(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 187 633 A1

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

(43) Date of publication:
05.07.2017 Bulletin 2017/27

(21) Application number: **15836915.7**

(22) Date of filing: **24.03.2015**

(51) Int Cl.:
D04B 15/88 *(2006.01)* ***D04B 9/56*** *(2006.01)*
D04B 15/02 *(2006.01)* ***D04B 15/06*** *(2006.01)*

(86) International application number:
PCT/JP2015/058877

(87) International publication number:
WO 2016/031282 (03.03.2016 Gazette 2016/09)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA

(30) Priority: **29.08.2014 JP 2014176630**

(71) Applicant: **Nagata Seiki Co., Ltd.**
Tokyo
170-0004 (JP)

(72) Inventor: **TAMAKI, Kazuhiko**
Tsubame-shi
Niigata 959-0181 (JP)

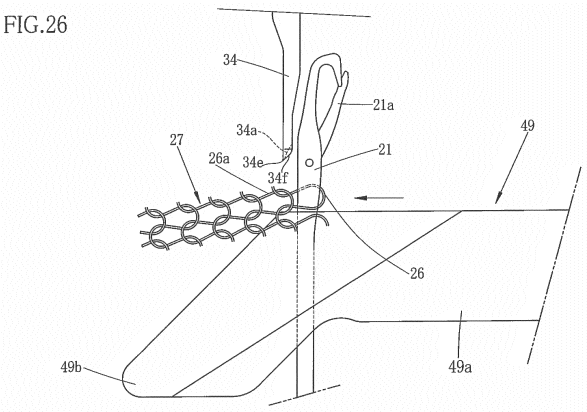
(74) Representative: **Grünecker Patent- und Rechtsanwälte**
PartG mbB
Leopoldstraße 4
80802 München (DE)

(54) CIRCULAR KNITTING MACHINE KNITTED FABRIC SEAMING METHOD AND CIRCULAR KNITTING MACHINE SYSTEM

(57) Provided are a knitted-fabric seaming method for a circular knitting machine for making a linking portion dense as with other loops, and a circular knitting machine system.

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 tip-end protrusions (34e) of each of the transferring needles (34) is shifted inward. Transferring sinkers (49) are moved from the knitting needles (21) to the transferring needles (34) in the axial direction of the knitting needles (21). Tip-end protrusions (34e) of the transferring needles (34) are inserted into inner loops (26a) of a knitted fabric (27), which are located inside final loops (26) caught on the knitting needles (21), such that the knitted fabric (27) is transferred from the knitting needles (21) to the transferring needles (34). The inner loops (26a) transferred to the transferring needles (34) are linked. The size of each of the loops to be linked becomes smaller in comparison with the case where the final loops are transferred to the transferring needles to perform the linking. Thus, it is possible to make a linking portion dense as with other loops, so as to increase durability and the quality of the outer appearance.

FIG.26



EP 3 187 633 A1

Description

TECHNICAL FIELD

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

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. In general, as a seaming method, there are a method called as a linking or looping method, and a sewing method called as a Rosso method. In the former linking or looping method, in order to close the loops (stitches) of an open end of a sock, a pair of corresponding loops is surely seamed on a one-to-one basis. In the latter sewing method, an open end is joined and seamed once or two or more times regardless of loops of a sock by a dedicated sewing machine.

[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 Patent Documents 1, 2, and 3). 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 an apparatus for carrying out hosiery disclosed in Patent Document 1, a toe portion of a knitted sock in a state of being held is removed from knitting needles, and turned inside out, and then conveyed to a post-process (i.e., a sewing machine) disposed outside a machine. Thereby, it is possible to perform automatic sewing. In an apparatus disclosed in Patent Document 2, a hosiery product is automatically picked up at the end of the forming of its tubular part and taken to a sewing station, so as to provide a traditional stitched seam on the inside of the hosiery product.

[0005] According to Patent Document 3, a method for seaming a toe portion of a sock is a linking method. A knitted fabric of the sock knitted by a circular knitting machine to achieve a toe portion thereof is automatically taken out of a circular knitting machine, and linking of a space between each of adjacent loops of the toe portion is automatically performed.

Prior Art Documents

Patent Documents

[0006]

Patent Document 1: Japanese Patent Laid-Open Publication No. 2002-266208
Patent Document 2: United States Patent Application Publication No. 2008/190340 corresponding to Japanese Patent No. 4981675
Patent Document 3: United States Patent Application Publication No. 2006/144095 corresponding to Japanese Patent No. 4268136

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0007] In the apparatus for carrying out hosiery disclosed in Patent Document 1, the knitted sick is received by a holding member which vertically moves and synchronously rotates with a knitting needle cylinder, pins protruded from the holding member, and a sock-receiving tool for receiving the sock from the holding member. However, the number of the pins is smaller than that of the knitting needles, and each of the pins is arranged at a position away from the knitting needle to the inside of the knitting needle cylinder. Therefore, reliability of holding the same position constantly is insufficient due to the characteristics of the knitted fabric.

[0008] The automatic sewing device disclosed in Paten Document 2 includes moving blades and fixed blades for picking up the last row of the hosiery product. The fixed and moving blades are divided into sectors with multiple teeth each. The fixed and moving blades have at least one position on the outside of the diameter where there are knitting needles and at least one position inside the diameter where there are knitting needles. Therefore, it is necessary to divide each of the moving blades and fixed blades radially with respect to the knitting needles, and increase the number of dividing each of the moving blades and fixed blades, for example, up to sixteen, such that each of the teeth is sufficiently movable in the space between the knitting needles. Concurrently, it is necessary to prepare pneumatic actuators of a driving source corresponding to the number of sectors, and therefore a lot of components become necessary.

[0009] Further, according to Patent Document 1, a Rosso course portion and a waste yarn portion are formed following the open end of the toe portion. According to Patent Document 2, it is necessary to form a portion called as a selvage at the end of the process for knitting the hosiery product. Each of the waste yarn portion and the selvage is cut away from the hosiery product in the sewing with use of a sewing machine at the time of closing the open end of the toe portion of the sock. Accordingly, the formation of the waste yarn portion or the selvage

results in not only waste of time but also consumption of unnecessary yarn, disadvantageously.

[0010] According to the method and apparatus for seaming an edges of a tubular knitted product disclosed in Patent Document 3, the knitted fabric is transferred from the knitting needles to a removal member, the knitted fabric is moved to a hook-up station and turned inside out, and one of the pair of stitches is moved to come closer to the other of the pair of stitches. Thereafter, hooking-up (linking) of a space between the stitches is performed. According to Patent Document 3, the knitting needles are continuous with the transferring needles in an axial direction of the knitting needles, and the final loops are transferred from the knitting needles to the transferring needles. Therefore, each of the final loops passes through a portion at which a tip end of the knitting needle is continuous with a tip end of the transferring needle, and thereby a loop size of each of the final loops is larger than those of other inner loops. Accordingly, in the case where the linking of the final loops each having the large loop size is performed, the continuity of the loop size between the linking portion and other portions, and the density of the linking portion is insufficient. Therefore, in some cases, intensity of the linking portion decreases, and a problem of durability of the linking portion occurs. Additionally, the consistency of the loop sizes is deteriorated, and the quality of the outer appearance is decreased.

[0011] In view of the foregoing problems, an object of the present invention is to provide a knitted-fabric seaming method and apparatus for a circular knitting machine capable of making a linking portion dense as with other loops and performing linking such that durability and quality of an outer appearance of a knitted fabric are increased. Further, another object of the present invention is to provide a knitted-fabric seaming method for a circular knitting machine and a circular knitting machine system capable of solidly seaming one end of a knitted fabric knitted by a circular knitting machine for producing hosiery without disposing a wasteful knitting unit.

Means for Solving the Problems

[0012] To achieve the above and other objects, according to a knitted-fabric seaming method for a circular knitting machine of the present invention, one end of a knitted fabric knitted by a circular knitting machine is transferred from knitting needles of a knitting needle cylinder of the circular knitting machine to transferring needles in a state that the number of the knitting needles is the same as the number of the transferring needles, and thereafter the one end of the knitted fabric is closed by a sewing machine unit. Inner loops, which are located inside final loops of the knitted fabric caught on the knitting needles, are divided in half into a first loop group and a second loop group in a circumferential direction of the knitted fabric. Loops facing each other are joined at the time of closing the first loop group and the second loop group, and the joined loops are seamed by a sewing machine of the sewing machine unit.

[0013] The transferring needles are preferably used to transfer the knitted fabric from the knitting needles. In this case, the transferring needles and the knitting needles are moved relative to each other in an axial direction of the knitting needles, such that an external surface of a tip end of each of the transferring needles comes close to an internal surface of a tip end of the corresponding knitting needle. Next, a transferring member 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 guide the knitting needle by a distal end portion of each of the transferring members. Then, the transferring members are moved from the knitting needles to the transferring needles in an axial direction of the knitting needles, such that tip ends of the transferring needles are inserted into the inner loops.

[0014] A circular knitting machine of the present invention transfers one end of a knitted fabric knitted by a circular knitting machine from knitting needles of a knitting needle cylinder of the circular knitting machine to transferring needles in a state that the number of the knitting needles is the same as the number of the transferring needles, and thereafter the circular knitting machine closes the one end of the knitted fabric by a sewing machine unit. The circular knitting machine includes a transferring needle unit, transferring members, a loop joining mechanism, and a sewing machine unit. The transferring needle unit holds the transferring needles into each of which an inner loop located inside a final loop of the knitted fabric caught on the knitting needle is inserted, and moves upward and downward along a center line of the knitting needle cylinder so as to come into a retreated state in which the transferring needles are retreated from the knitting needles and a close state in which the transferring needles come close to the knitting needles. Each of the transferring members transfers the knitted fabric from the knitting needles to the transferring needles when the transferring needle unit is in the close state. The loop joining mechanism divides the inner loops in half into a first loop group and a second loop group in a circumferential direction of the knitted fabric, and joins loops facing each other at the time of closing the first loop group and the second loop group. The sewing machine unit seams the loops joined by the loop joining mechanism. Incidentally, each of the transferring members is preferably inserted into the 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 guide the knitting needles by a distal end portion thereof.

[0015] A tip-end protrusion of each of the transferring needles preferably leans inward. Thereby, it is possible surely insert the transferring needles into the inner loops located inside the final loops of the knitted fabric.

[0016] The knitting needles and the transferring nee-

dles are arranged at a constant pitch in the circumferential direction so as to constitute a knitting needle group and a transferring needle group. The transferring needle group is divided 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 to which the first loop group is transferred is attached to a fixed half dial and the second transferring needle group to which the second loop group is transferred 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. 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.

[0017] The first transferring needle group and the second transferring needle group are preferably 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 fixed half dial and the movable half dial 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 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 in the closed state, and the first transferring needle group is continuous with the second transferring needle group in an axial direction of the transferring needles. In this case, it is possible to surely connect the first transferring needle group to the second transferring needle group in the axial direction by the housing groove, and surely transfer the loops from one of the first transferring needle group and the second transferring needle group to the other of them.

[0018] It is preferable that each of the transferring members is a transferring sinker which includes a transferring sinker main body having the shape of a belt plate and the distal end portion having a tapered portion so as to be formed to have an acute angle. The distal end 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, which is 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. 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.

[0019] Each of the transferring sinkers is inserted into the space between the adjacent knitting needles of the knitting needle cylinder from outside to inside in a radial direction of the knitting needle cylinder by a transferring-sinker advancing/retreating mechanism. The transferring sinker and the transferring-sinker advancing/retreating mechanism are caused to insert the tip ends of the transferring needles into the inner loops by a transferring-sinker vertically-moving mechanism, so as to transfer the knitted fabric from the knitting needles to the transferring needles.

[0020] Preferably, before the inner loops are transferred to the transferring needles, each of the transferring members is inserted into the space between the adjacent knitting needles above 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. In the case of the knitted fabric of 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 are not aligned 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 surely insert the transferring sinkers under the knitted fabric.

[0021] Preferably, after the knitted fabric is transferred to the transferring needles, the knitted fabric is conveyed to the sewing machine unit so as to seam 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. Specifically, it is preferable that there are provided a knitted-fabric transferring apparatus for transferring the knitted fabric to the sewing machine unit so as to seam the inner loops of the knitted fabric after the inner loops are transferred to the transferring needles, and a rotation mechanism for rotating the fixed half dial in the circumferential direction in conjunction with vertical movement of a sewing needle of the sewing machine unit. In this case, it is not necessary to move the sewing machine unit along the knitted fabric, and therefore the structure becomes simplified.

[0022] Preferably, 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 inner loops at the time of linking the inner loop of each of the final loops, and the seaming is definitely performed.

[0023] It is preferable that the sewing machine unit is selectively set to a first seaming position where the sewing needle is inserted into the sewing needle guide groove or a second seaming position where the sewing needle is located inside with respect to the first seaming position in the circumferential direction of the knitted fabric. Then, linking or first sewing by the sewing machine unit at the first seaming position is performed, and the second sewing is performed at the second seaming position. In this case, after the linking or the first sewing is performed, the second sewing can be selectively performed as necessary, and therefore it becomes possible to select a method for closing the loops in accordance with the kind of hosiery. Further, it is preferable that the knitted fabric is held between a half ring disposed inside the fixed half dial and a lower knitted-fabric holding member disposed so as to face the half ring, and then the inner loops are removed from the transferring needles, and the first sewing and the second sewing are performed. In this case, in addition to definitely perform the seaming, it is possible to achieve strong seaming without restriction of the pitch of the loops.

Effect of the Invention

[0024] According to the present invention, the inner loops which are located inside the final loops of the knitted fabric caught on the knitting needles are divided in half into the first loop group and the second loop group in the circumferential direction of the knitted fabric, the loops facing each other are joined at the time of closing the first loop group and the second loop group, and the joined loops are seamed by the sewing machine of the sewing machine unit. Therefore, unlike the case where the first loop group and the second loop group are closed through the final loops so as to link the first loop group and the second loop group in a conventional manner, the loop size of the linking portion is the same as those of the other portions, and therefore the density is maintained such that the durability and the quality of the outer appearance of the knitted fabric is increased. Namely, in the case where the knitted fabric is transferred from the knitting needles to the transferring needles, each of the final loops is required to pass through the thick portion at which the knitting needle and the transferring needle are continuous with each other, and therefore it is necessary to knit the knitted fabric in which the loop size of the final loop is larger than those of the inner loops. As a result, it is possible to solve a problem that the density of the liking portion is insufficient due to the difference in the loop size between the linking portion and other portions at the time of linking the final loops. The linking portion has the same loop size as those of the other portions by linking the inner loops, and the density is maintained, such that the durability and the quality of the outer appearance of the knitted fabric is increased. Furthermore, one end of the knitted fabric can be seamed by not only the linking but also the sewing and second sewing as the additional sewing, and thereby it is possible to achieve strong seaming.

BRIEF DESCRIPTION OF DRAWINGS

[0025]

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 the 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 to the transferring needles.

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 transferring sinkers are located at the advanced position and the knitting needles are located at a position where the knitting needles can be inserted into inner loops preceding the final loops of the knitted fabric on a one-to-one basis.

Fig. 26 is a side elevational view illustrating a positional relationship among the loops of the knitted fabric, the transferring sinker, the transferring needle, and the knitting needle.

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 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 first seaming position so as to seam the knitted fabric by linking with use of the transferring needles as a guide.

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 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 first seaming.

Fig. 42 is a vertical longitudinal sectional view showing 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 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 knit-

ted-fabric seaming method to seam one end of the knitted fabric.

Fig. 46A is a flowchart showing one example of a toe-open-end seaming process by linking.

Fig. 46B is a flowchart showing one example of a toe-open-end seaming process by sewing.

Fig. 46C is a flowchart showing one example of a toe-open-end seaming process by second sewing.

Fig. 46D is a flowchart showing one example of a toe-open-end seaming process by the linking and the sewing.

Fig. 47 is a vertical longitudinal sectional view showing a state that the sewing machine unit is set to the first seaming position and the first sewing of the knitted fabric is performed without use of the transferring needles as a guide.

Fig. 48 is a vertical longitudinal sectional view showing a state that the sewing machine unit is set to a second seaming position and the second sewing of the knitted fabric is performed.

Fig. 49 is a vertical longitudinal sectional view showing a state that the cutter is activated so as to cut the sewing yarn after completion of the second sewing.

DESCRIPTION OF THE INVENTION

[0026] 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.

[0027] 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.

[0028] 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.

[0029] 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. 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.

[0030] 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.

[0031] 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.

[0032] 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 in half 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 inner loops 26a preceding the final loops 26 (see Fig. 24) of the knitted fabric 27 by the sewing 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 inner loops 26a. Thereby, sewing yarn 108 is passed through each of the inner loops 26, and linking can be performed on a single stitch basis. Further, even in a state that the knitted fabric 27 is removed from the transferring needles 34 as shown in Figs. 47 and 48, when the fixed half dial 43 is caused to rotate intermittently in conjunction with vertical movement of the sewing needle 107 while the knitted fabric 27 is held between the half ring 60 and a lower knitted-fabric holding member 115, it is possible to sew the knitted fabric 27 at a predefined interval regardless of the space between the loops. 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.

[0033] 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.

[0034] 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 set 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 inner loops 26a 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 inner loops 26a 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 inner loops 26a 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.

[0035] 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 smaller 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.

[0036] 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.

[0037] 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.

[0038] 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 is removed from the transferring needles 34 (see Figs. 40, 47, and 48) or a third position at which the sewing yarn 108 is cut after the knitted fabric 27 is seamed (see Figs. 41 and 49). Upon downward movement of the half ring 60, the sewing yarn 108 is cut away from the seamed knitted fabric 27.

[0039] 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 constitute a loop joining mechanism, and 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.

[0040] 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.

[0041] 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. The distal end portion 49b has a tapered portion 49d and is formed to have an acute angle. Each of the distal end portion 49b and the tapered portion 49d is thinner than the transferring sinker main body 49a. Further, the thickness of the transferring sinker main body 49a is the same as the 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.

[0042] 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.

[0043] 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.

[0044] 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.

[0045] 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.

[0046] 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.

[0047] 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 may not be necessarily formed to be gradually thinner. Instead, the distal end portion 49b may have a constant thickness thinner than the transferring sinker main body 49a.

[0048] 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.

[0049] 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 inner loops 26a corresponding to one half of the open end and the inner loops 26a corresponding to the other half of the open end of the knitted fabric 27 to be seamed are joined, and the joined inner loops 26a are seamed by the sewing machine unit 100. Thus, a sock is completed.

[0050] 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 sewing-machine advancing/retreating positioning air cylinder 104b for determining an approach amount of the movement mechanism 104 with respect 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.

[0051] 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 mecha-

nism 112, a turning rod 113 (see Figs. 42 and 43), and a turning-rod vertically-moving mechanism (not shown in the drawing).

