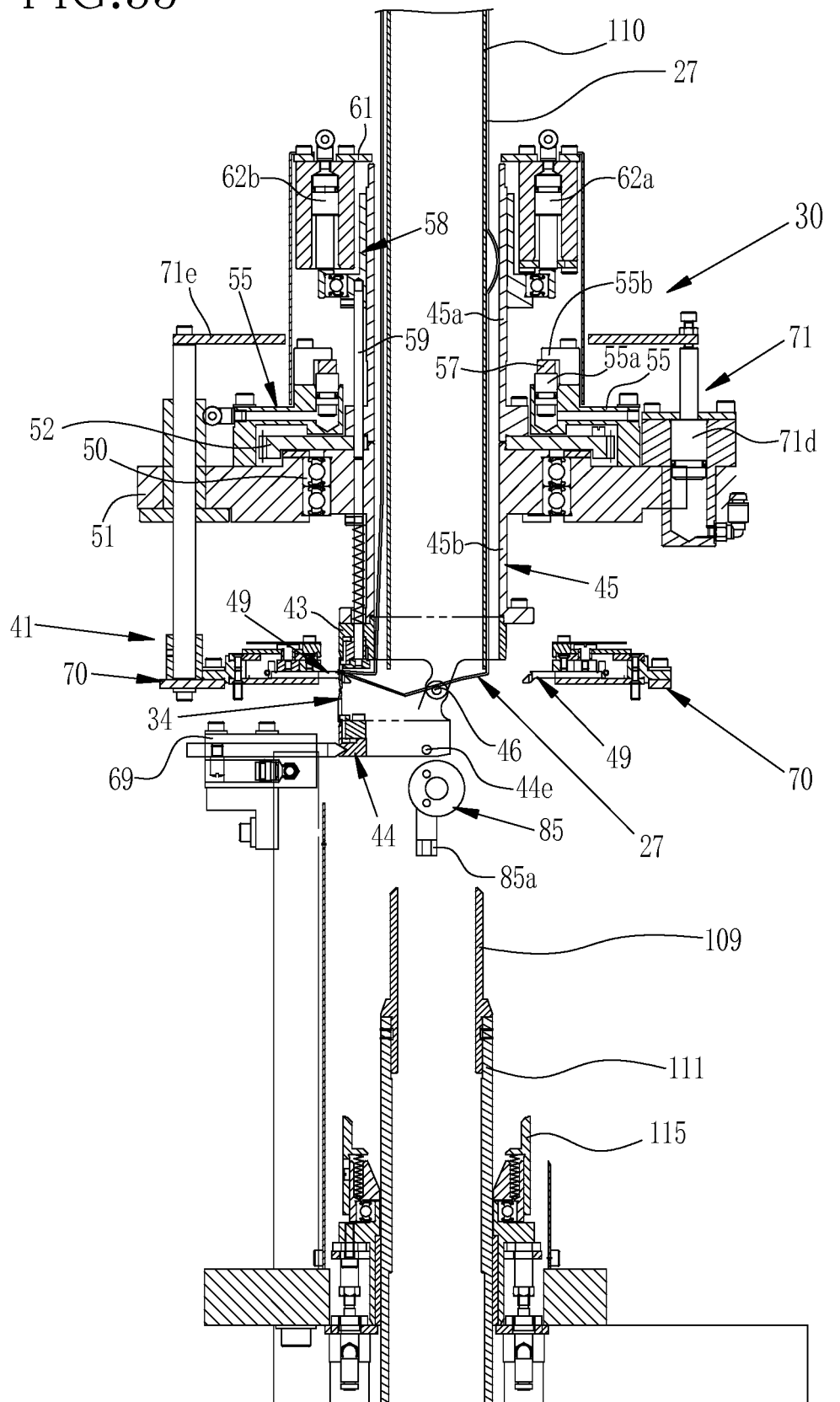


FIG.36

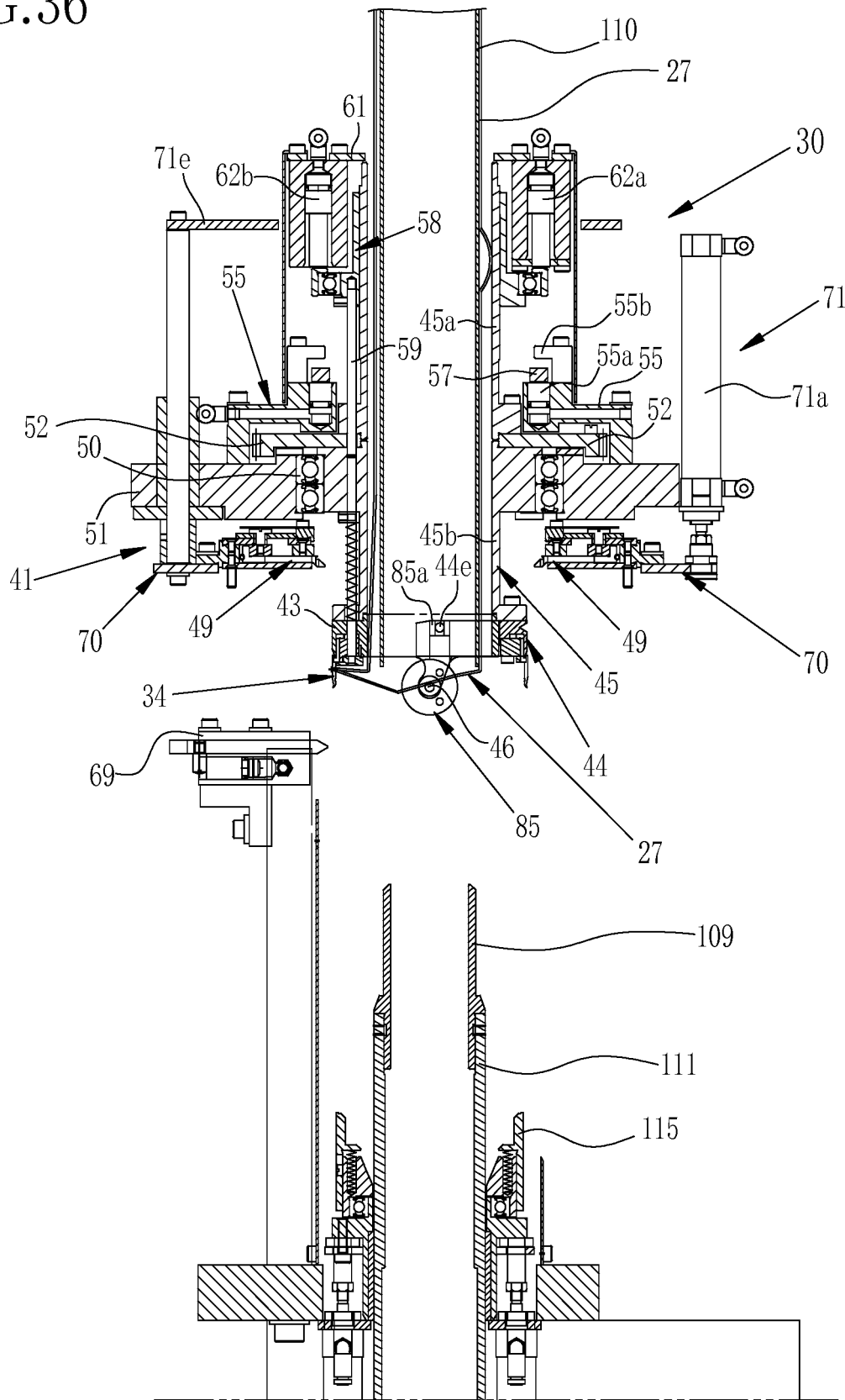