[0052] The structure and operation of each component are described hereinbelow by referring to an operation procedure of the circular knitting machine system 10. As shown in Fig. 45, the operation procedure of the circular knitting machine system 10 includes a transfer preparation process ST1, a knitted-fabric transferring apparatus moving process ST2, a knitted-fabric loop alignment process ST3, a knitted-fabric transferring process ST4, a knitted-fabric moving process ST5, a knitted-fabric turning inside out process ST6, a toe-portion-open-end joining process ST7, a toe-portion-open-end seaming process ST8, a knitted-fabric turning right-side out and discharging process ST9, and an apparatus restitution process ST10. These processes are sequentially performed.

[0053] In the transfer preparation process ST1, the following processing is performed. 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.

[0054] 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).

[0055] 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.

[0056] In the knitted-fabric transferring apparatus moving process ST2, the following processing is performed. 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.

[0057] In the knitted-fabric loop alignment process ST3, the following processing is performed. 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.

[0058] 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, each of the transferring sinkers 49 is always brought into contact with the knitted fabric 27 at a certain position.

[0059] In the knitted-fabric transferring process ST4, the following processing is performed. At first, 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.

[0060] 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 transferring sinkers 49 are inserted under the knitted fabric 27.

[0061] Fig. 24 illustrates the knitted fabric 27 in 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 the knitted fabric 27 in 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. In this state, the transferring needles 34 are located above the inner loops 26a, and therefore it is possible to lift up the knitted fabric 27 from bottom up such that the inner loops 26a are transferred to the transferring needles 34.

[0062] 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 brought into contact with or comes 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 smaller 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 space appears between each of the transferring needles 34 of the movable half dial 44 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 movable half dial 44 for arranging the transferring needles 34 is smaller than the radius of the fixed half dial 43 for arranging the transferring needles 34. However, as shown in Fig. 26, the space, which appears between each of the transferring needles 34 of the movable half dial 44 and the corresponding knitting needle 21, is acceptable for the loop size. Consequently, 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 inner loops 26a of the knitted fabric 27 to the transferring needles 34.

[0063] As shown in Fig. 25, in a state that the final loops 26 are held by the knitting needles 21, each of the transferring needles 34 which is located away from the corresponding knitting needle 21 by a predefined distance faces the corresponding inner loop 26a, and therefore it is possible to surely insert each of the transferring needles 34 into the corresponding inner loop 26a in the same course. In particular, each of the transferring needles 34 has a tip-end protrusion 34e which is pointed to have a triangular pyramid shape. Each of the tip-end protrusions 34e is shifted inward so as to be away a little from the corresponding knitting needle 21, and therefore each of the transferring needles 34 is surely inserted into the inner loop 26a located inside the corresponding final loop 26.

[0064] 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 inner loops 26a of the knitted fabric 27 are inserted into the transferring needles 34, it is possible to prevent the knitted fabric 27 from being dropped from the transferring sinkers 49 such that the inner loops 26a are surely held by the transferring needles 34 due to the existence of the transferring sinkers 49. Incidentally, as shown in Fig. 22, the tip end of each of the transferring needles 34 of the fixed half dial 43 is in contact with the rear surface of the corresponding knitting needle 21. However, each of the knitting needles 21 can oscillate inwardly slightly, and the inner loops 26a can be smoothly transferred from the knitting needles 21 to the transferring needles 34 without being engaged by the portion at which the tip end of the transferring needle 34 is in contact with the rear surface of the knitting needle 21. This is because, although not shown in the drawings, each of the knitting needles 21 is housed in a transferring needle holding groove of the knitting needle cylinder 19 so as to oscillate slightly in the radial direction of the knitting needle cylinder 19. Further, since the tip-end protrusion 34e of each of the transferring needles 34 is shifted inward, each of the transferring needles 34 is surely inserted into the corresponding inner loop 26a.

[0065] In the knitted-fabric moving process ST5, the following processing is performed. At first, the arm-ver-

tically-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.

[0066] 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.

[0067] 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.

[0068] In the knitted-fabric turning inside out process ST6, the following processing is performed. Firstly, 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, and 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.

[0069] In the toe-portion-open-end joining process ST7, the following processing is performed. At first, 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 (see Fig. 10). 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.

[0070] 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 inner loop 26a 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 inner loops 26a 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.

[0071] 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.

[0072] As shown in Fig. 37, the turning-pipe holder 109 and the lower knitted-fabric holding member 115 move upward, and hold the knitted fabric 27 against the half ring 60.

[0073] In the toe-portion-open-end seaming process ST8, the following processing is performed. In the toe-portion-open-end seaming process ST8, it is possible to select from among four processes including a first toe-portion-open-end seaming process ST8A, a second toe-

portion-open-end seaming process ST8B, a third toe-portion-open-end seaming process ST8C, and a fourth toe-portion-open-end seaming process ST8D, as shown in Figs. 46A to 46D.

[0074] As shown in Fig. 46A, In the first toe-portion-open-end seaming process ST8A, the seaming is performed by a linking method. The first toe-portion-open-end seaming process ST8A includes a linking process, a knitted fabric removal process, and a sewing yarn cutting process. At first, in the linking process, 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 in a state that the sewing-machine advancing/retreating positioning air cylinder 104b is extended, and the sewing machine main body 103 is set to a first seaming position. Then, the sewing machine main body 103 is activated, and the motor 53 is driven in conjunction with the operation of the sewing needle 107. Thereby, the inner loops 26a are seamed on a single stitch basis in the linking state by the sewing needle 107. Note that, the final loop 26 is in a state of being wrapped by the linked sewing yarn 108.

[0075] 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, in the seaming in the linking state, 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 inner loops 26a held by the corresponding transferring needle 34. Accordingly, the seaming can be performed surely performed for each inner loop 26.

[0076] As shown in Figs. 26 and 39, the tip-end protrusion 34e of each of the transferring needles 34 is pointed to have a triangular pyramid shape. As shown in Fig. 26, each of the tip-end protrusions 34e is formed on an extended line from an internal surface of the transferring needle 34, and as a result, each of the tip-end protrusions 34e is shifted inward. The tip-end protrusion 34e is shifted inward so as to form an inclined surface 34f at the tip end of the each of the transferring needles 34. When the knitted fabric 27 is transferred upward in accordance with the upward movement of each of the transferring sinkers 49, the inclined surface 34f functions as a guide surface such that the tip-end protrusion 34e is advanced into the inner loop 26a. Accordingly, each of the transferring needles 34 is surely inserted into the corresponding inner loop 26a, and the knitted fabric 27 can be transferred or closed by each of the transferring needles 34.

[0077] As shown in Fig. 40, in the knitted fabric removal process, 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 inner loops 26a are removed from the transferring needles 34. At the time of the removal, the knitted fabric 27 remains to be held between the lower knitted-fabric holding member 115 and the half ring 60. Thereafter, the sewing machine main body 103 makes about 10 yarn chains, for example, using the sewing yarn 108.

[0078] In the sewing yarn cutting process, 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. The operations described above are performed in the first toe-portion-open-end seaming process ST8A.

[0079] As shown in Fig. 46B, the second toe-portion-open-end seaming process ST8B includes the knitted fabric removal process, the sewing process, and the sewing yarn cutting process. The knitted fabric removal process and the sewing yarn cutting process are the same as those in the first toe-portion-open-end seaming process ST8A, and the explanation thereof is omitted. Incidentally, in the knitted fabric removal process in the first toe-portion-open-end seaming process ST8A, about 10 yarn chains are made by the sewing machine main body 103 at the last stage of the knitted fabric removal process because the knitted fabric removal process is performed after the linking process. However, in the second toe-portion-open-end seaming process ST8B, the linking process is not performed, and therefore this operation is omitted.

[0080] In the sewing process, the motor 53 (see Fig. 7) makes the transferring needle rotary gear 52 rotate, such that the seaming starting portion of the knitted fabric 27 is moved to the position where the sewing needle 107 is located. Thereafter, in the state that the sewing-machine advancing/retreating positioning air cylinder 104b is extended, the sewing-machine advancing/retreating air cylinder 104a is extended, and the sewing machine main body 103 is set to the first seaming position. Next, as shown in Fig. 47, the sewing machine main body 103 is activated, and the motor 53 is driven in conjunction with the operation of the sewing needle 107. Thereby,

the knitted fabric 27 is sewn by the sewing needle 107. The driving pitch of the motor 53 does not depend on the pitch of the loops, and may be arbitrarily determined. Incidentally, each of the final loops 26 is wrapped by the sewing yarn 108 used in the sewing. After the knitted fabric 27 is sewn, subsequently, about 10 yarn chains are made using the sewing yarn 108 by the sewing machine main body 103.

[0081] As shown in Fig. 46c, the third toe-portion-open-end seaming process ST8C includes a second sewing process and a sewing yarn cutting process followed by the knitted fabric removal process, the sewing process (i.e., first sewing process), and the sewing yarn cutting process. Incidentally, the knitted fabric removal process, the first sewing process, and the sewing yarn cutting process are the same as those in the second toe-portion-open-end seaming process ST8B, and therefore the explanation thereof is omitted. In the second sewing process, as shown in Fig. 48, in a state that the half-ring lowering second air cylinder 62b is contracted again, the position of the knitted fabric 27 held between the lower knitted-fabric holding member 115 and the half ring 60 is moved upward. Next, the motor 53 (see Fig. 7) makes the transferring needle rotary gear 52 rotate, such that the seaming starting portion of the knitted fabric 27 is moved to the position where the sewing needle 107 is located. Thereafter, the sewing-machine advancing/retreating positioning air cylinder 104b is contracted, and then the sewing-machine advancing/retreating air cylinder 104a is further extended, such that the sewing machine main body 103 is set to the second seaming position. Next, the sewing machine main body 103 is activated, and the motor 53 is driven in conjunction with the operation of the sewing needle 107. Thereby, a position of the knitted fabric 27 different from the first seaming position is sewn by the sewing needle 107. The driving pitch of the motor 53 does not depend on the pitch of the loops, and may be arbitrarily determined. Incidentally, each of the final loops 26 and the sewing yarn 108 used in the first sewing process are wrapped by the sewing yarn used in the second sewing process. After the knitted fabric 27 is sewn, subsequently, about 10 yarn chains are made using the sewing yarn 108 by the sewing machine main body 103, for example.

[0082] In the second sewing yarn cutting process, as shown in Fig. 49, 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 the cutter 121 is inserted into an upper portion of the yarn chain made using the sewing yarn 108. Next, the cutter vertically-moving air cylinder 122 is extended such that the cutter 121 is set to a position for cutting the yarn chain. Next, the cutter advancing/retreating air cylinder 120 is contracted, and the cutter 121 is retreated, and thereby the yarn chain is cut. Thereafter, the cutter vertically-moving air cylinder 122 is contracted, such that the cutter 121 is returned to the default position. The operations described above are performed in the third toe-portion-open-end seaming process ST8C.

[0083] As shown in Fig. 46D, the fourth toe-portion-open-end seaming process ST8D includes the second sewing process and the sewing yarn cutting process of the third toe-portion-open-end seaming process ST8C followed by the first toe-portion-open-end seaming process ST8A. These processes are the same as those in the first toe-portion-open-end seaming process ST8A and the third toe-portion-open-end seaming process ST8C, respectively, and therefore redundant explanation thereof is omitted.

[0084] As described above, the linking and sewing operations are performed on the inner loops 26a (see Fig. 25) preceding the final loops 26, and therefore FTY (Filament Twisted Yarn) is preferably used for the final loops 26. The FTY is commonly used as under yarn for the hosiery, and consists of stretchy polyurethane and polyester, for example. The FTY is fine and excellent in the stretching properties. Thereby, even when each of the final loops 26 is wrapped by the sewing yarn 108 used for the linking or sewing, each of the final loops 26 is hardly swollen, and therefore the quality of the outer appearance of the hosiery is hardly deteriorated. Further, in the case where the tip end of each of the transferring needles 34 is inserted into the corresponding inner loop 26a of the knitted fabric 27, the final loops 26 can be easily adhered tightly to the knitting needles 21 by using the resilient yarn such as the FTY. Thereby, it is possible to surely insert the tip end of each of the transferring needles 34 into the corresponding inner loop 26a located inside the final loop 26. Incidentally, it is described that the inner loop, into which the transferring needle 34 is inserted, is the loop 26a preceding the final loop 26. However, each of the transferring needles 34 may be inserted into the second preceding loop or further preceding loop. Alternately, each of the transferring needles 34 may be inserted into the preceding loop, the second preceding loop, and the like in a mixed manner. Moreover, the same yarn may be used for the final loops 26 and the inner loops 26a.

[0085] Since any one of the toe-portion-open-end seaming processes ST8A to ST8D is selected so as to seam the open end of the toe portion, it is possible to achieve stronger seaming, in addition to the seaming only by the linking, in accordance with the thickness of the knitted fabric, the design, and the like, by one circular knitting machine system 10. After the toe-portion-open-end seaming processes ST8A to ST8D are finished, the sewing-machine advancing/retreating air cylinder 104a and the sewing-machine advancing/retreating positioning air cylinder 104b are contracted, and the sewing machine main body 103 is set to the retreated position.

[0086] In the knitted-fabric turning right-side out and discharging process ST9, the following processing is performed. At first, 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 comes into a 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.

[0087] In the apparatus restitution process ST10, the following processing is performed. At first, 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.

[0088] 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 cylinder 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.

[0089] 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.

[0090] Fig. 45 is a flowchart showing the processes ST1 to ST 10. In this embodiment, the 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 the transfer preparation process ST1, the knitted-fabric transferring apparatus moving process ST2, the knitted-fabric loop alignment process ST3, the knitted-fabric transferring process ST4, the knitted-fabric moving process ST5, the knitted-fabric turning inside out process ST6, the toe-portion-open-end joining process ST7, the toe-portion-open-end seaming process ST8, the knitted-fabric turning right-side out and discharging process ST9, and the apparatus restitution process ST10.

[0091] 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.

[0092] 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 inner loops 26a 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 knitted-fabric transferring process ST4, as shown in Figs. 21, 23, and 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 inner loops 26a of the knitted fabric 27 to the transferring needles 34.

[0093] In the knitted-fabric moving process ST5, 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.

[0094] In the knitted-fabric turning inside out process ST6, 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.

[0095] In the toe-portion-open-end joining process ST7, 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 inner loops 26a 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.

[0096] In the toe-portion-open-end seaming process ST8, as shown in Figs. 46A to 46D, in accordance with the intended purpose of the knitted product such as the hosiery, one of the toe-portion-open-end seaming processes ST8A to ST8D may be selected. In the first toe-

portion-open-end seaming process 8A, linking is performed once, and as shown in Fig. 38, the overlapped inner loops 26a on the transferring needles 34 of the fixed half dial 43 are seamed using the sewing yarn 108 for each of the loops 26a (for each stitch). Concurrently, each of the inner loops 26a 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 the inner loops 26a are surely seamed on a single stitch basis using the sewing yarn 108. Further, in the first toe-portion-open-end seaming process ST8A, as shown in Fig. 39, the sewing needle 107 is guided by the sewing needle guide groove 34b of each of the transferring needles 34 in accordance with the vertical movement of the sewing needle 107, and therefore it is possible to surely pass the sewing needle 107 into each of the inner loops 26a.

[0097] In the second toe-portion-open-end seaming process ST8B, sewing is performed once. As shown in Fig. 40, before the sewing, in the state that the knitted fabric 27 is held between the lower knitted-fabric holding member 115 and the half ring 60, the inner loops 26a are removed from the transferring needles 34, and sewing can be performed without restriction of the pitch of the loops by a sewing machine of the sewing machine unit 100.

[0098] In the third toe-portion-open-end seaming process ST8C, sewing is further performed after the second toe-portion-open-end seaming process ST8B. As shown in Fig. 48, after the sewing machine unit 100 is moved, the sewing is performed again so as to increase the intensity of a seamed portion of the knitted fabric 27.

[0099] In the fourth toe-portion-open-end seaming process ST8D, sewing is further performed after the first toe-portion-open-end seaming process ST8A. As in the case of the third toe-portion-open-end seaming process ST8C, as shown in Fig. 48, after the sewing machine unit 100 is moved, the sewing is performed again so as to increase the intensity of the seamed portion of the knitted fabric 27.

[0100] In the knitted-fabric turning right-side out and discharging process ST9, 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. Thereafter, 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.

[0101] In the apparatus restitution process ST10, 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.

[0102] In the above embodiment, the transferring needles 34 are inserted into the inner loops 26a located inside the final loops 26 so as to transfer the knitted fabric 27 from the knitting needles 21 to the transferring needles 34. However, each of the transferring needles 34 may be replaced with a transferring needle dedicated for the final loop, in which a tip-end protrusion of the transferring needle is shifted to the outside, so as to insert the transferring needles into the final loops 26 and transfer the knitted fabric 27 from the knitting needles 21 to the transferring needles. In this case, instead of the inner loops 26a, the final loops 26 may be linked.

[0103] In the above embodiment, at the time of transferring the knitted fabric 27 from the knitting needles 21 to the transferring needles 34, the inner loops 26a located inside the final loops 26 are transferred to the transferring needles 34. However, the present invention is not limited thereto. For example, at the time of transferring the knitted fabric 27 from the knitting needles 21 to the transferring needles 34, the final loops 26 of the knitted fabric 27 may be transferred to the transferring needles in each of which the tip-end protrusion thereof is shifted to the outside as described above, and then the inner loop 26a may be inserted into intermediate needles from the transferring needles to which the final loops 26 of the knitted fabric 27 are transferred, so as to hold the knitted fabric 27 at the inner loops 26a. Also in this case, the inner loops 26a are divided in half into the first loop group and the second loop group in the circumferential direction of the knitted fabric 27. At the time of closing the first loop group and the second loop group, the loops facing each other are joined and seamed by the sewing machine of the sewing machine unit 100. The intermediate needle may be a point needle, which holds the knitted fabric 27, for the purpose of the linking, or a knitted fabric holding needle which holds the knitted fabric 27 at the stage before transferring the knitted fabric 27 to the point needle.

[0104] For example, as disclosed in United States Patent Application Publication No. 2006/144095, in the case where the method includes: the first knitted fabric transferring process for transferring the final loops held by the knitting needles to the transferring needles (the removal member of the stitches); the final loop joining process for joining the half dials (crowns) each holding the transferring needles so as to move the final loops facing each other to one of the half dials; the second knitted fabric transferring process for inserting the point needles (hook-up spines) of the sewing machine unit (hook-up station) into the final loops in the state that the final loops are held by the transferring needles so as to move the knitted fabric to the point needles; and the linking process for linking (hooking up) the final loops of the knitted fabric by the sewing machine unit, the point needles of the sewing machine unit are inserted into the inner loops in the state that the transferring needles hold the final loops so as to transfer the knitted fabric to the point needles in the second knitted fabric transferring process. Thereby, as in the case of the above embodiment, it is possible to make the linking portion dense as with the other loops, and increase the durability and the quality of the outer appearance.

[0105] Further, as disclosed in United States Patent

Application Publication No.2010/313607 (corresponding to Japanese Patent No. 5389830), in the case where the method includes: the first knitted fabric transferring process for transferring the final loops held by the knitting needles to the transferring needles (pick-up members); the second knitted fabric transferring process for inserting the point needles (spikes) of the sewing machine unit (looping station) into the final loops in the state that the final loops are held by the transferring needles so as to move the knitted fabric to the point needles; the final loop joining process for joining the half dials (semiannular elements) each holding the point needles so as to move the final loops facing each other to one of the half dials; and the linking process for linking (looping) the final loops by the sewing machine unit, the point needles of the sewing machine unit are inserted into the inner loops in the state that the transferring needles hold the final loops so as to transfer the knitted fabric to the point needles in the second knitted fabric transferring process. Further, the half dials each holding the point needles are joined together so as to move the inner loops facing each other to one of the half dials in the final loop joining process. Thereby, as in the case of the above embodiment, it is possible to make the linking portion dense as with the other loops, and increase the durability and the quality of the outer appearance.

[0106] Further, in the above embodiment, at the time of linking the inner loops 26a, the sewing yarn 108 is passed through each of the inner loops 26a once. However, alternatively, the sewing yarn 108 may be passed through each of the inner loops 26a 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 inner loops 26a starts and the following some loops and the loop at which the closing of the inner loops 26a 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 linking. 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.

[0107] 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.

[0108]

10	advancing/retreating mechanism
11	circular knitting machine
12	knitted-fabric open-end seaming apparatus
13	knitted-fabric transferring apparatus
19	knitting needle cylinder
21	knitting needle
26	final loop
26a	inner loop
27	knitted fabric
33	moving arm
34	transferring needle
34b	sewing needle guide groove
40	transferring needle unit
41	transferring sinker unit
43	fixed half dial
44	movable half dial
45	transferring needle holding cylinder
46	hinge portion
49	transferring sinker
70	transferring-sinker advancing/retreating mechanism
71	transferring-sinker vertically-moving mechanism
85	movable-half-dial inversion driving section

Claims

1. A knitted-fabric seaming method for a circular knitting machine, in which one end of a knitted fabric (27) knitted by a circular knitting machine (11) is transferred from knitting needles (21) of a knitting needle cylinder (19) of the circular knitting machine to transferring needles (34) in a state that the number of the knitting needles is the same as the number of the transferring needles, and thereafter the one end of the knitted fabric is closed by a sewing machine unit (100), wherein

inner loops (26a), which are located inside final loops (26) of the knitted fabric caught on the knitting needles, are divided in half into a first loop group and a second loop group in a circumferential direction of the knitted fabric, loops facing each other are joined at the time of closing the first loop group and the second loop group, and the joined loops are seamed by a sewing machine of the sewing machine unit.

2. The knitted-fabric seaming method for a circular knitting machine as defined in claim 1, wherein

the transferring needles and the knitting needles are moved relative to each other in an axial direction of the knitting needles such that an external surface of a tip end of each of the transferring needles comes close to an internal surface of a tip end of the corresponding knitting needle, for the purpose of transferring the knitted

fabric from the knitting needles with use of the transferring needles;
a transferring member (49) 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 guide the knitting needle by the distal end portion (49b) of each of the transferring members, and
the transferring member is moved from the knitting needle to the transferring needle in the axial direction of the knitting needles, and the tip ends of the transferring needles are inserted into the inner loops, so as to transfer the knitted fabric from the knitting needles to the transferring needles.

3. The knitted-fabric seaming method for a circular knitting machine as defined in claim 1 or 2, wherein a tip-end protrusion (34e) of each of the transferring needles leans inward.

4. The knitted-fabric seaming method for a circular knitting machine as defined in any one of claims 1 to 3, wherein

the knitting needles and the transferring needles are arranged at a constant pitch in the circumferential direction so as to constitute a knitting needle group and a transferring needle group,
the transferring needle group is divided 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 to which the first loop group is transferred is attached to a fixed half dial (43) and the second transferring needle group to which the second loop group is transferred is attached to a movable half dial (44),
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.

5. The knitted-fabric seaming method for a circular knitting machine as defined in claim 4, 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 fixed half dial and the movable half dial 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, and 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 in the closed state, such that the first transferring needle group is continuous with the second transferring needle group in an axial direction of the transferring needles.

6. The knitted-fabric seaming method for a circular knitting machine as defined in any one of claims 2 to 5, wherein

each of the transferring members is a transferring sinker which includes a transferring sinker main body (49a) having the shape of a belt plate and the distal end portion having a tapered portion (49d) so as to be formed to have an acute angle,
the distal end 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.

7. The knitted-fabric seaming method for a circular knitting machine as defined in claim 6, wherein

each of the transferring sinkers is inserted into the space between the adjacent knitting needles of the knitting needle cylinder from outside to inside in the radial direction of the knitting needle cylinder by a transferring-sinker advancing/retreating mechanism (10), and
the transferring sinkers and the transferring-sinker advancing/retreating mechanism are caused to insert the tip ends of the transferring needles into the inner loops by a transferring-sinker vertically-moving mechanism (71), so as to transfer the knitted fabric from the knitting needles to the transferring needles.

8. The knitted-fabric seaming method for a circular knitting machine as defined in any one of claims 2 to 7, wherein before the inner loops are transferred to the transferring needles, each of the transferring members is inserted into the space between the adjacent knitting needles above 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 members, in order to align heights of the final loops before being transferred.

9. The knitted-fabric seaming method for a circular knitting machine as defined in any one of claims 4, 5, or 6 to 8 according to claim 4 or 5, wherein after the inner loops are transferred to the transferring needles, the knitted fabric is moved to the sewing machine unit so as to seam the inner loops, 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.

10. The knitted-fabric seaming method for a circular knitting machine as defined in claim 9, wherein each of the transferring needles of the fixed half dial has a sewing needle guide groove (34b) extending in the axial direction, so as to guide the sewing needle by the sewing needle guide groove in the vertical movement of the sewing needle.

11. The knitted-fabric seaming method for a circular knitting machine as defined in claim 10, wherein the sewing machine unit is selectively set to a first seaming position where the sewing needle is inserted into the sewing needle guide groove or a second seaming position where the sewing needle is located inside with respect to the first seaming position in the circumferential direction of the knitted fabric, and linking or first sewing by the sewing machine unit at the first seaming position, or second sewing at the second seaming position is performed.

12. The knitted-fabric seaming method for a circular knitting machine as defined in claim 11, wherein the knitted fabric is held between a half ring (60) disposed inside the fixed half dial and a lower knitted-fabric holding member (115) disposed so as to face the half ring, and then the inner loops are removed from the transferring needles, and the first sewing and the second sewing are performed.

13. A circular knitting machine system (10) for transferring one end of 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) in a state that the number of the knitting needles is the same as the number of the transferring needles, and thereafter closing the one end of the knitted fabric by a sewing machine unit (100), the circular knitting machine system comprising:

a transferring needle unit (40) for holding the transferring needles into each of which an inner loop (26a) located inside a final loop (26) of the knitted fabric caught on the knitting needle is inserted, the transferring needle unit moving upward and downward along a center line of the knitting needle cylinder so as to come into a retreated state in which the transferring needles are retreated from the knitting needles and a close state in which the transferring needles come close to the knitting needles;
a transferring member (49) for transferring the knitted fabric from the knitting needles to the transferring needles when the transferring needle unit is in the close state;
a loop joining mechanism (52, 53, 60, 68, 69) for dividing the inner loops in half into a first loop group and a second loop group in a circumferential direction of the knitted fabric, and joining loops facing each other at the time of closing the first loop group and the second loop group; and
a sewing machine unit (100) for seaming the loops joined by the loop joining mechanism.

14. The circular knitting machine system as defined in claim 13, wherein each of the transferring members 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 guide the knitting needle by a distal end portion (49b) thereof when the transferring needle unit is in the close state.

15. The circular knitting machine system as defined in claim 13 or 14, wherein each of the transferring needles has a tip-end protrusion (34e), which leans toward a direction away from the corresponding knitting needle, in a state that the transferring needles are held by the transferring needle unit.

16. The circular knitting machine system as defined in any one of claims 13 to 15, wherein

the knitting needles and the transferring needles are arranged at a constant pitch in the circumferential direction so as to constitute a knitting needle group and a transferring needle group,
the transferring needle unit includes a fixed half dial (43) for holding a first transferring needle group to which the first loop group is transferred and a movable half dial (44) for holding a second transferring needle group to which the second loop group is transferred,
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.

17. The circular knitting machine system as defined in claim 16, 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 fixed half dial and the movable half dial 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 in the closed state, and the first transferring needle group is continuous with the second transferring needle group in an axial direction of the transferring needles.

18. The circular knitting machine system as defined in claim 17, wherein

each of the transferring members is a transferring sinker which includes a transferring sinker main body (49a) having the shape of a belt plate and the distal end portion having a tapered portion (49d) so as to be formed to have an acute angle, and
the distal end 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.

19. The circular knitting machine system as defined in claim 18, further comprising:

a transferring-sinker advancing/retreating mechanism for inserting each of the transferring sinkers into the space between the adjacent knitting needles of the knitting needle cylinder from outside to inside in the radial direction of the knitting needle cylinder; and
a transferring-sinker vertically-moving mechanism (71) for causing the transferring sinkers and the transferring-sinker advancing/retreating mechanism to move in the axial direction of the knitting needle and to insert the tip ends of the transferring needles into the inner loops, so as to transfer the knitted fabric from the knitting needles to the transferring needles.

20. The circular knitting machine system as defined in claim 18 or 19, wherein before the inner loops are transferred to the transferring needles, each of the transferring sinkers is inserted into the space between the adjacent knitting needles above 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.

21. The circular knitting machine system as defined in any one of claims 16, 17, or 18 to 20 according to claim 16 or 17, further comprising:

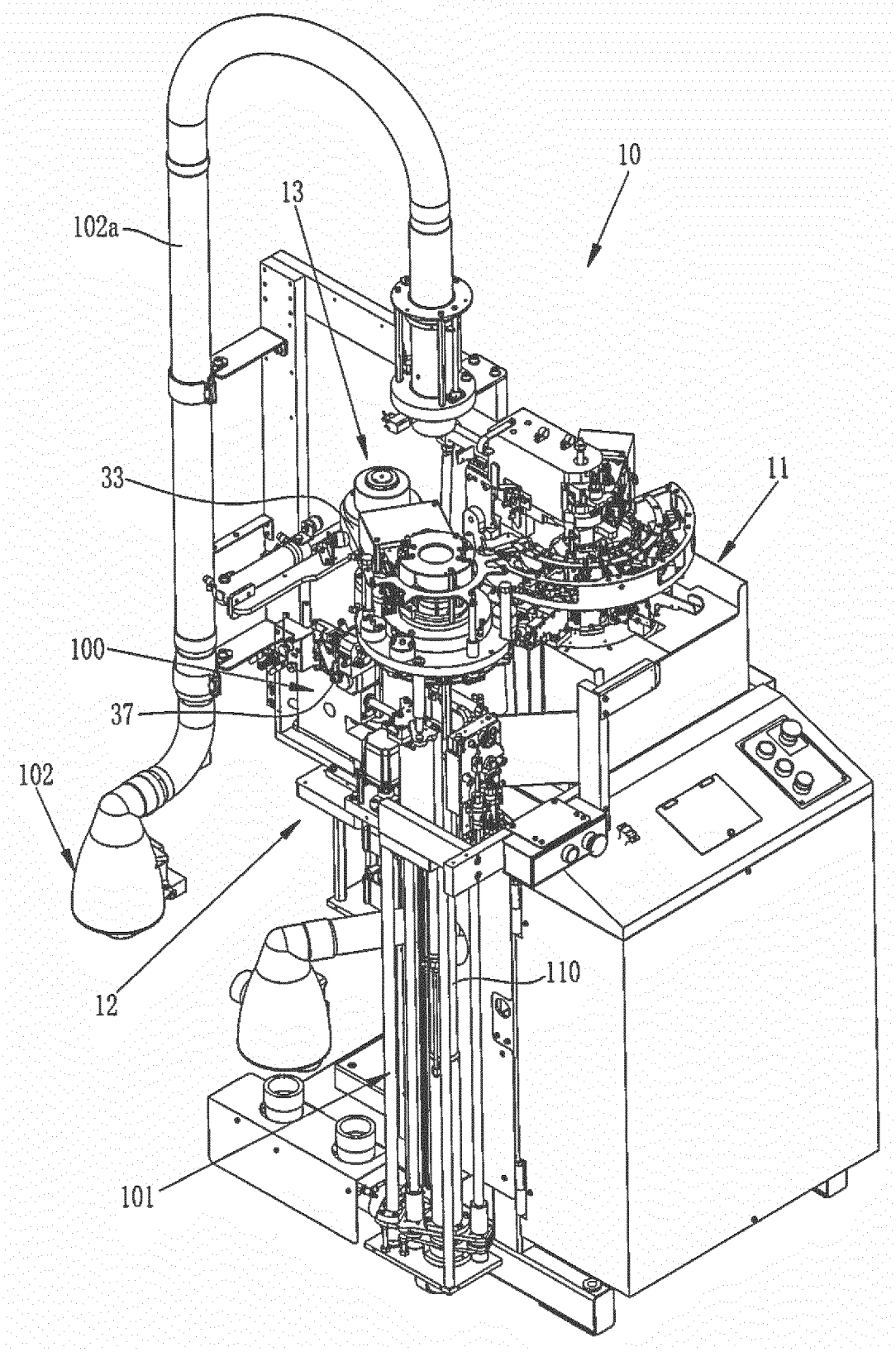
a knitted-fabric transferring apparatus (13) for transferring the knitted fabric to the sewing machine unit so as to seam the inner loops after the inner loops are transferred to the transferring needles; and
a rotation mechanism (106) for rotating the fixed half dial in a circumferential direction thereof in conjunction with vertical movement of a sewing needle (107) of the sewing machine unit.

22. The circular knitting machine system as defined in claim 21, wherein each of the transferring needles of the fixed half dial has a sewing needle guide groove (34b) extending in the axial direction, so as to guide the sewing needle by the sewing needle guide groove in the vertical movement of the sewing needle.

23. The circular knitting machine system as defined in claim 22, wherein the sewing machine unit is selectively set to a first seaming position where the sewing needle is inserted into the sewing needle guide groove or a second seaming position where the sewing needle is located inside with respect to the first seaming position in the circumferential direction of the knitted fabric, and linking or first sewing by the sewing machine unit at the first seaming position, or second sewing at the second seaming position is performed.

24. The circular knitting machine system as defined in claim 23, wherein the knitted fabric is held between a half ring (60) disposed inside the fixed half dial and a lower knitted-fabric holding member (115) disposed so as to face the half ring, and then the inner loops are removed from the transferring needles, and the first sewing and the second sewing are performed.