FIG.37

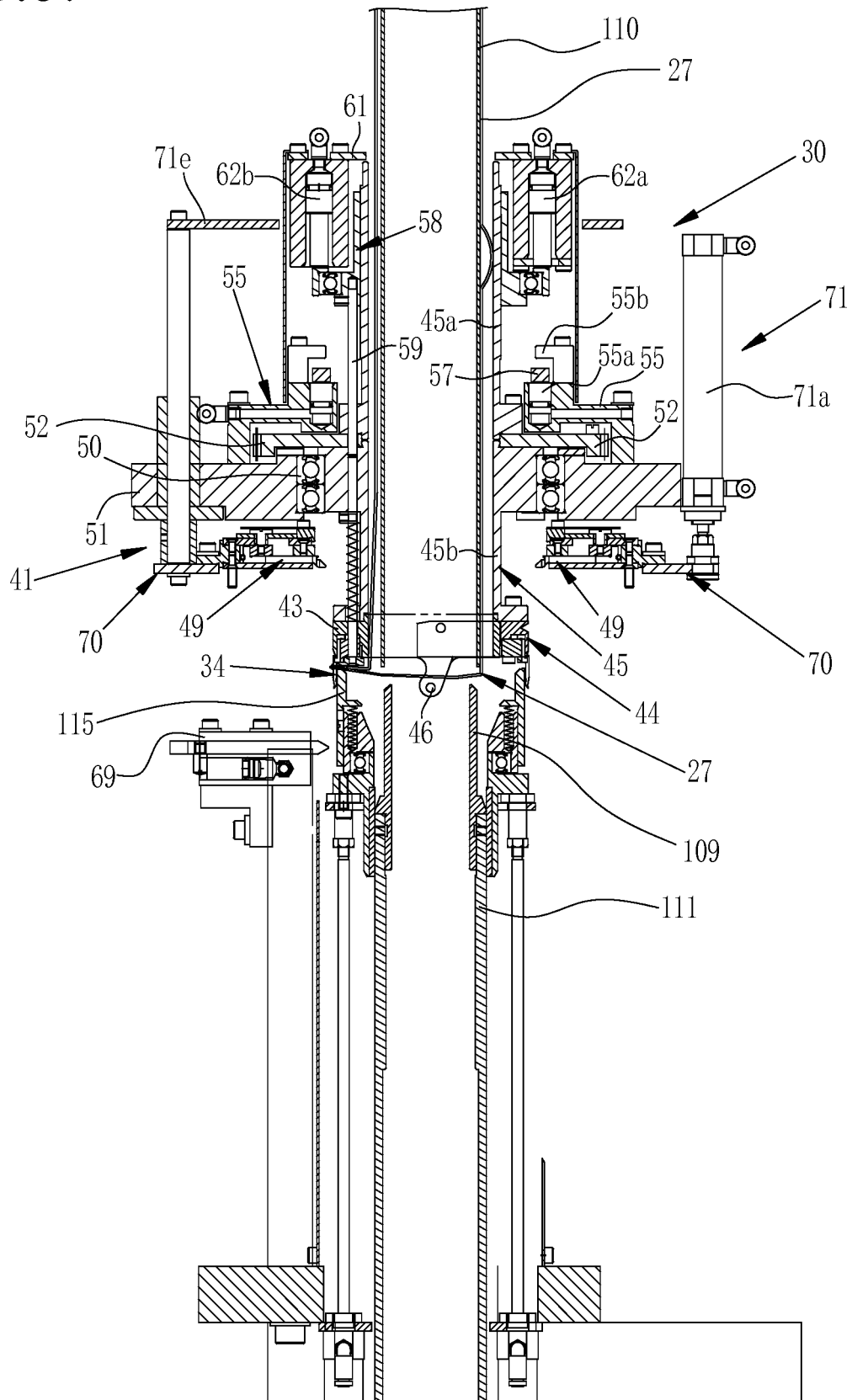


FIG.38