FIG.1



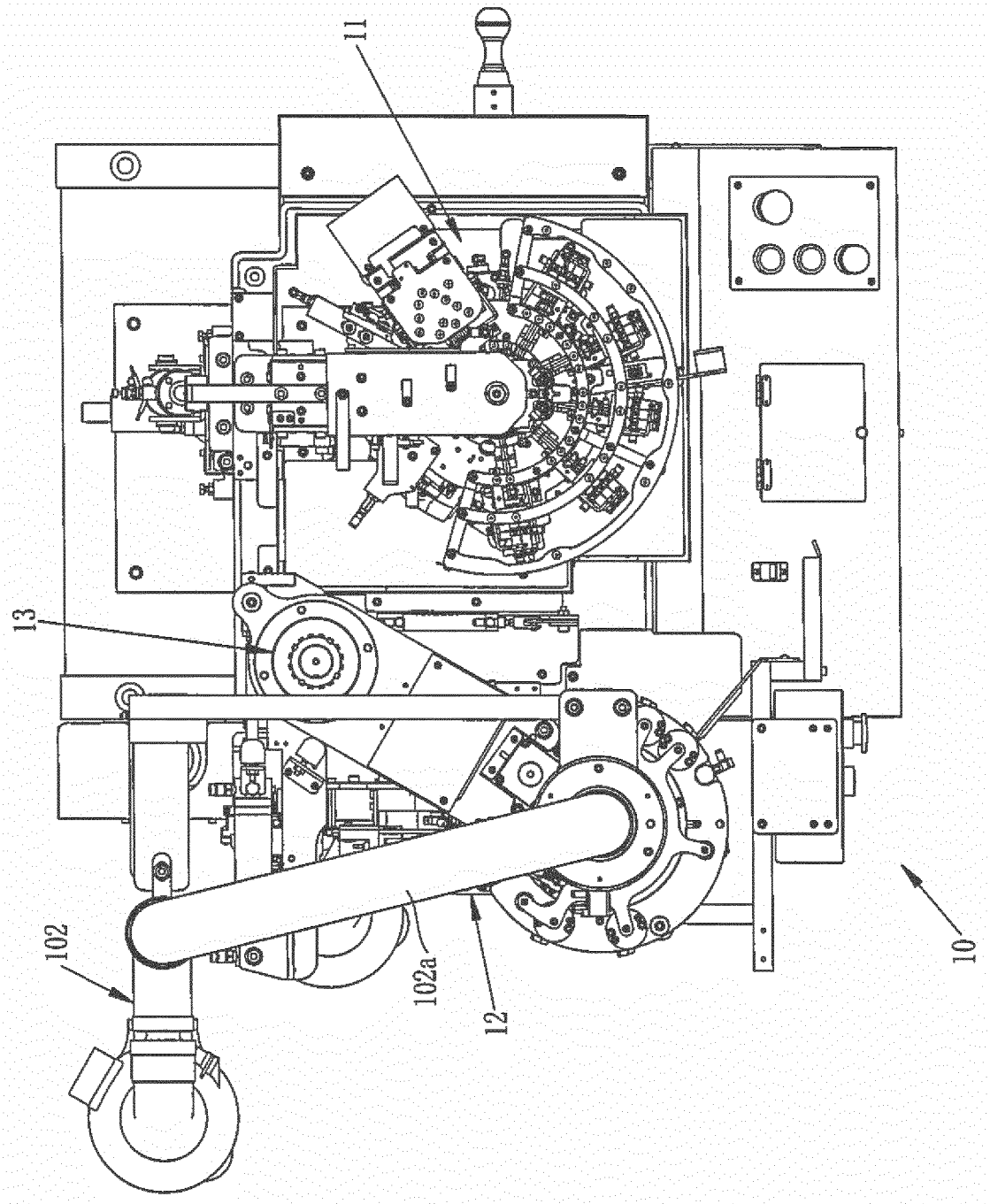


FIG.2

FIG.3

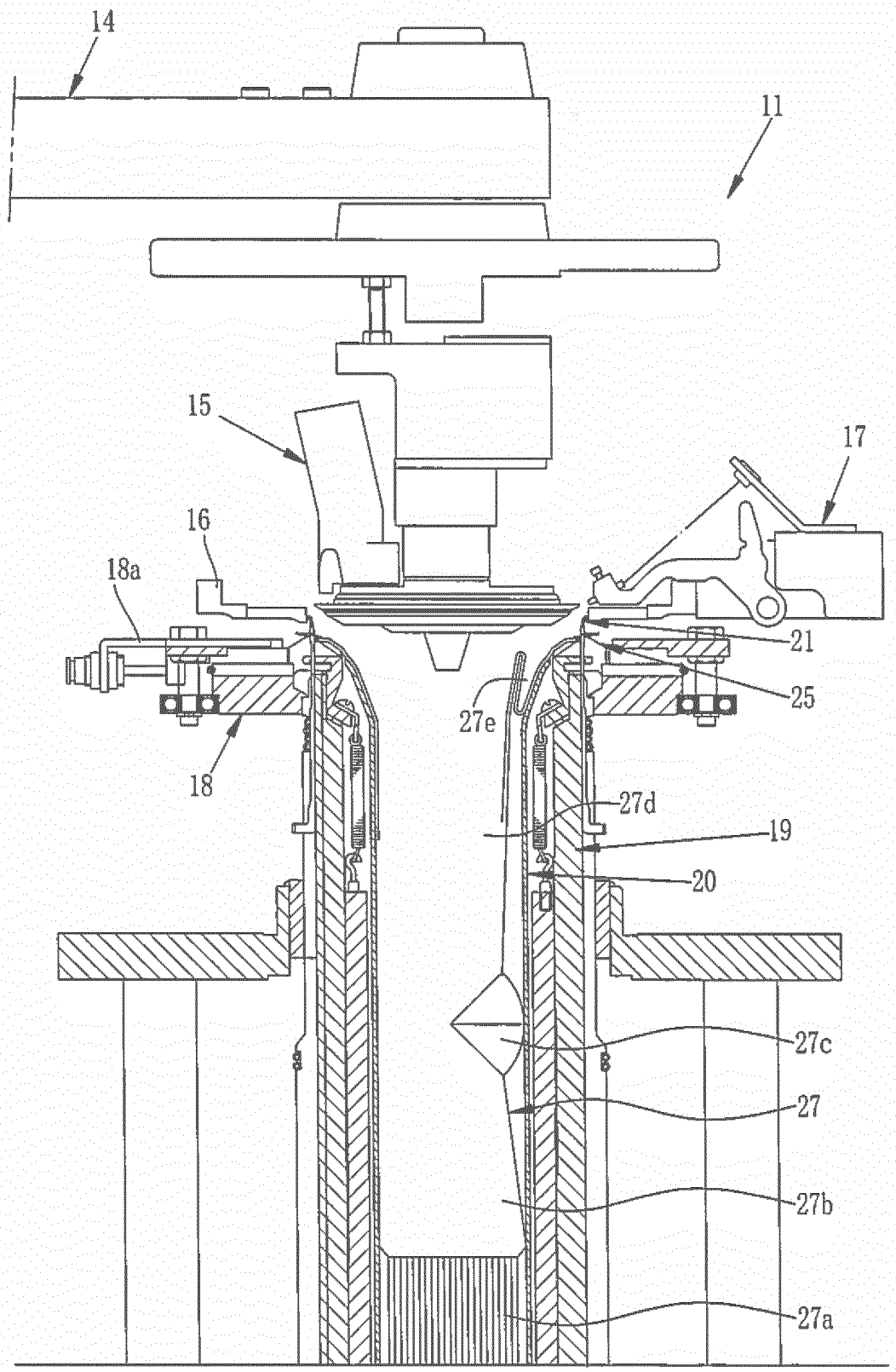


FIG.4

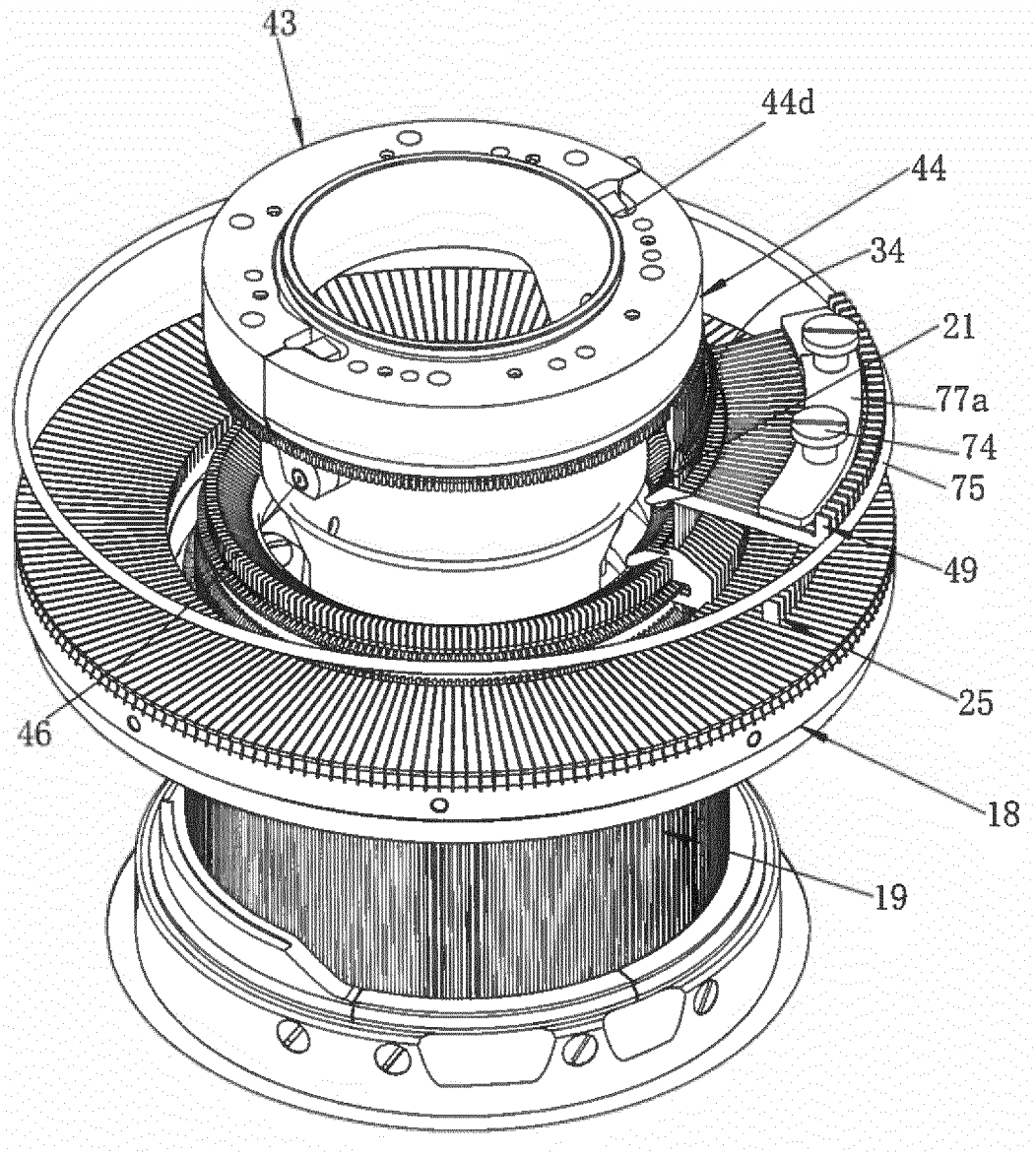


FIG.5

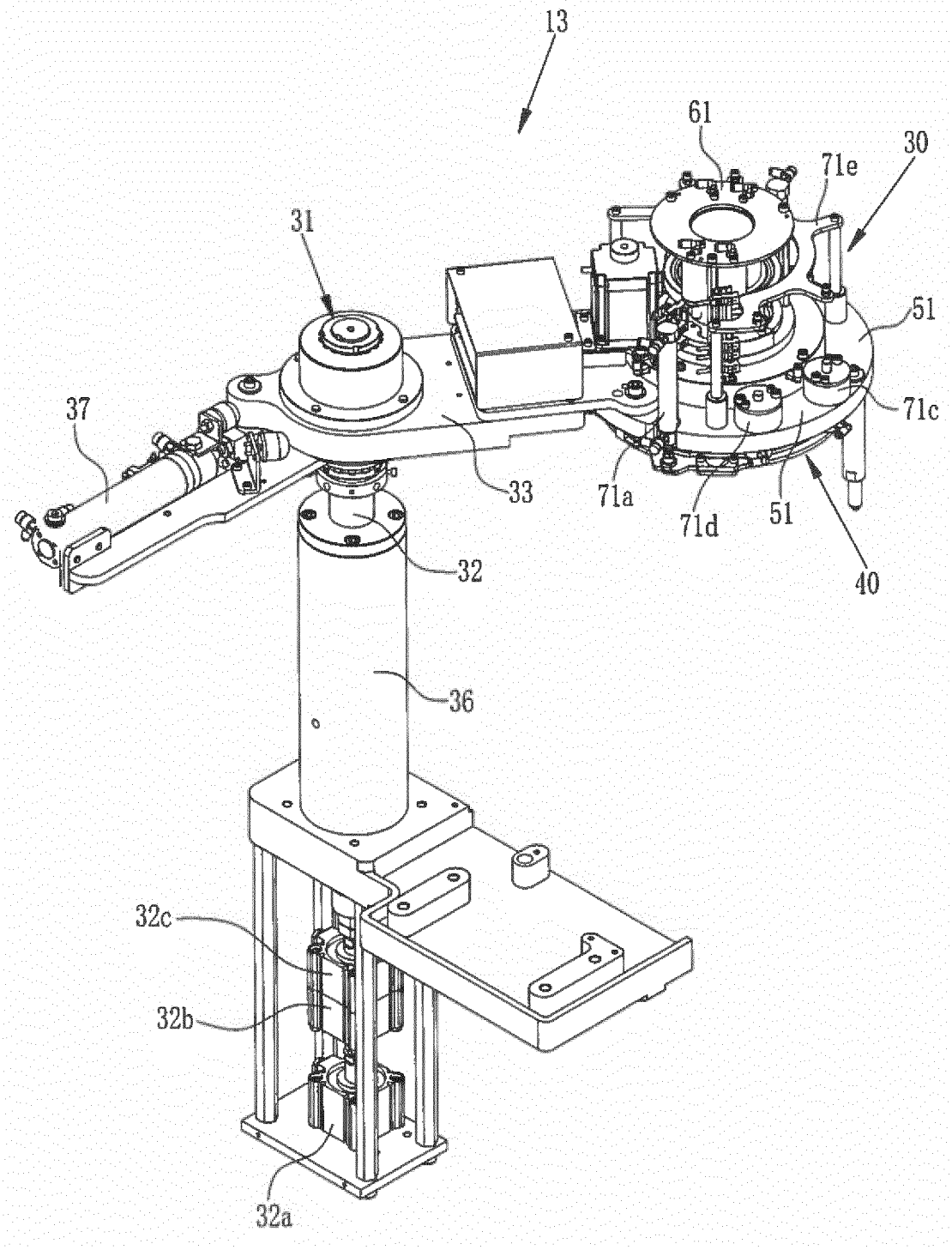


FIG.6

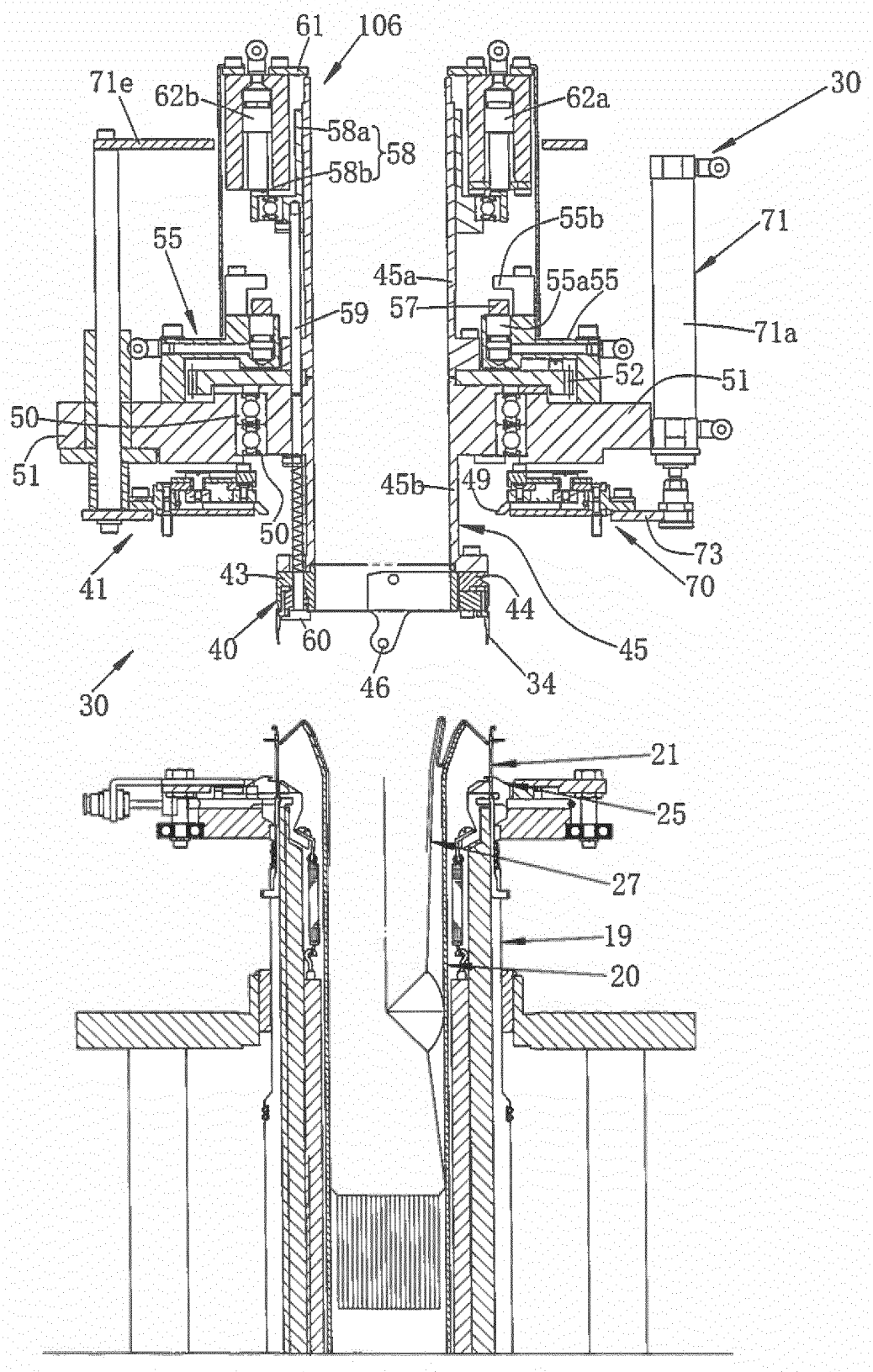

61
106
71e
62b
62a
30
58a
58
58b
55b
71
55
45a
55a
55
57
59
71a
52
51
50
51
45b
49
50
73
41
43
70
44
40
60
45
46
34
30
21
25
27
19
20

FIG.7

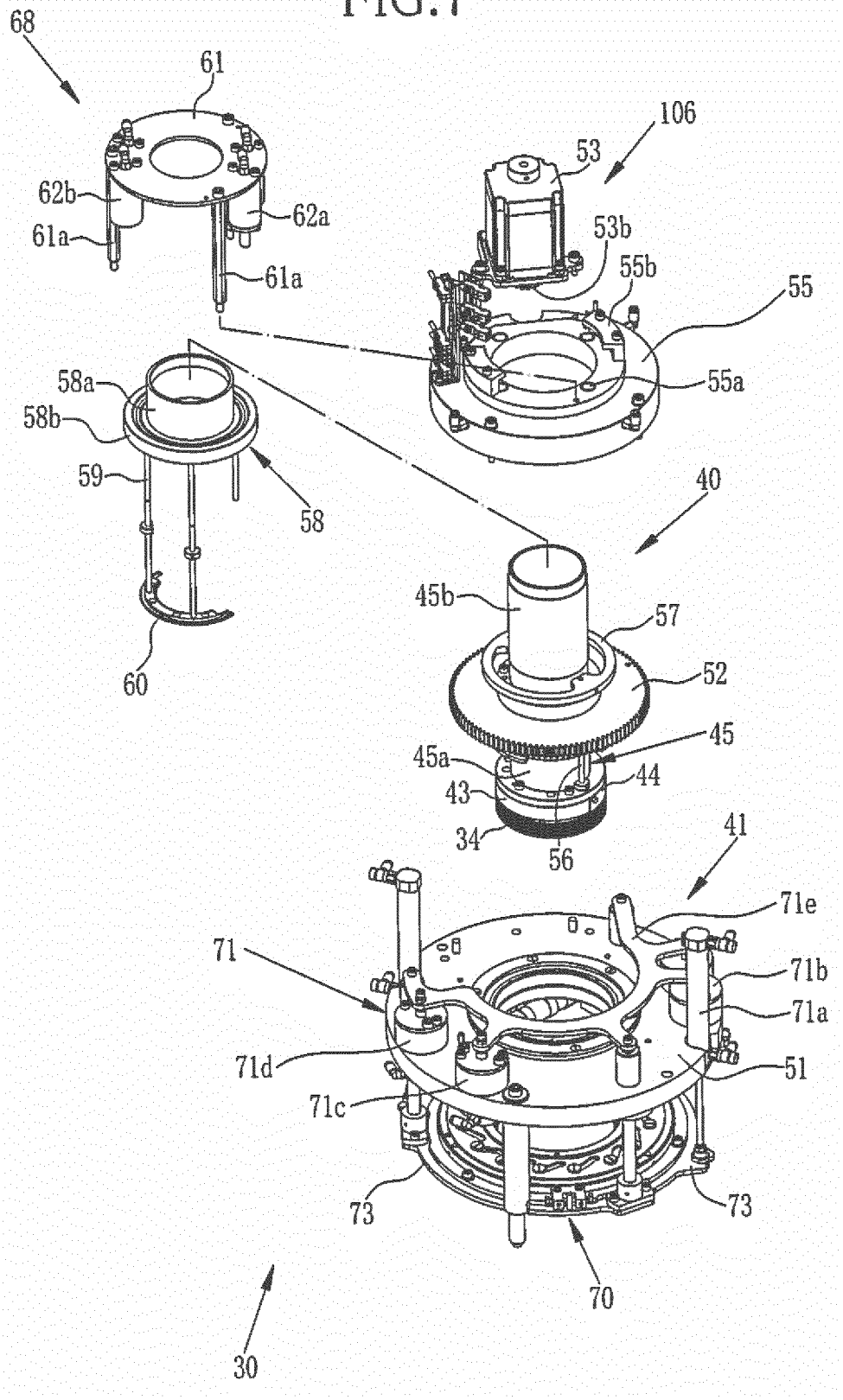

68
61
62b
61a
62a
61a
106
53
53b
55b
55
55a
58a
58b
59
58
60
40
45b
57
52
45
45a
44
43
34
56
41
71e
71
71b
71a
71d
51
71c
73
73
70
30