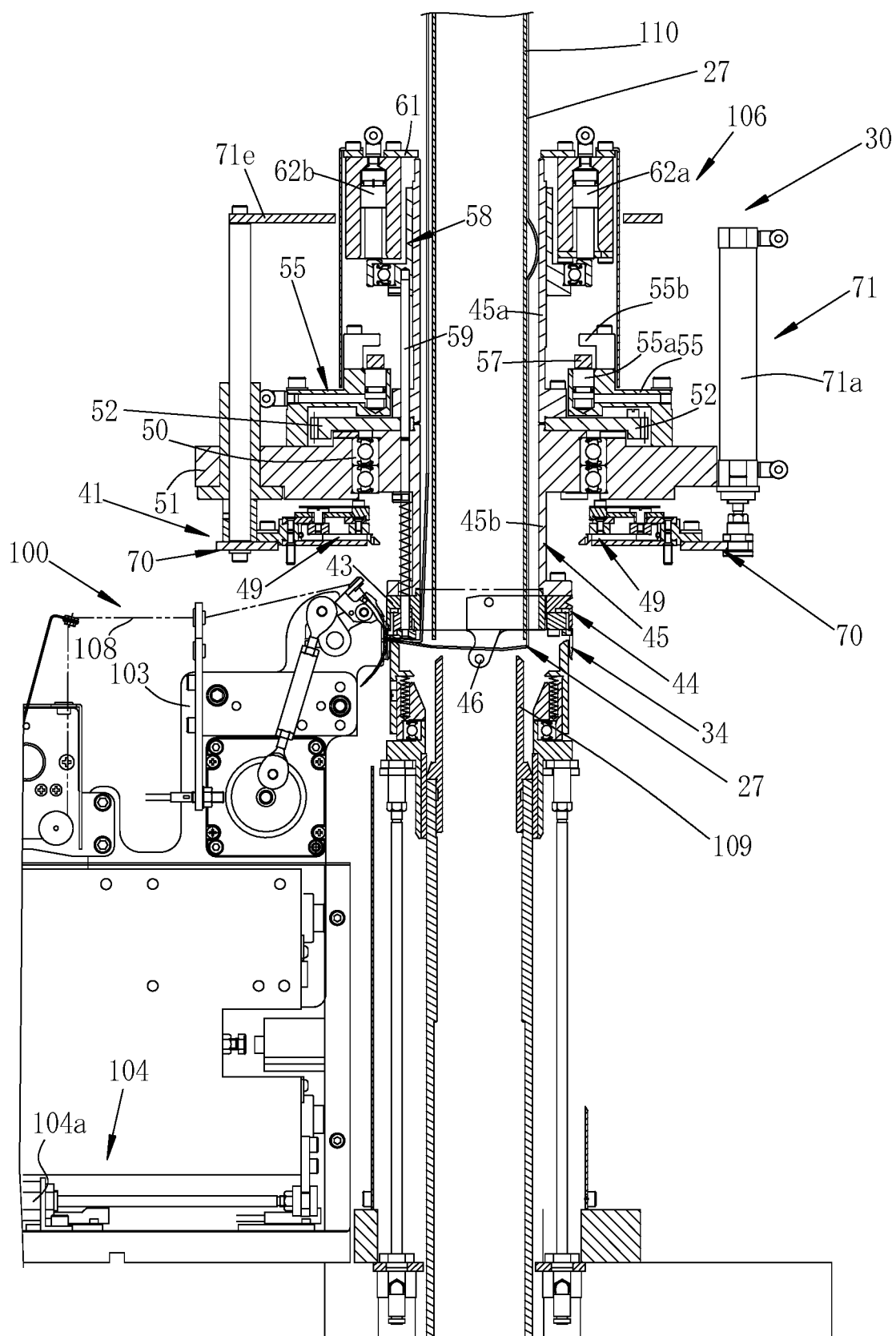


FIG.39

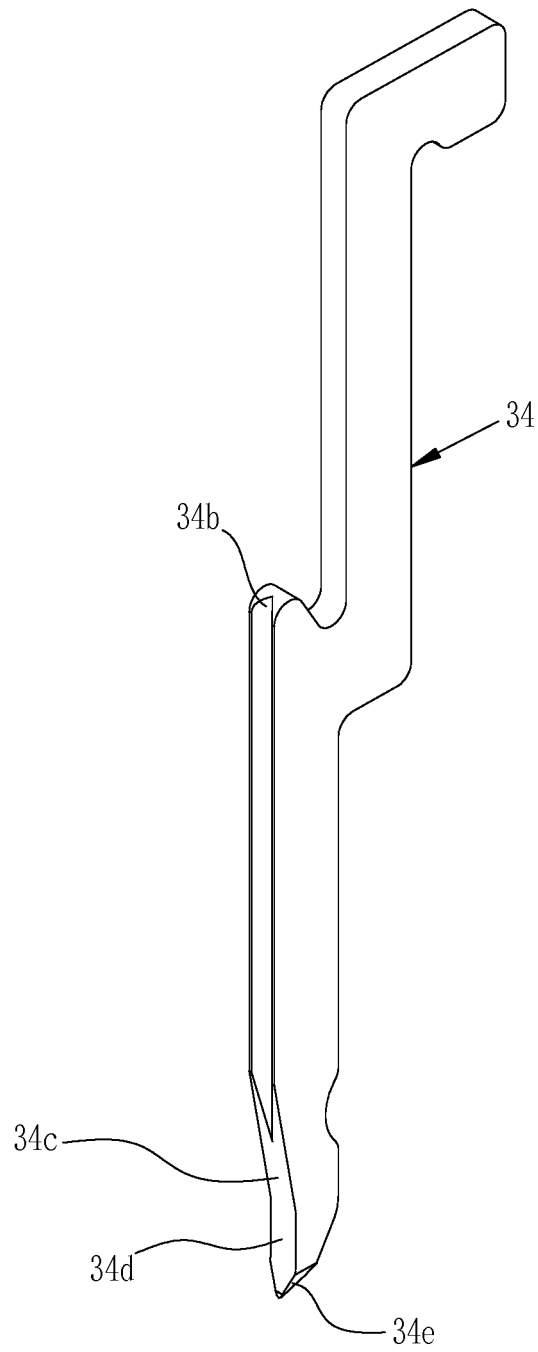


FIG.40

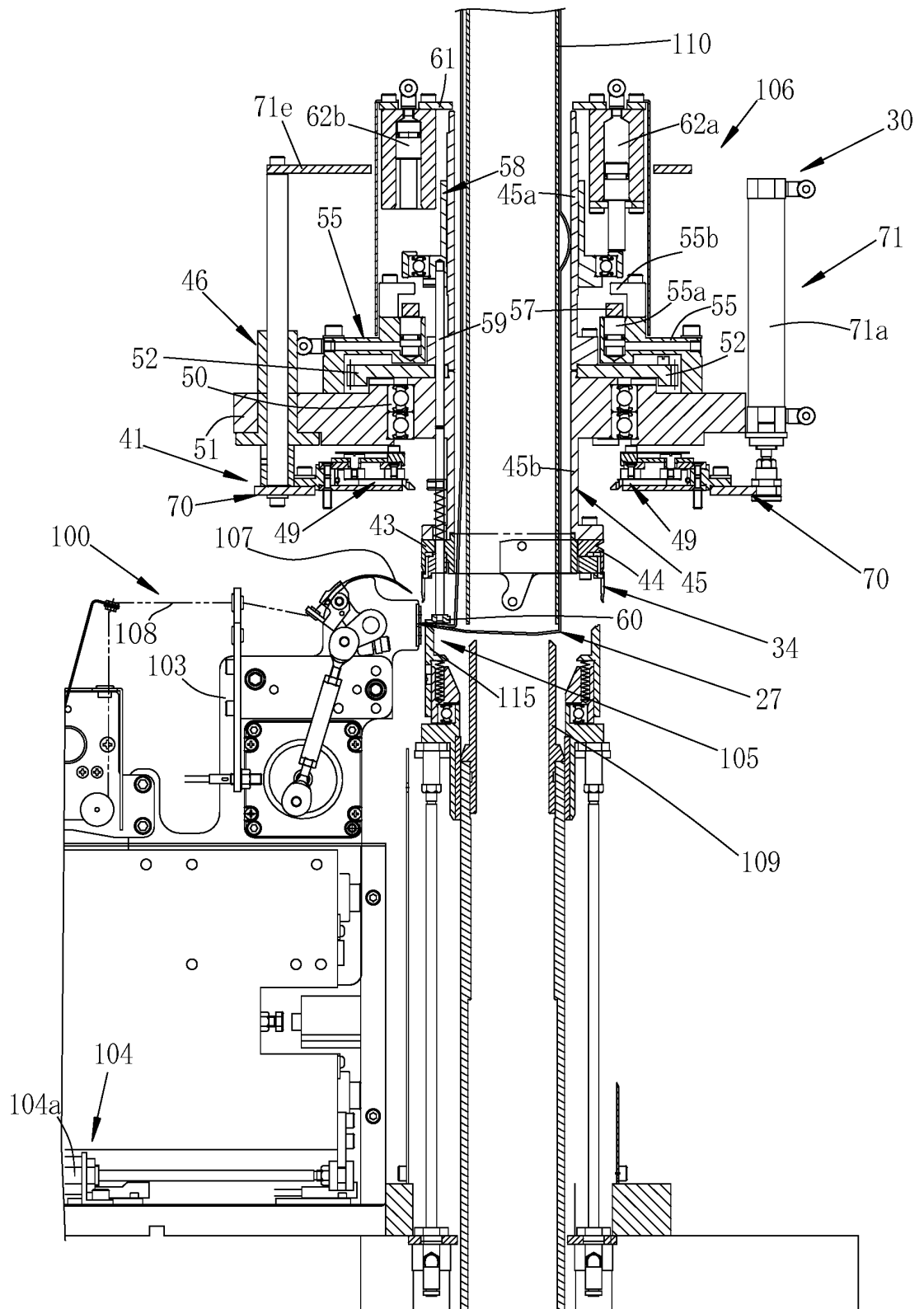


FIG.41

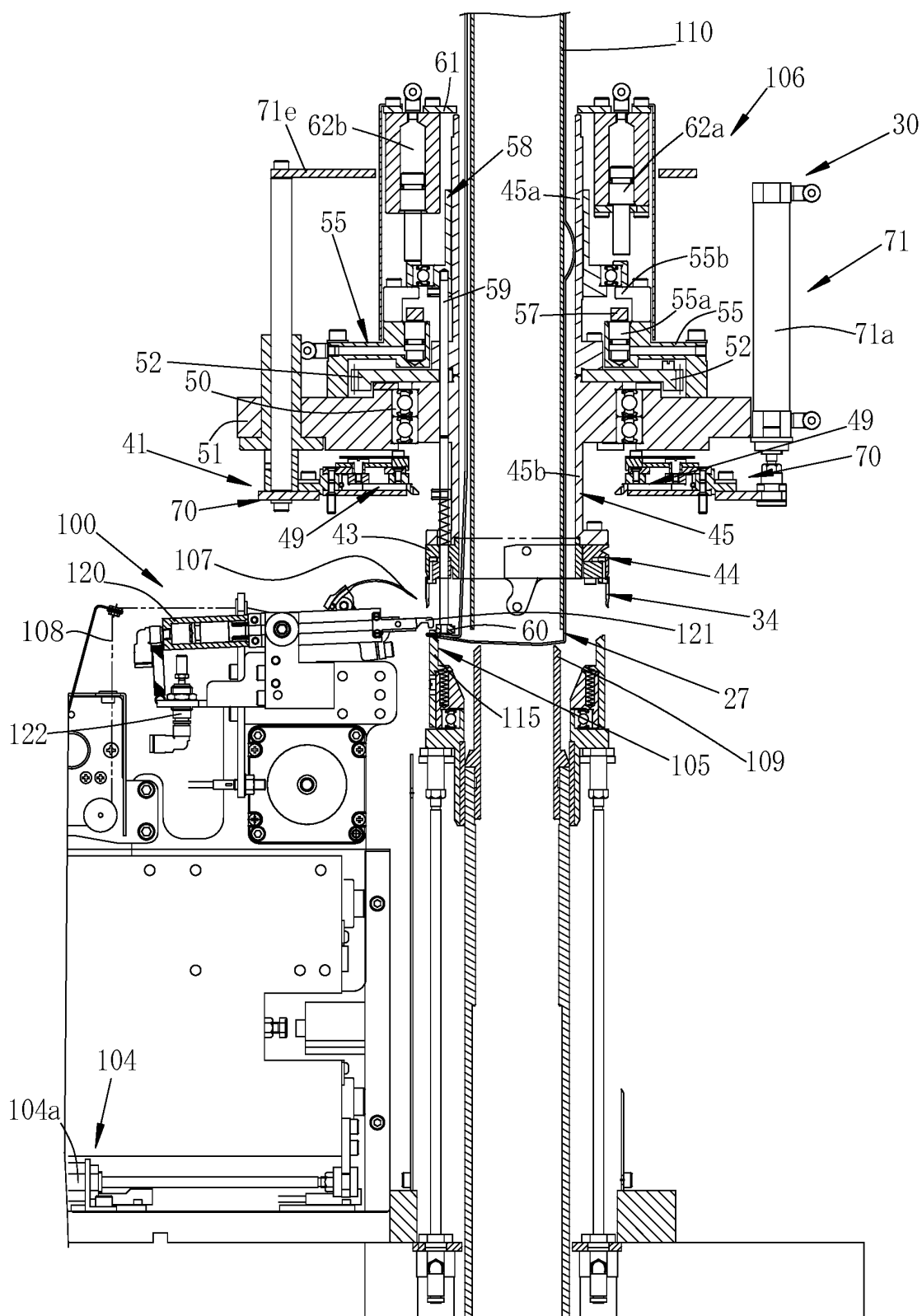