FIG.8

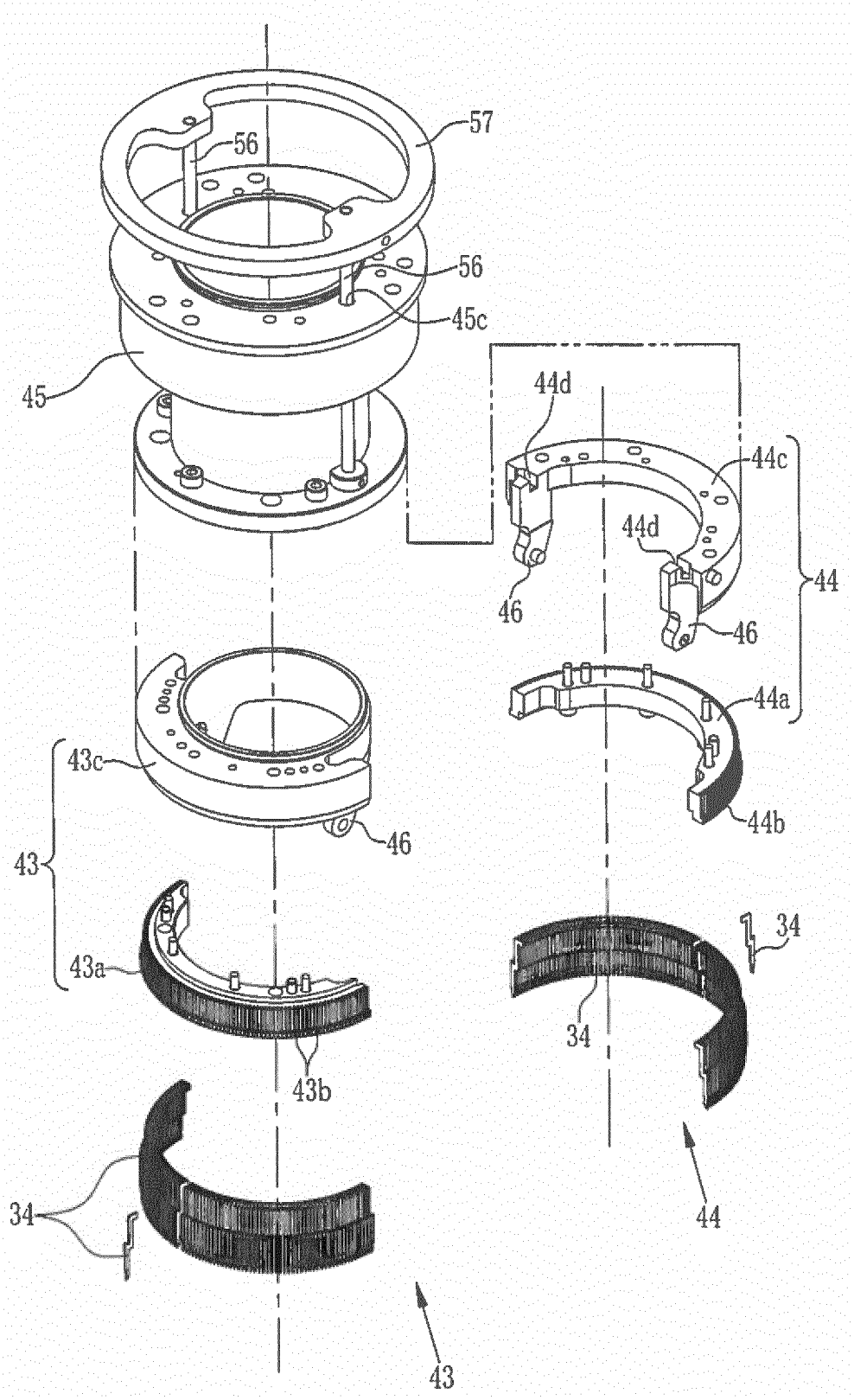

57
56
56
45c
45
44d
44c
44d
44
46
46
44a
44b
43c
46
43
43a
43b
34
34
34
44
43

FIG.9

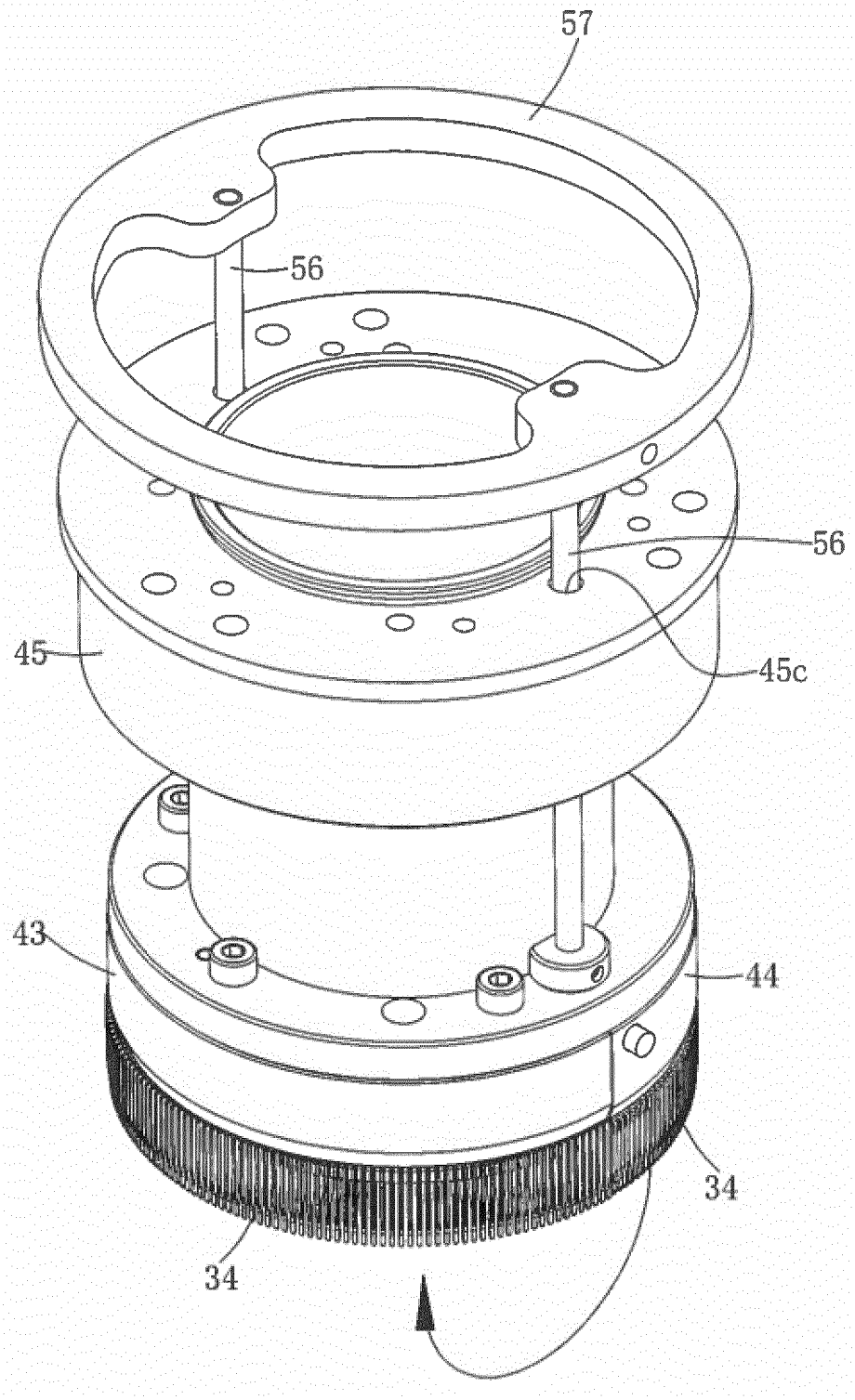


FIG.10

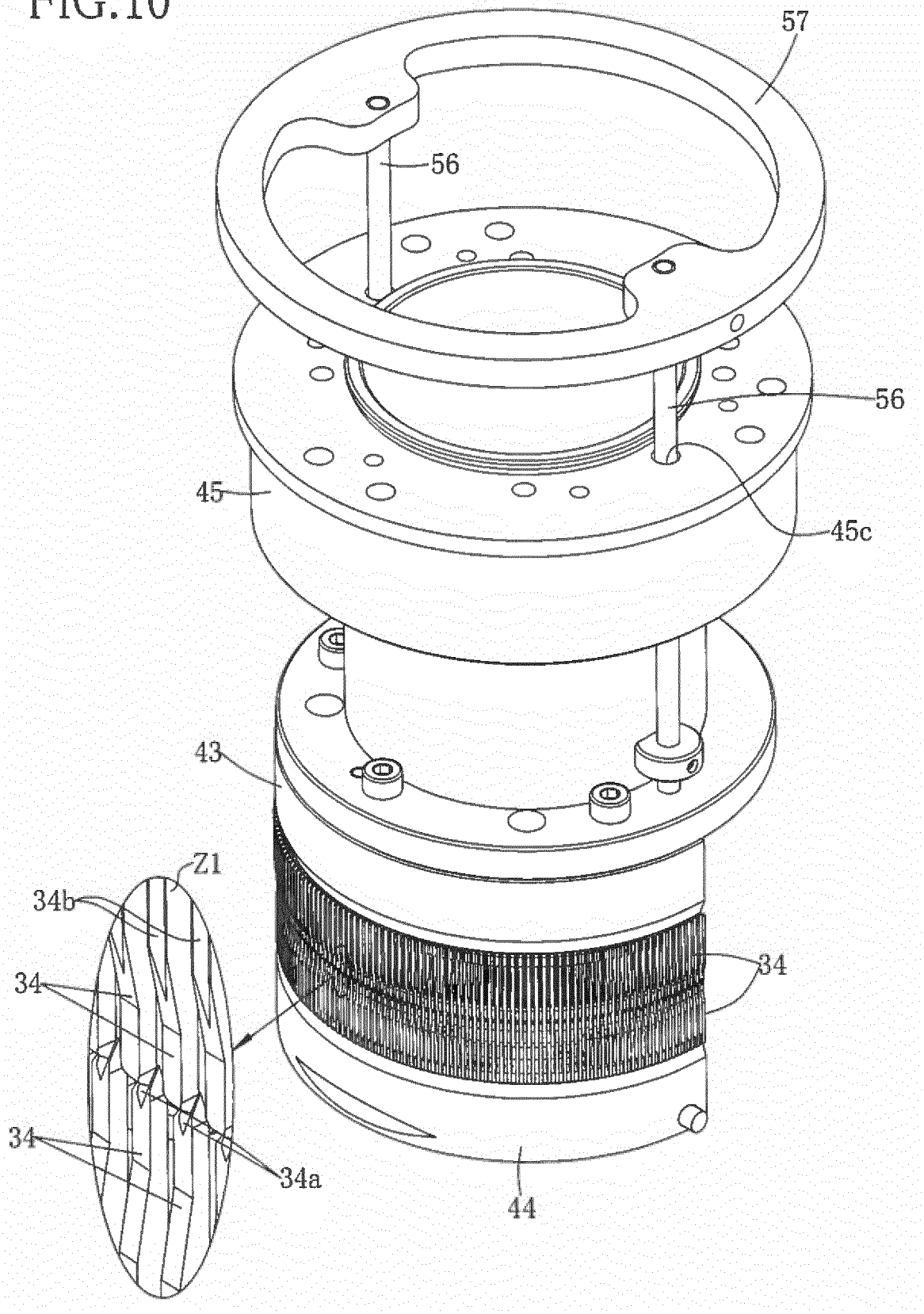


FIG.11

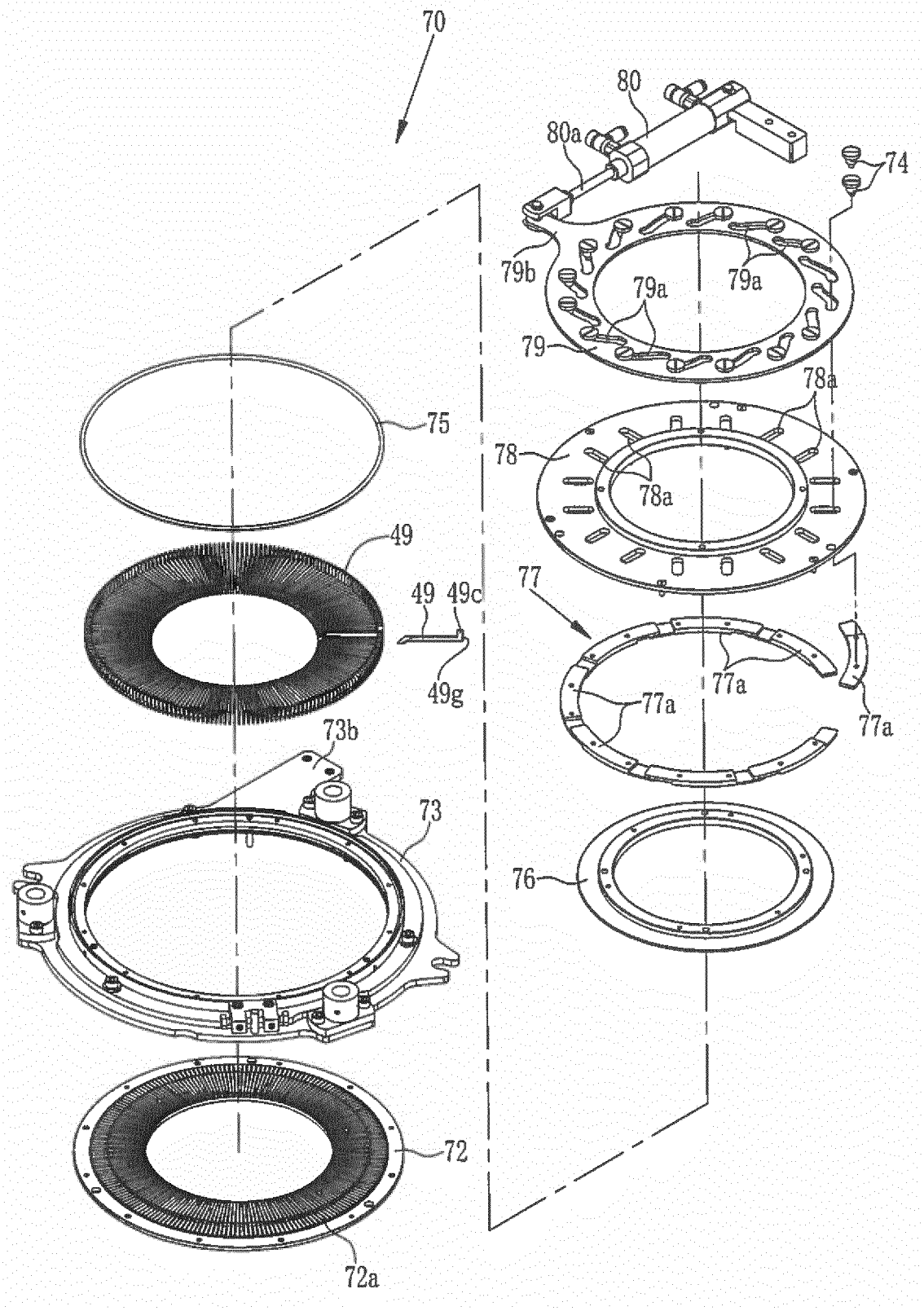

70
80
80a
74
79b
79a
79a
79
78a
75
78
78a
49
49
49c
77
49g
77a
77a
77a
73b
73
76
72
72a