FIG.42

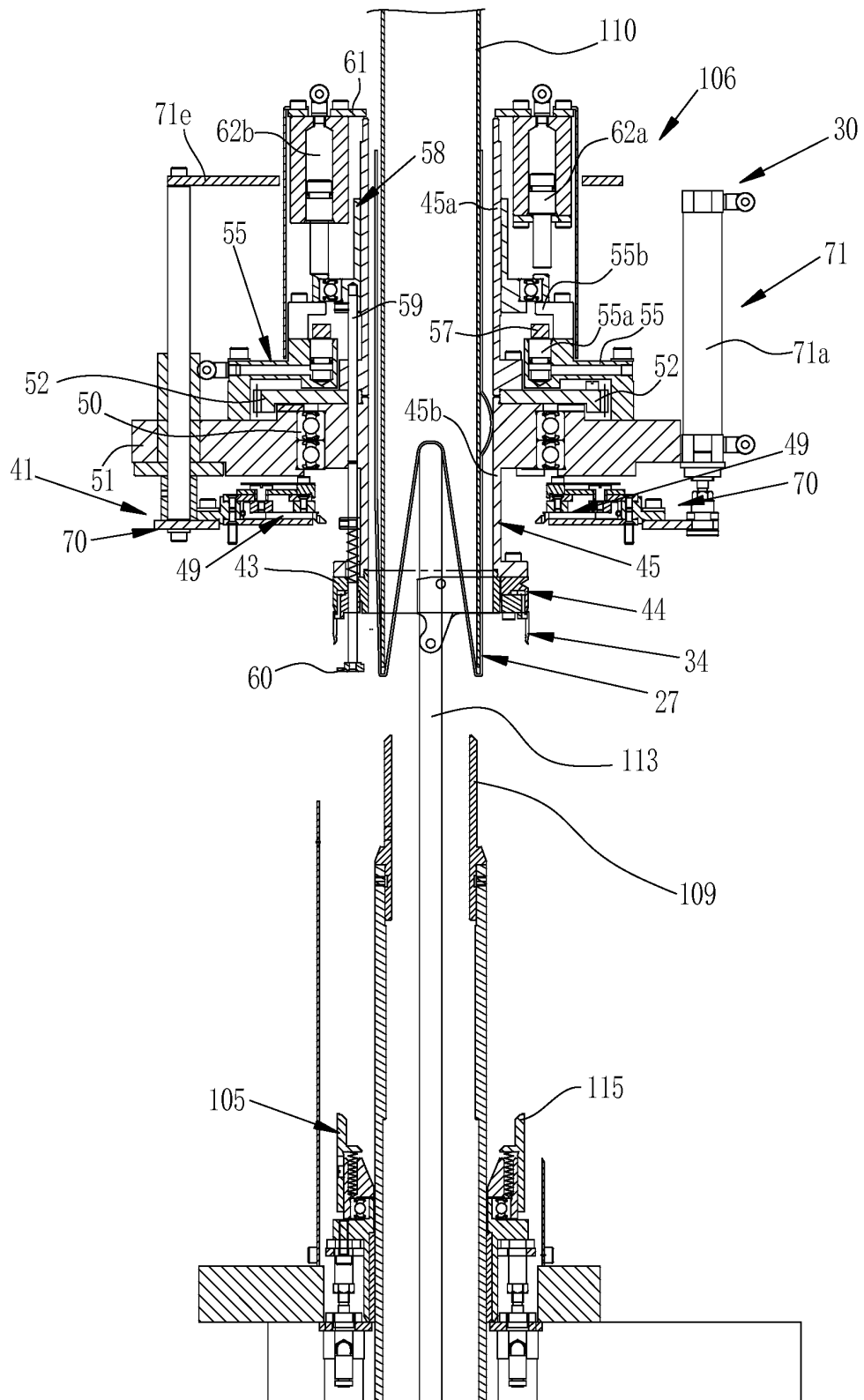


FIG.43

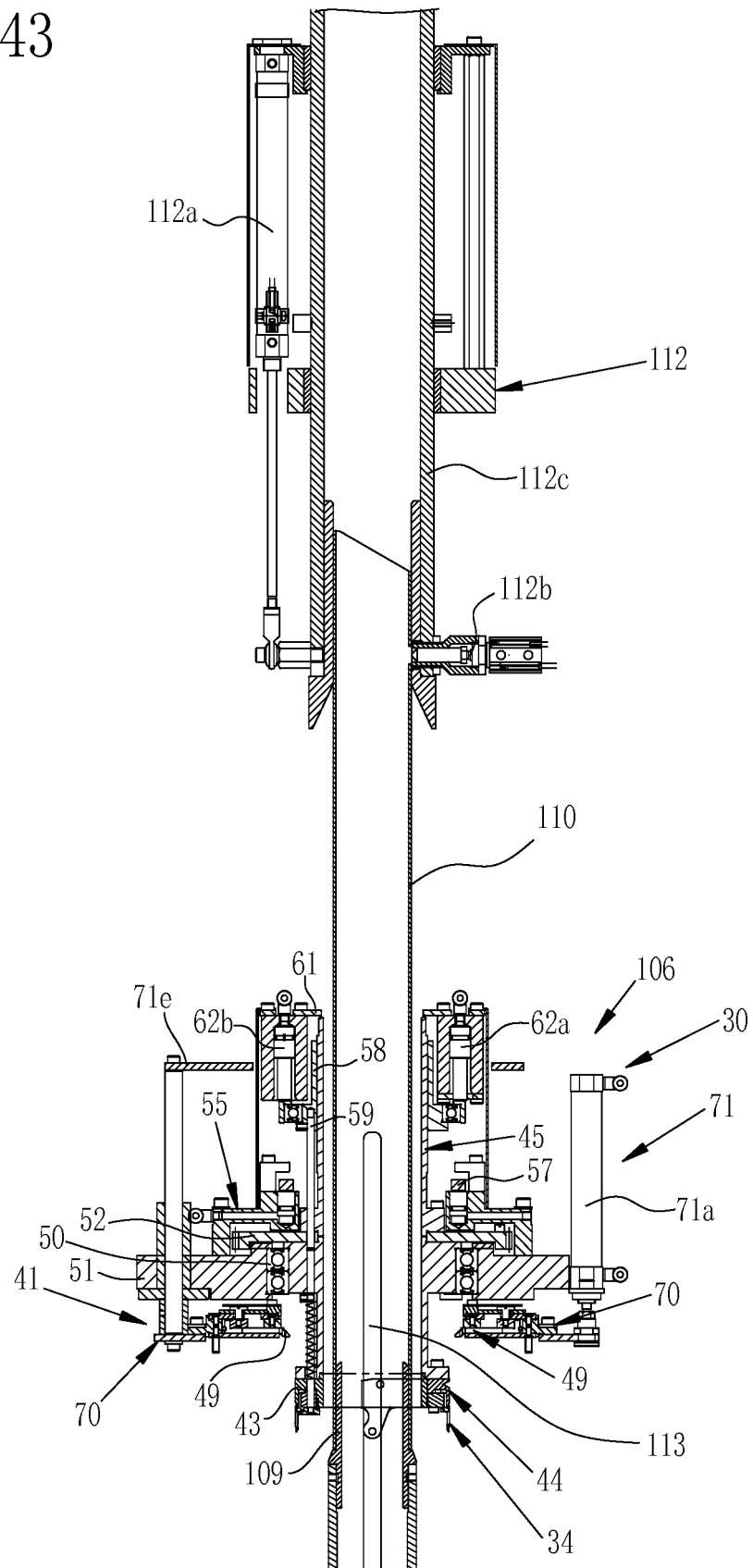


FIG.44

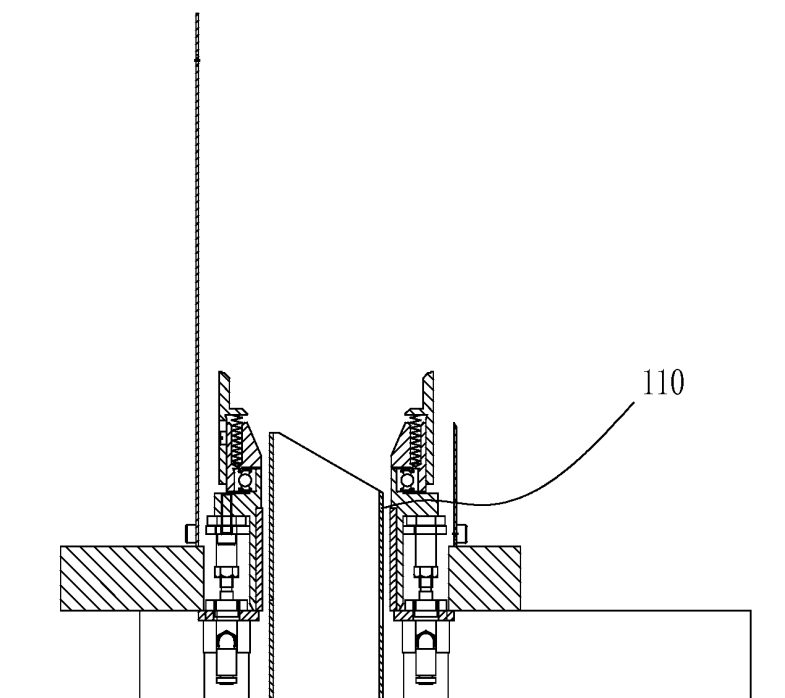