FIG.12

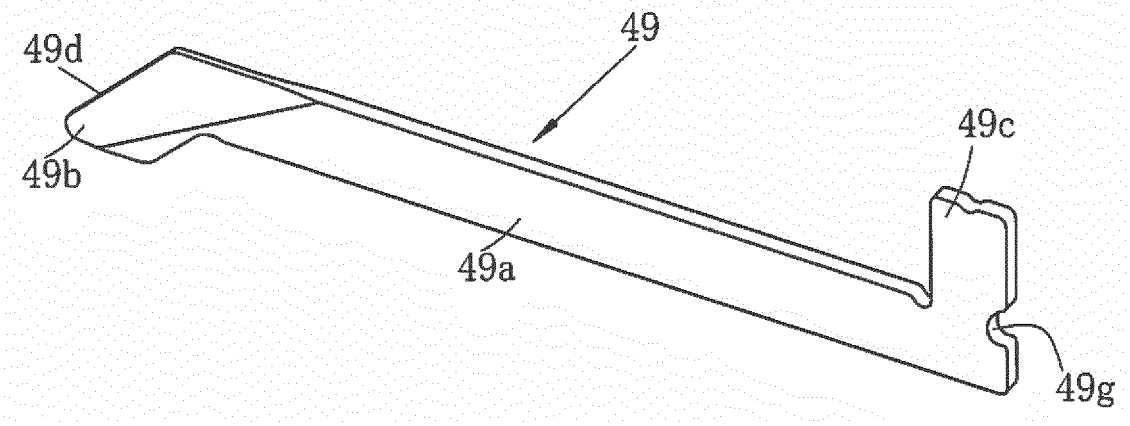


FIG.13A

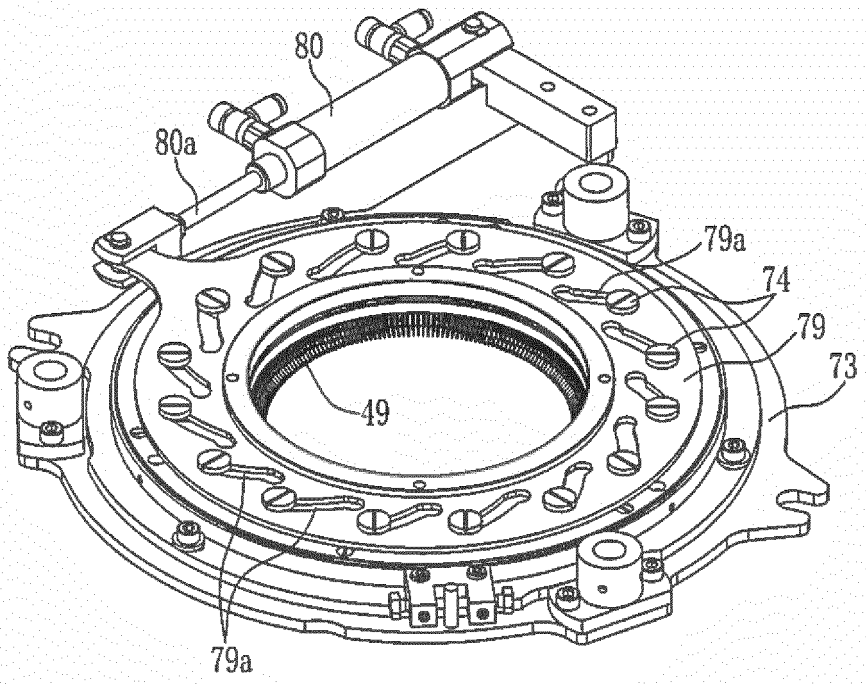


FIG.13B

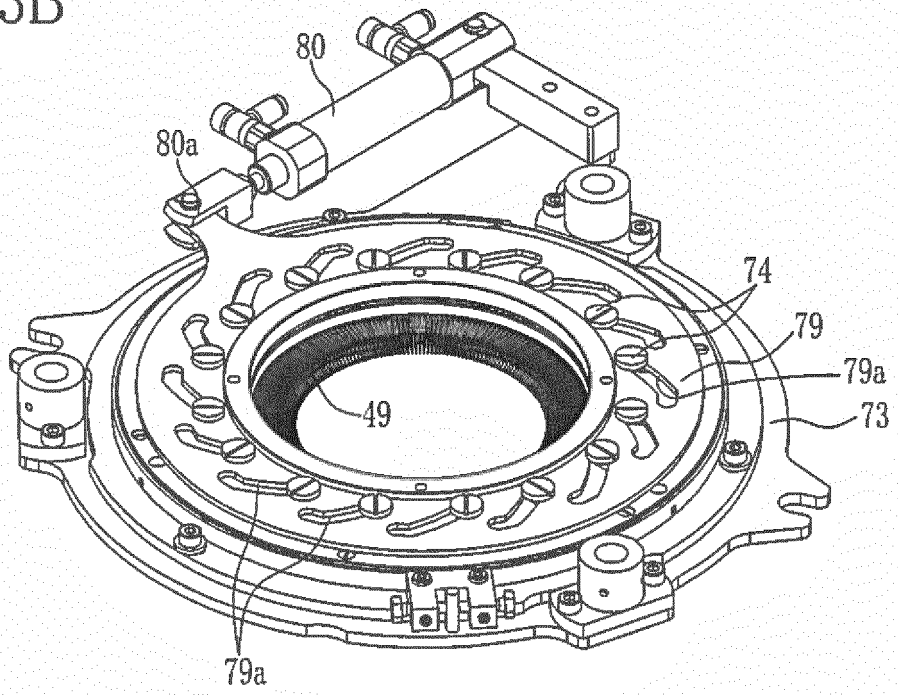


FIG.14

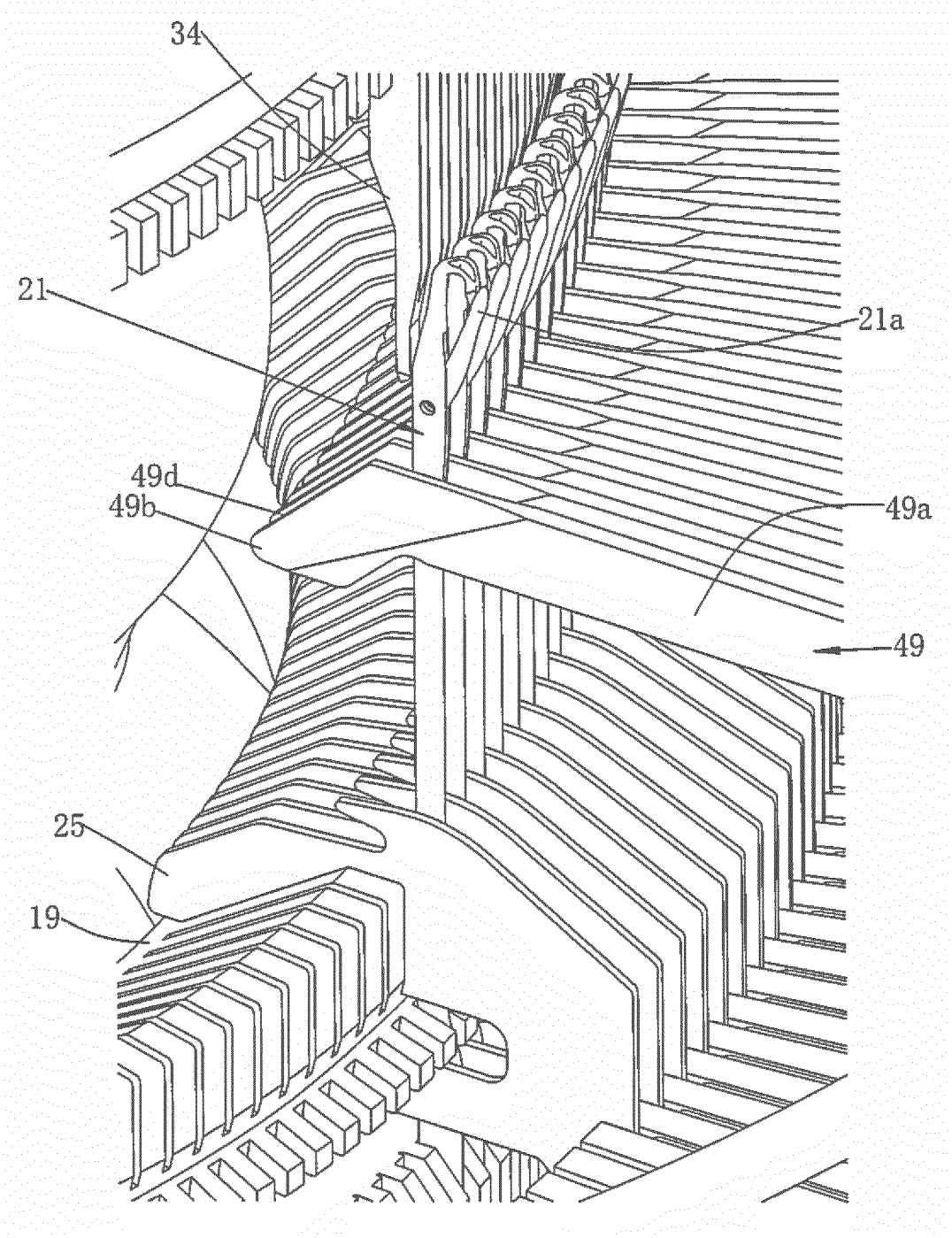


FIG.15

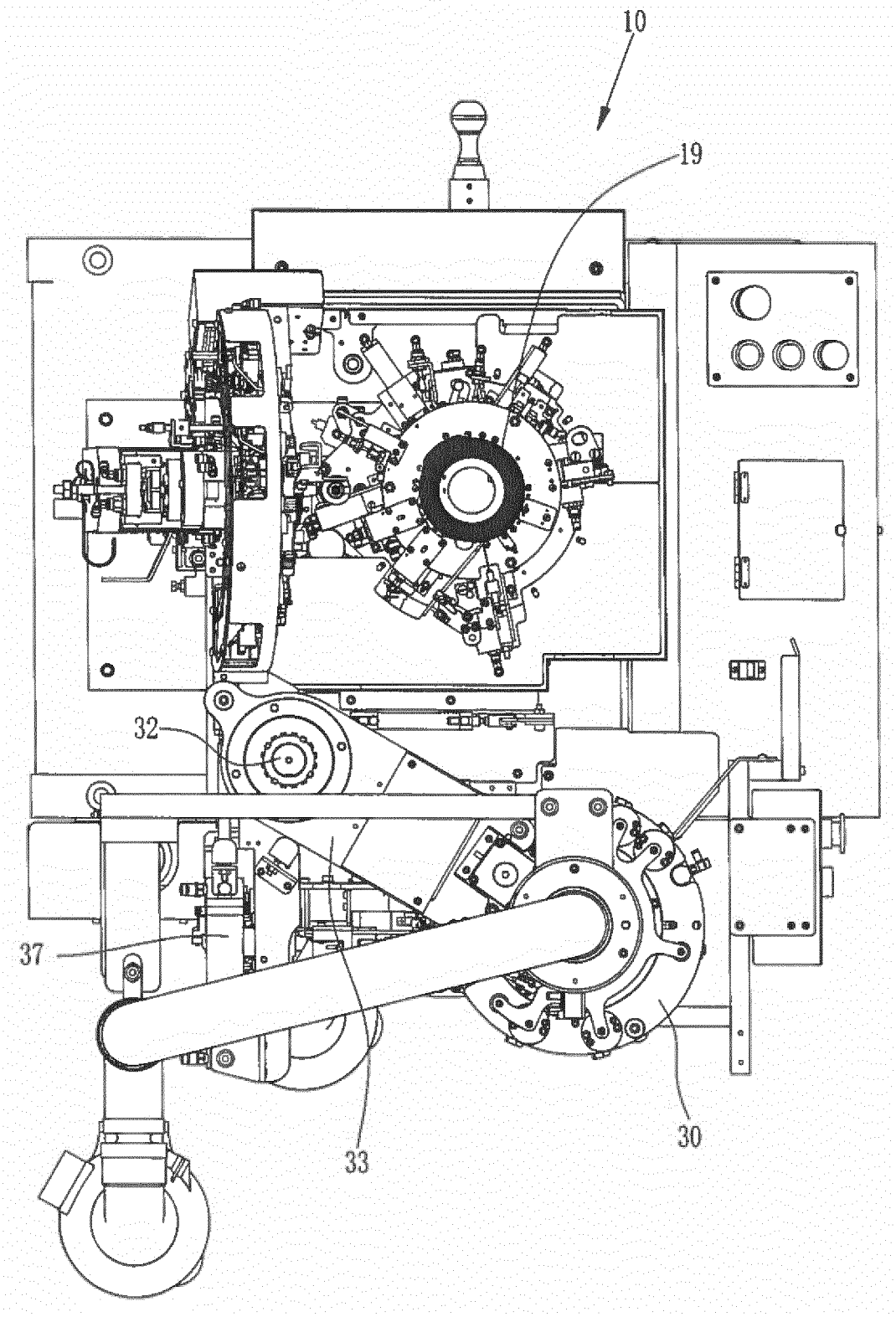


FIG.16

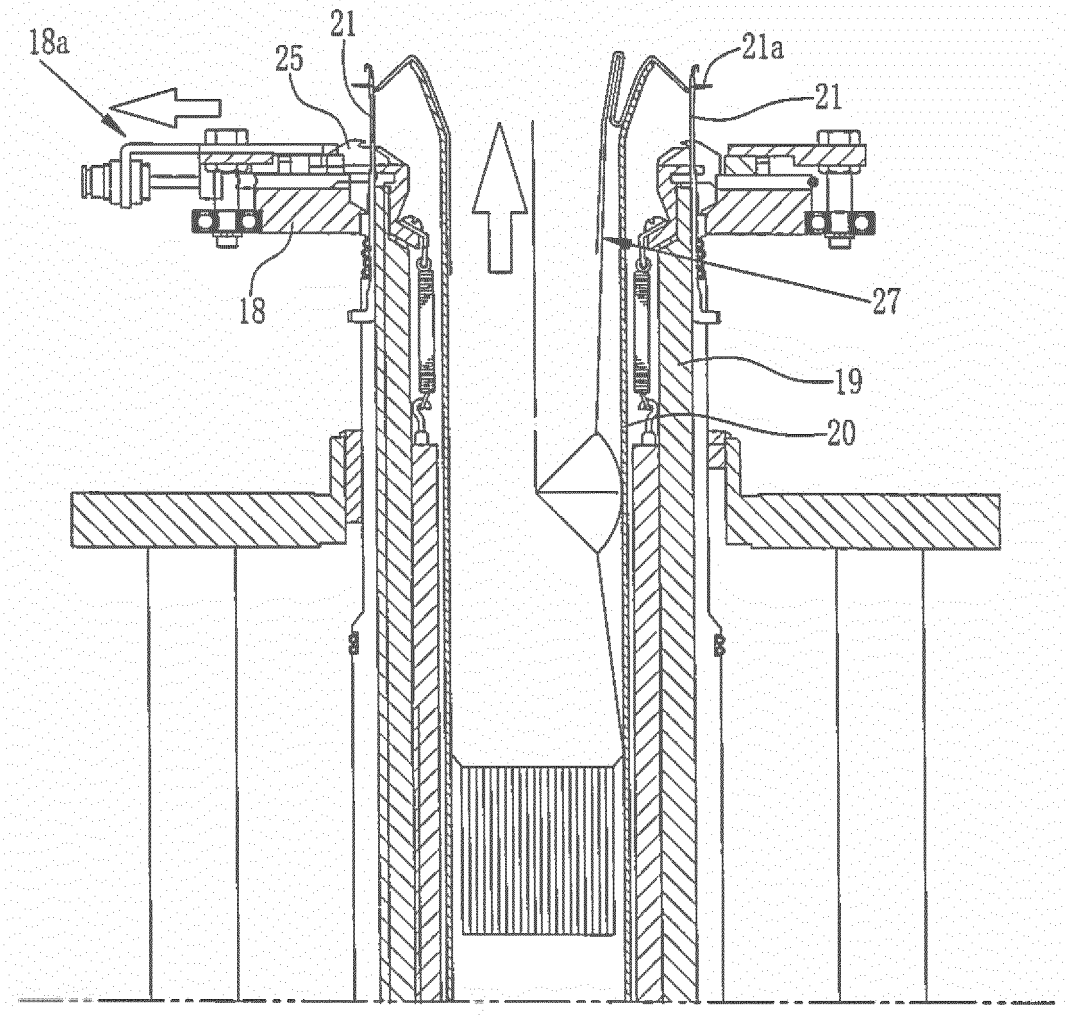


FIG.17

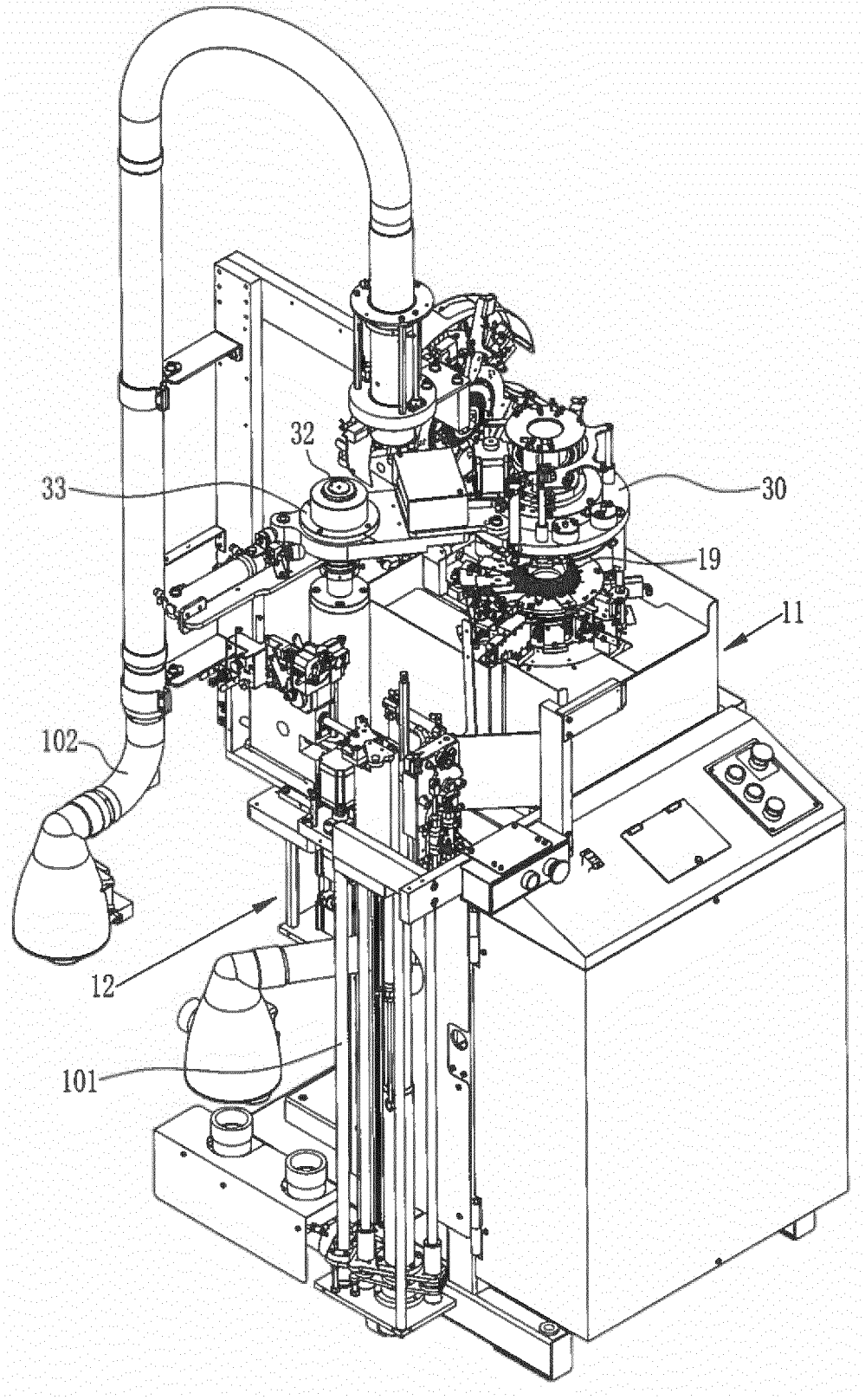


FIG.18

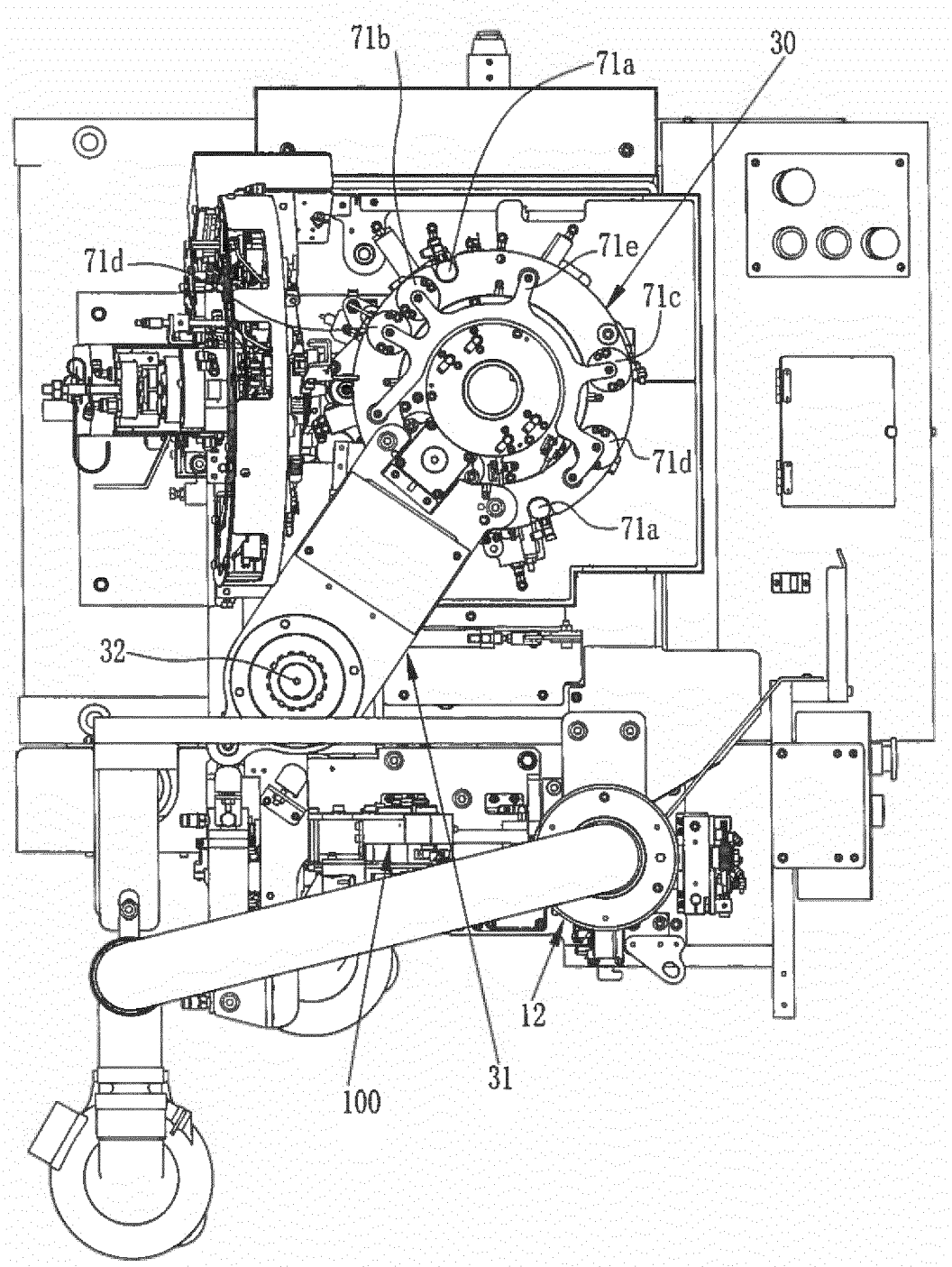


FIG.19

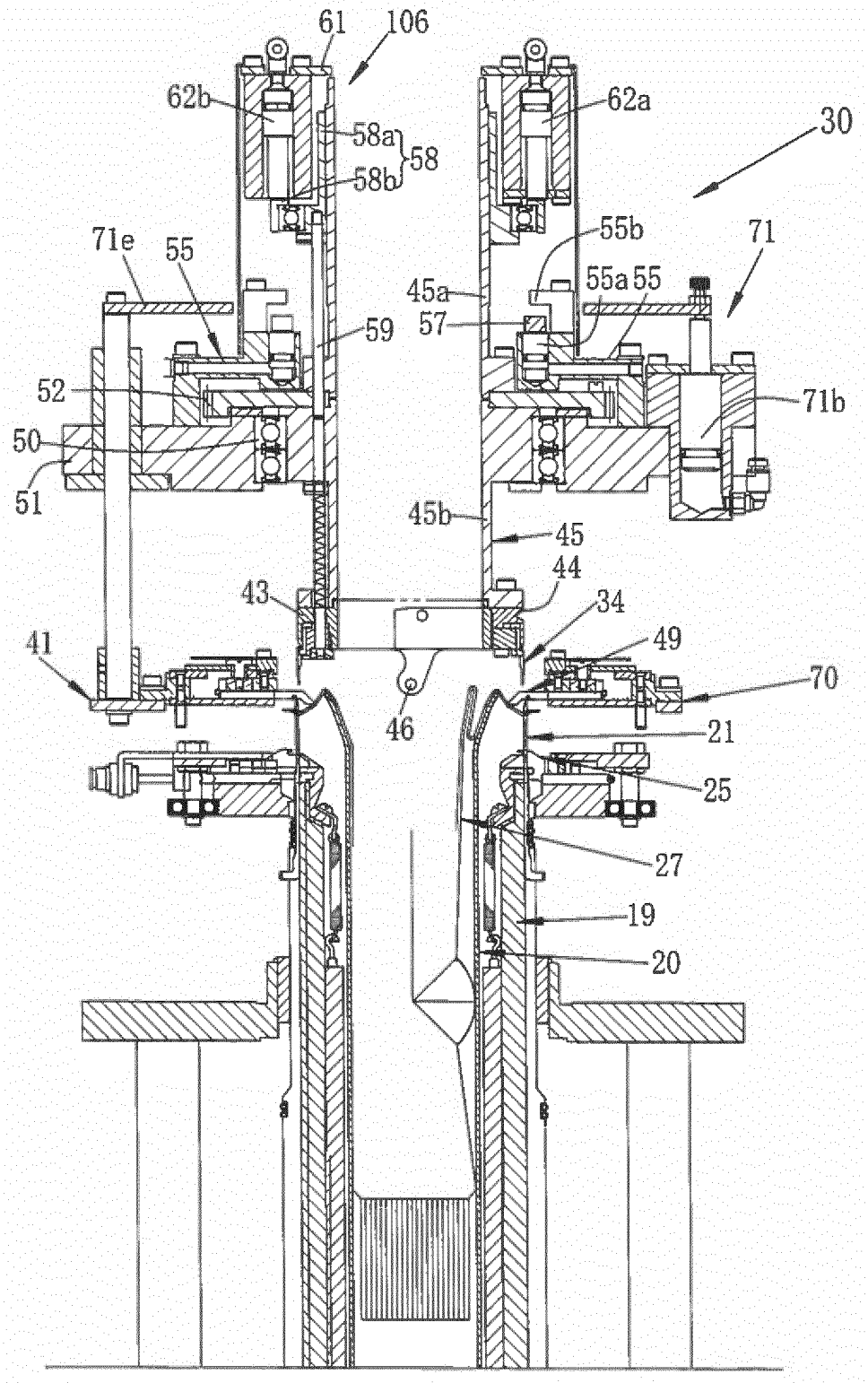