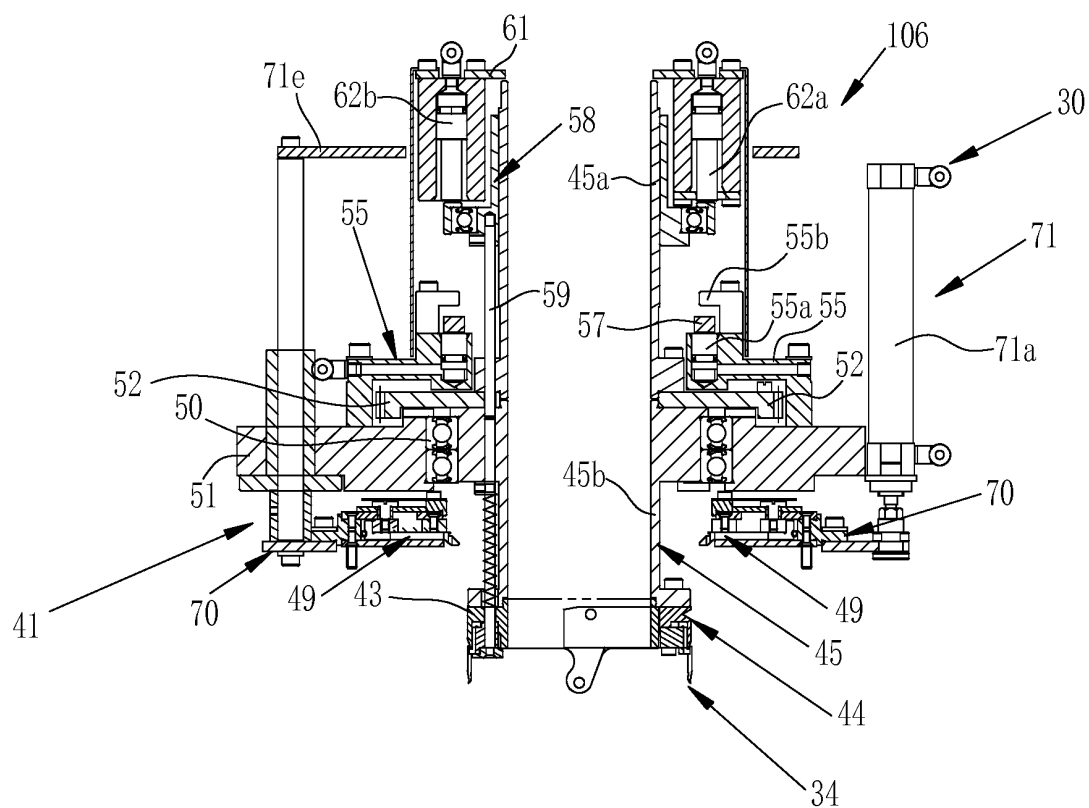
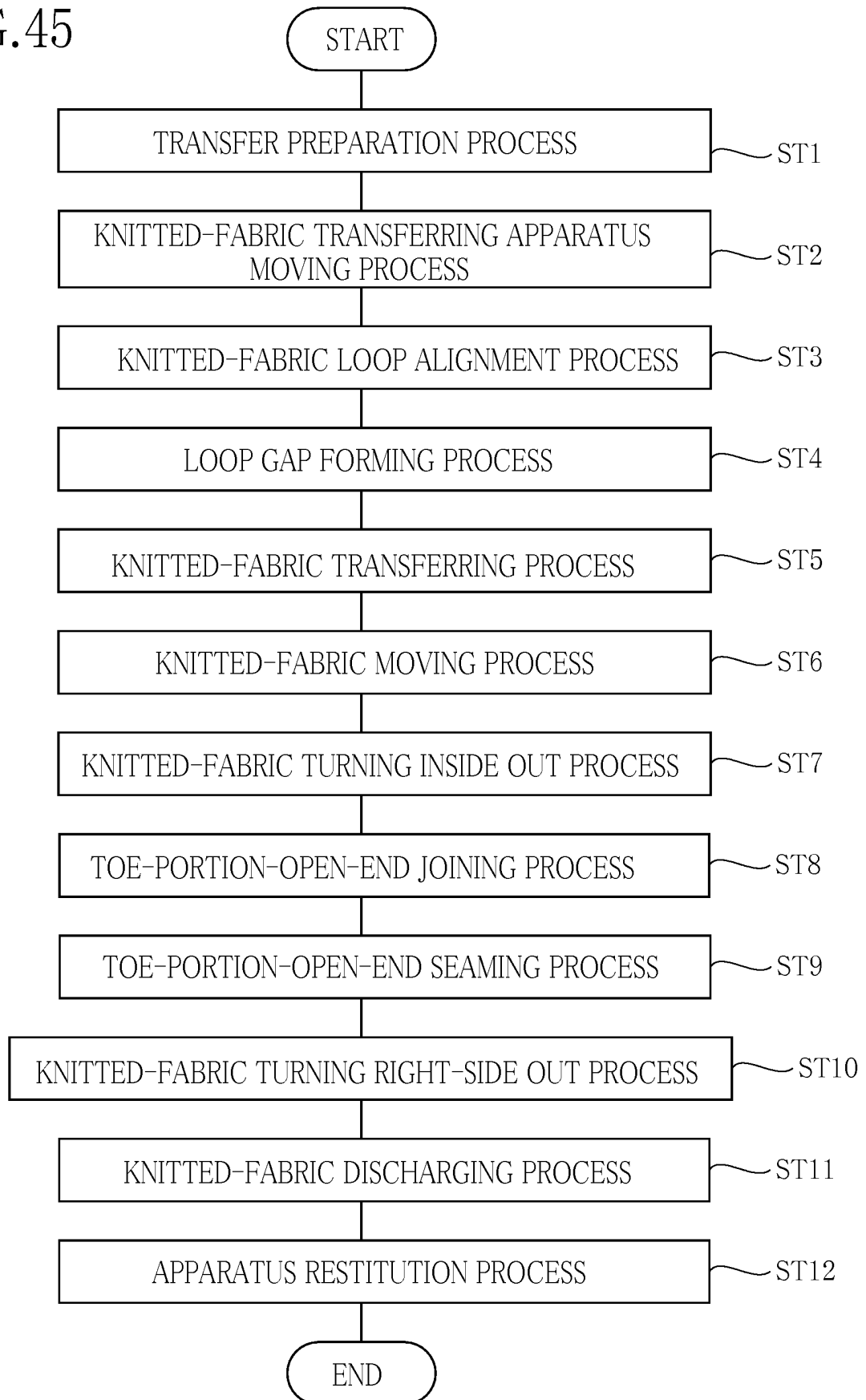


FIG.45



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/058876

A. CLASSIFICATION OF SUBJECT MATTER

D04B15/88(2006.01)i, D04B9/46(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)

D04B15/88, D04B9/46, D04B15/02, D04B15/06

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

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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.
Y	JP 4268136 B2 (Fabritex S.r.l.), 27 May 2009 (27.05.2009), claims; paragraphs [0096], [0107], [0108], [0121]; fig. 1 to 30, 54 to 74, 87, 88 & US 2006/0144095 A1 & WO 2004/035894 A1 & EP 1579046 A1 & KR 10-2005-0083795 A & CN 1723308 A	1-4, 6, 8-11, 13 5, 7, 12, 14
Y	US 2010/0319410 A1 (Massimo BLANCHI), 23 December 2010 (23.12.2010), paragraphs [0028] to [0037]; fig. 1 to 19 (Family: none)	1-4, 6, 8-11, 13
Y	JP 2000-355860 A (Lonati S.p.A.), 26 December 2000 (26.12.2000), fig. 9, 10 & US 6223564 B1 & EP 1054089 A2	2-4, 6, 9-11, 13

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search
03 June 2015 (03.06.15)Date of mailing of the international search report
16 June 2015 (16.06.15)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20060144095 A [0003] [0004] [0006] [0009]
- JP 4268136 B [0003]
- JP 4030853 B [0003] [0005] [0009] [0013]