61
106
62b
62a
58a
58
58b
30
71e
55
55b
71
45a
55a
55
57
59
52
71b
50
51
45b
45
44
43
34
49
41
70
46
21
25
27
19
20

FIG.20

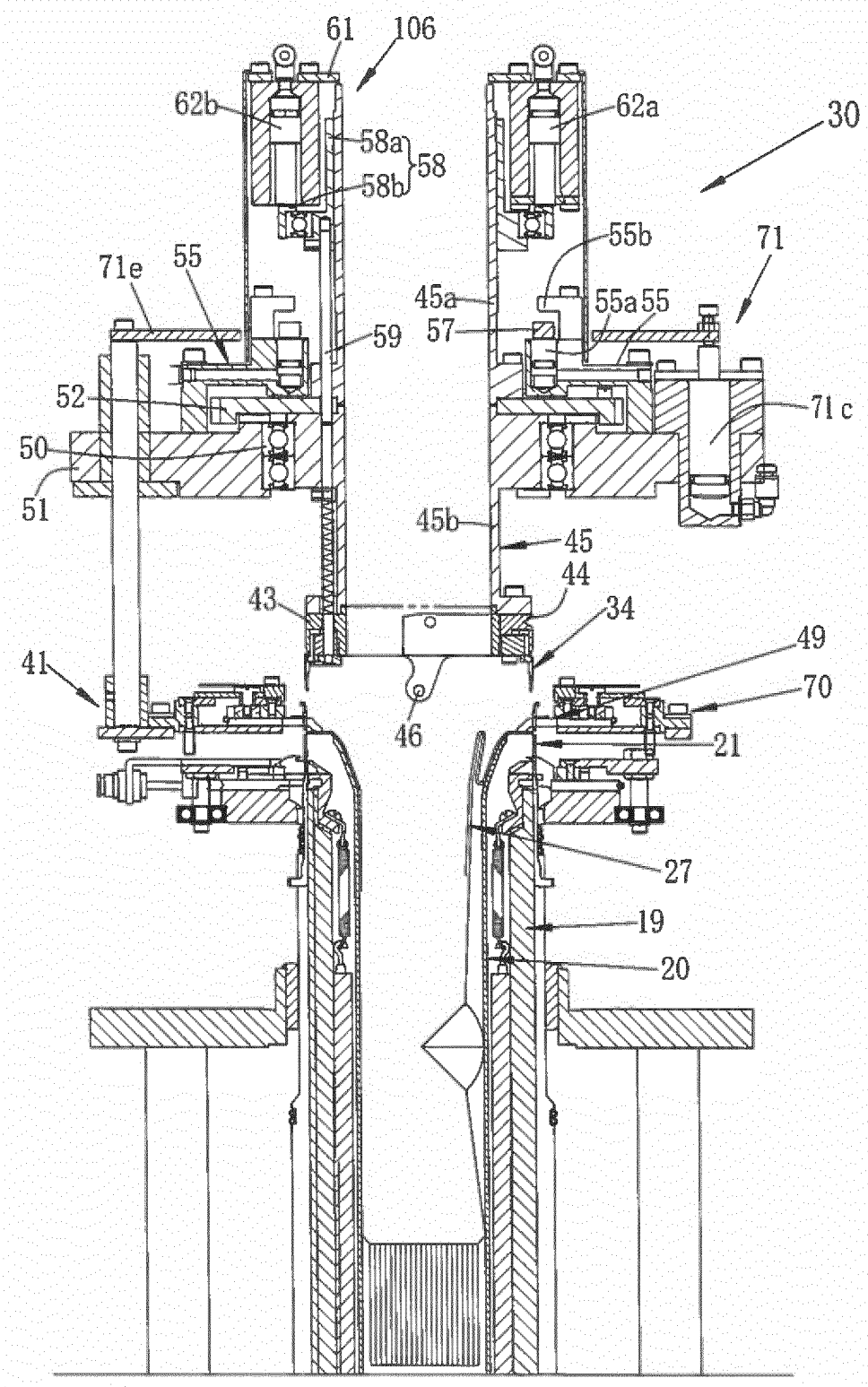

61
106
62b
62a
30
58a
58
58b
55b
71
71e
55
45a
55a
55
57
59
52
71c
50
51
45b
45
44
43
34
49
41
70
46
21
27
19
20

FIG.21

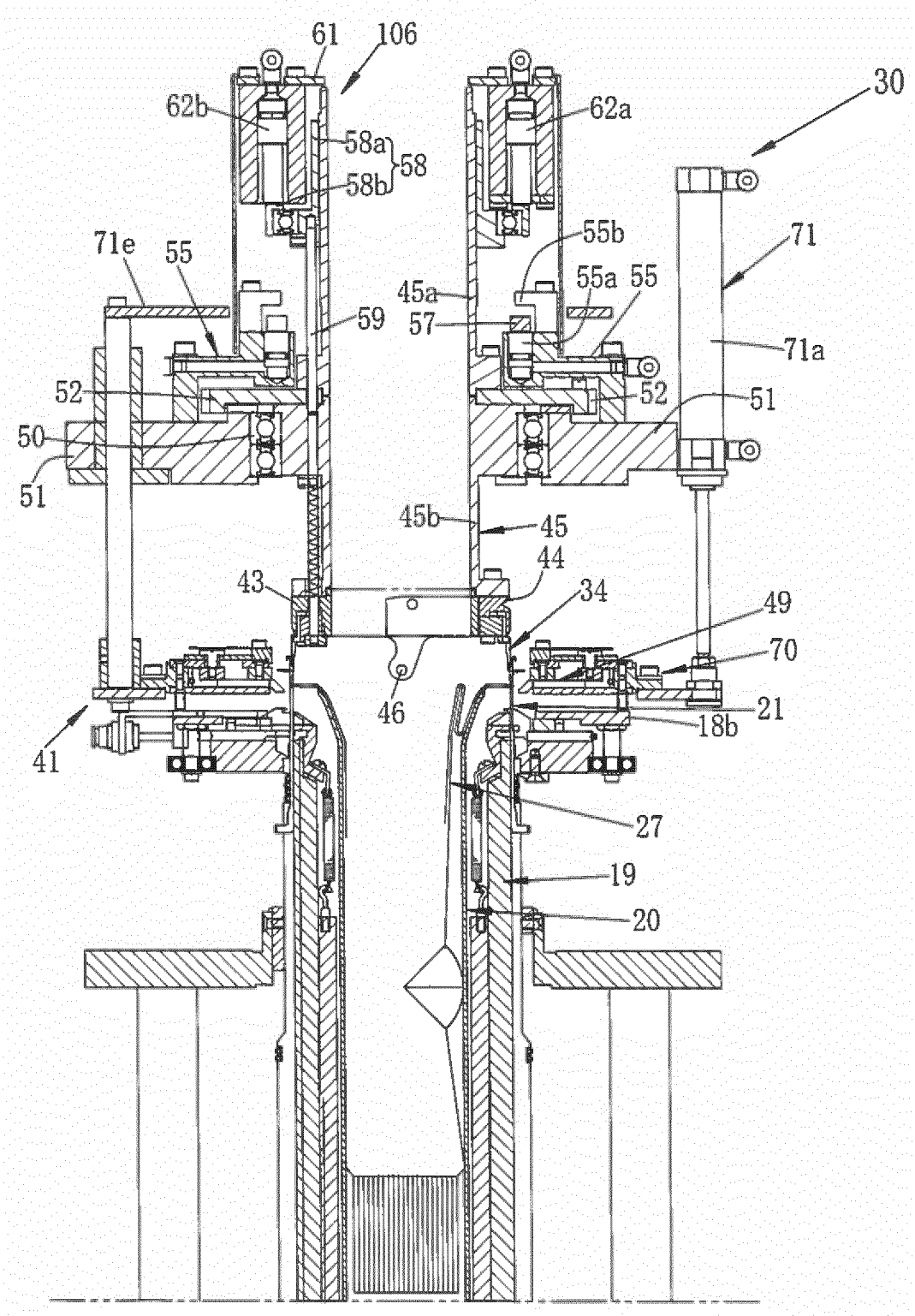

61
106
30
62b
62a
58a
58
58b
71e
55
55b
71
45a
55a
55
59
57
71a
52
52
51
50
51
45b
45
44
43
34
49
70
46
21
18b
41
27
19
20

FIG.22

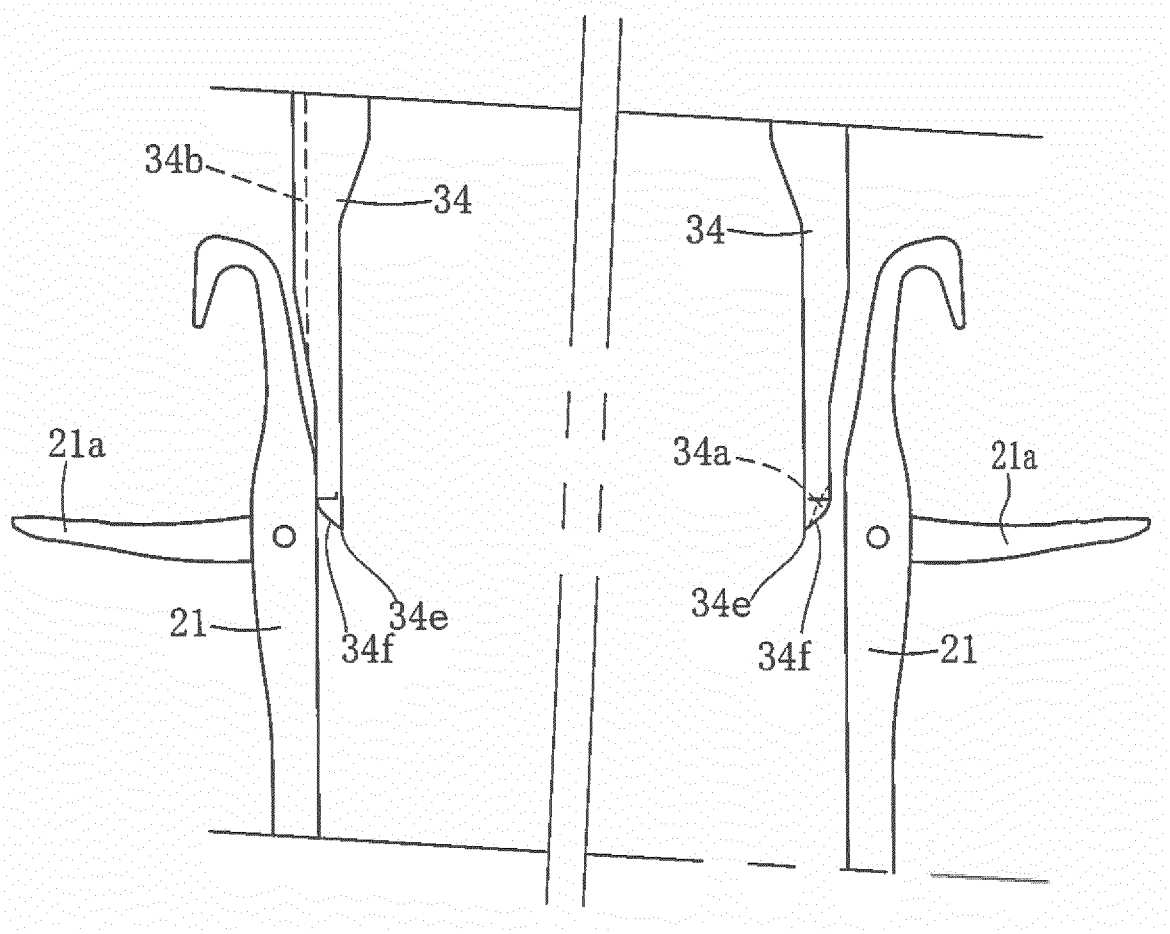


FIG.23

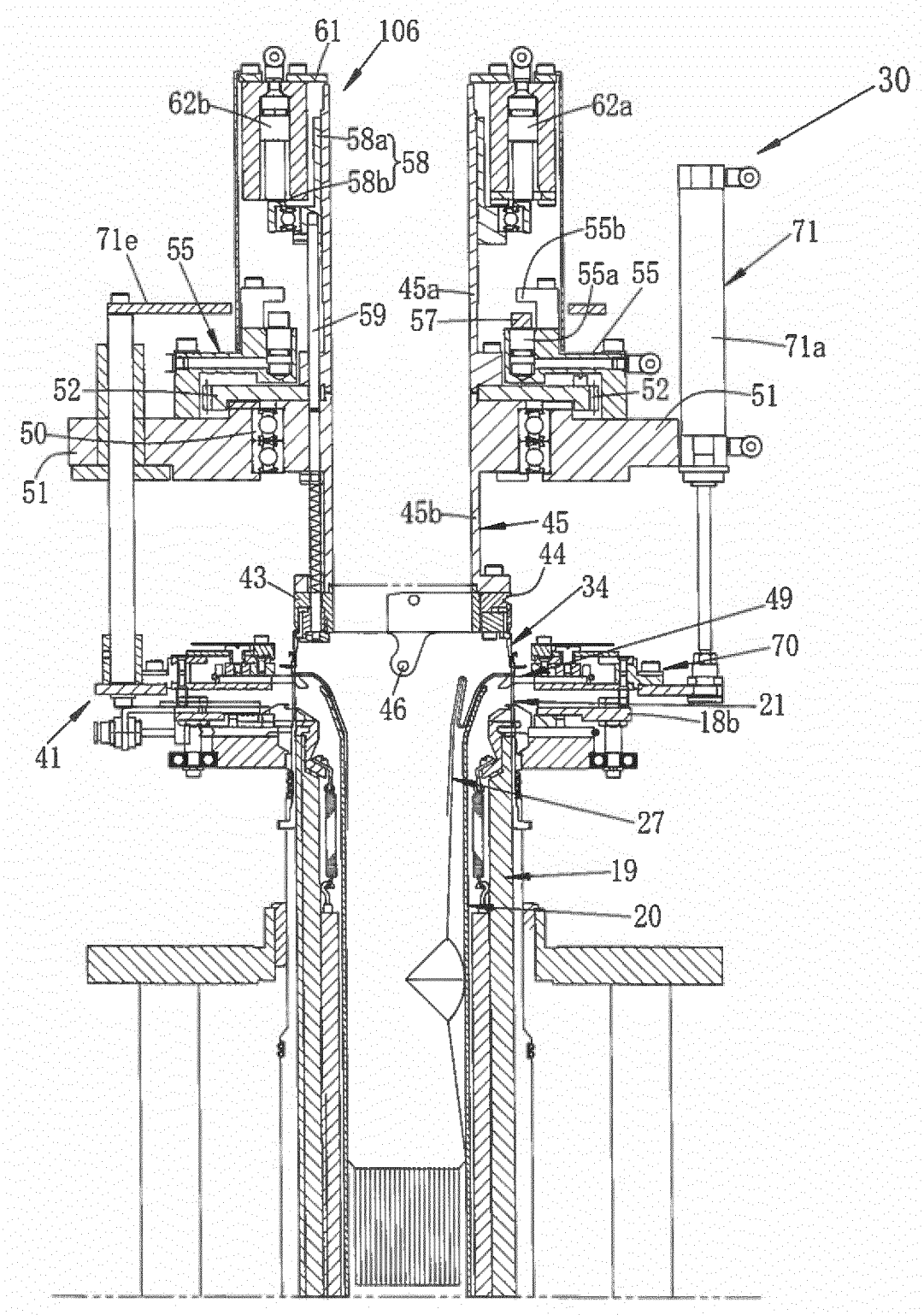

61
106
30
62b
62a
58a
58
58b
71e
55
55b
71
45a
55a
55
59
57
71a
52
52
51
50
51
45b
45
44
43
34
49
70
46
21
18b
41
27
19
20

FIG.24

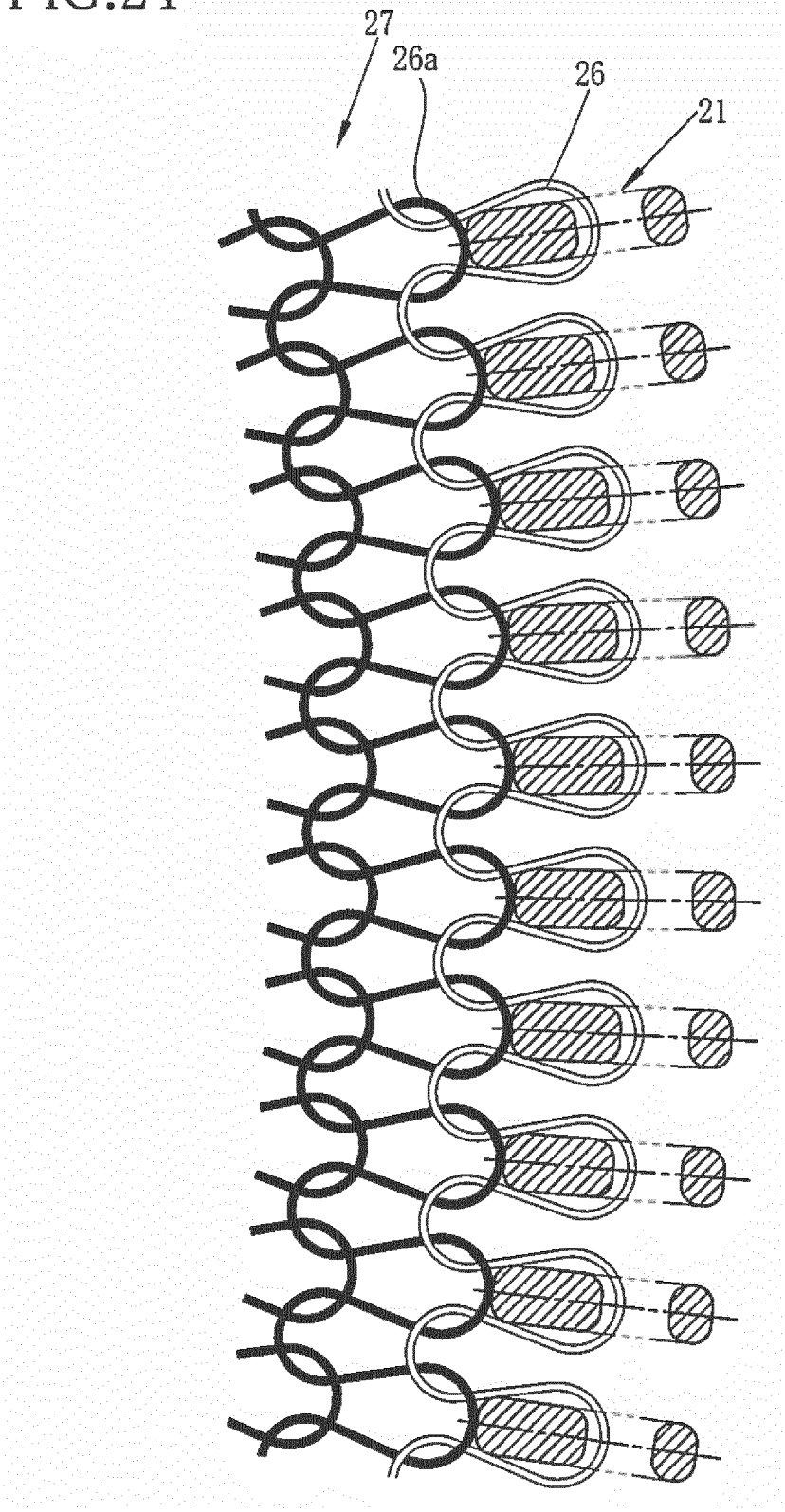
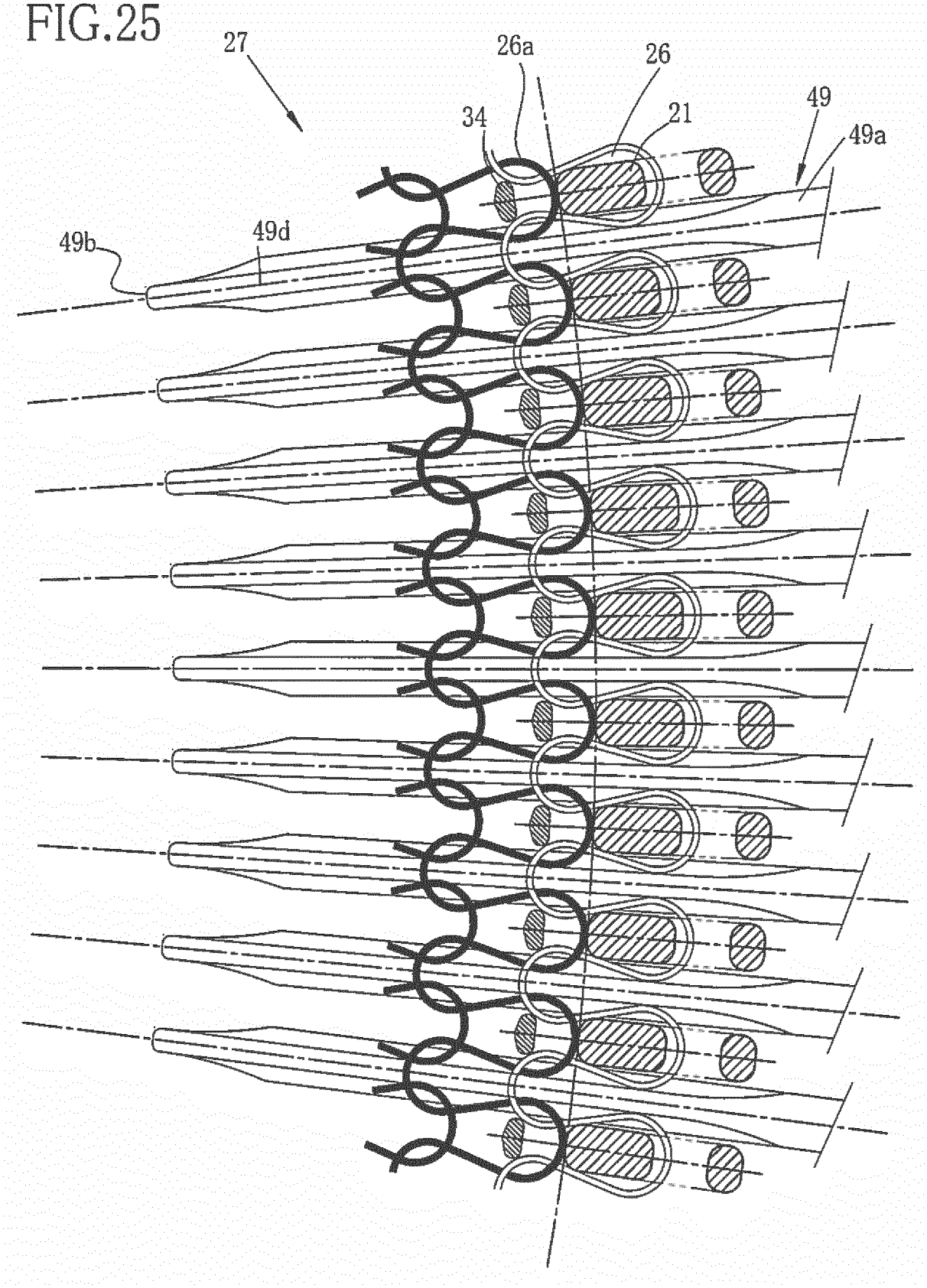


FIG.25



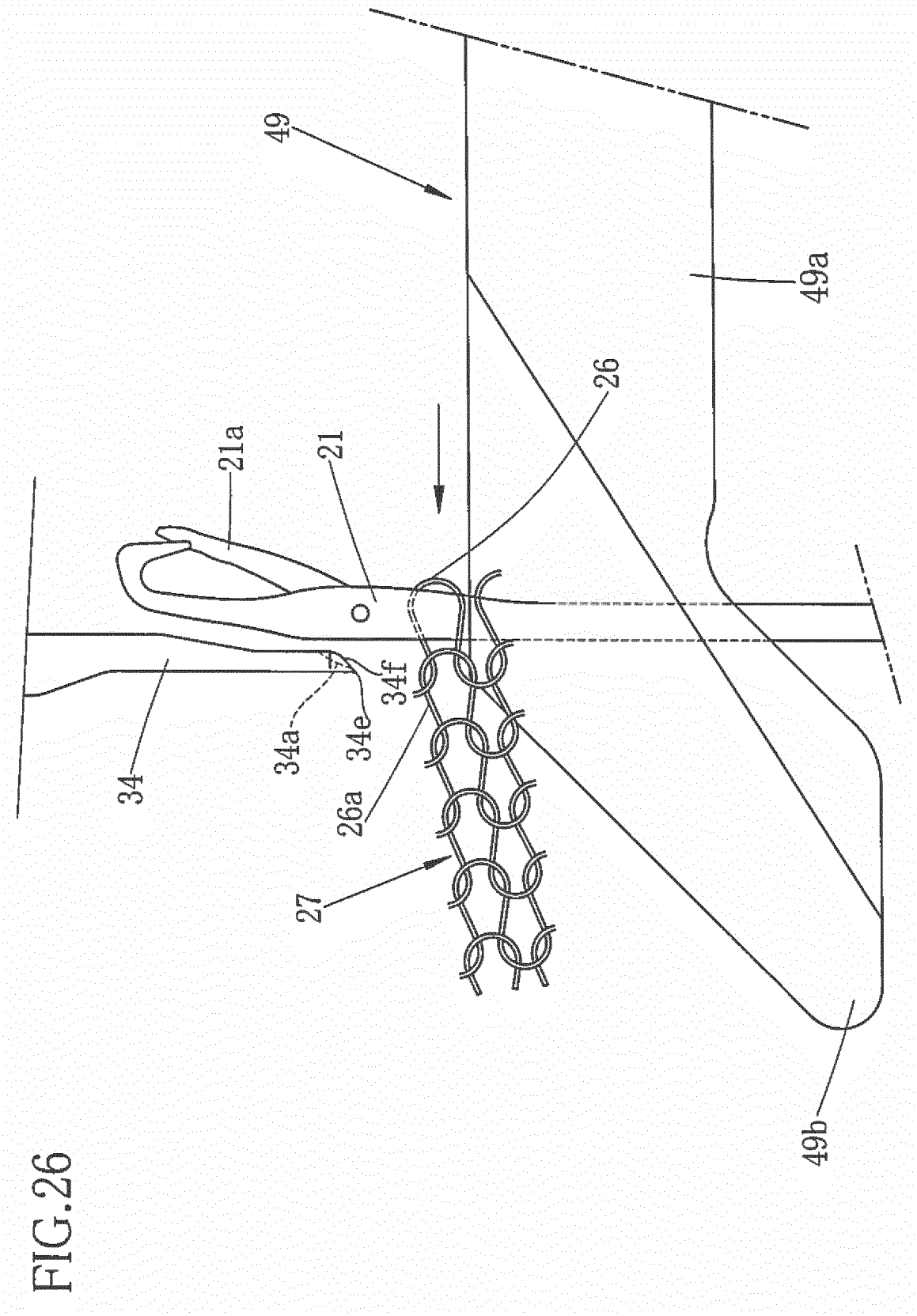


FIG.26

FIG.27

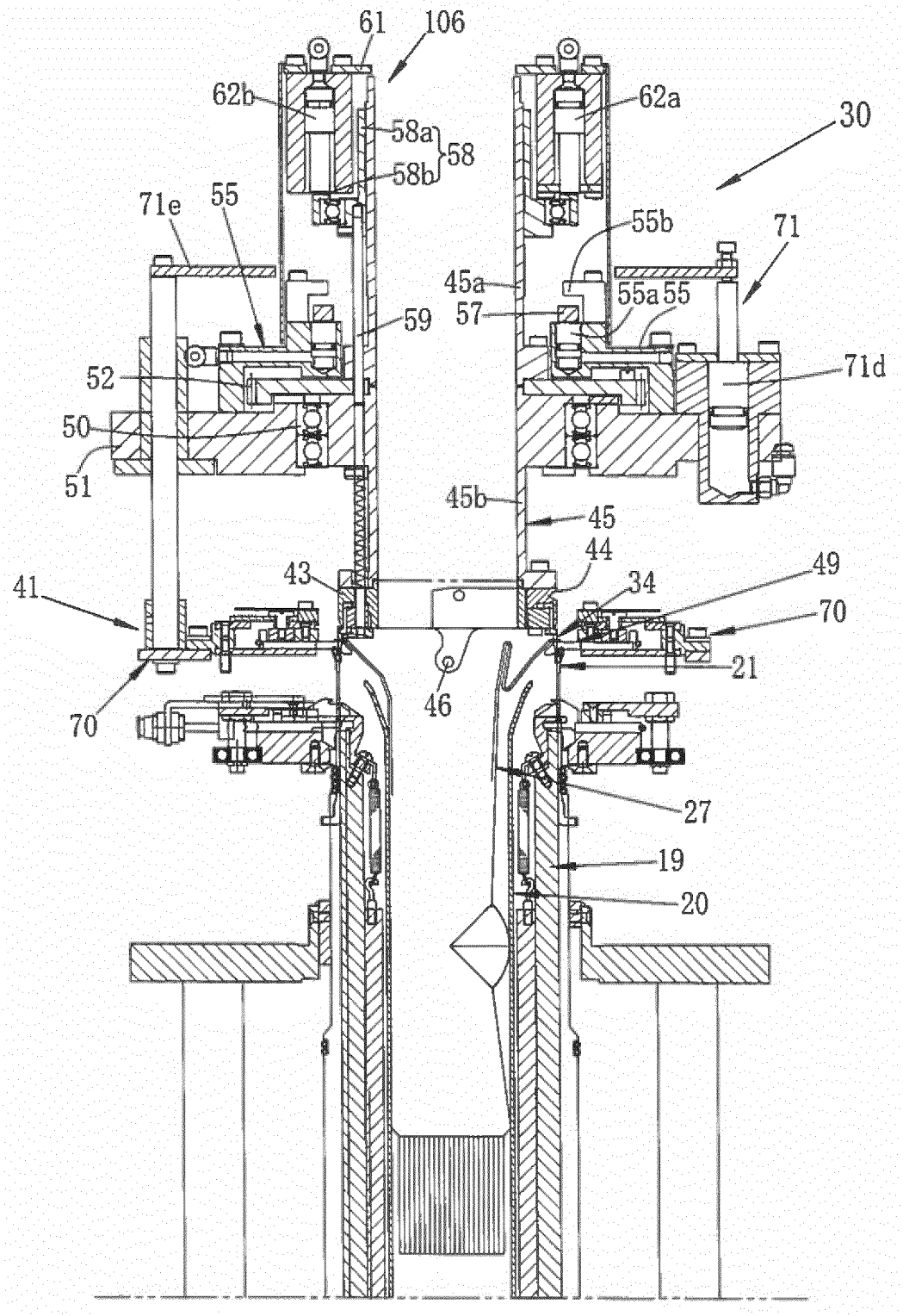

61
106
62b
62a
30
58a
58
58b
71e
55
55b
71
45a
55a
55
57
59
71d
52
50
51
45b
45
44
43
49
41
34
70
21
46
70
27
19
20

FIG.28

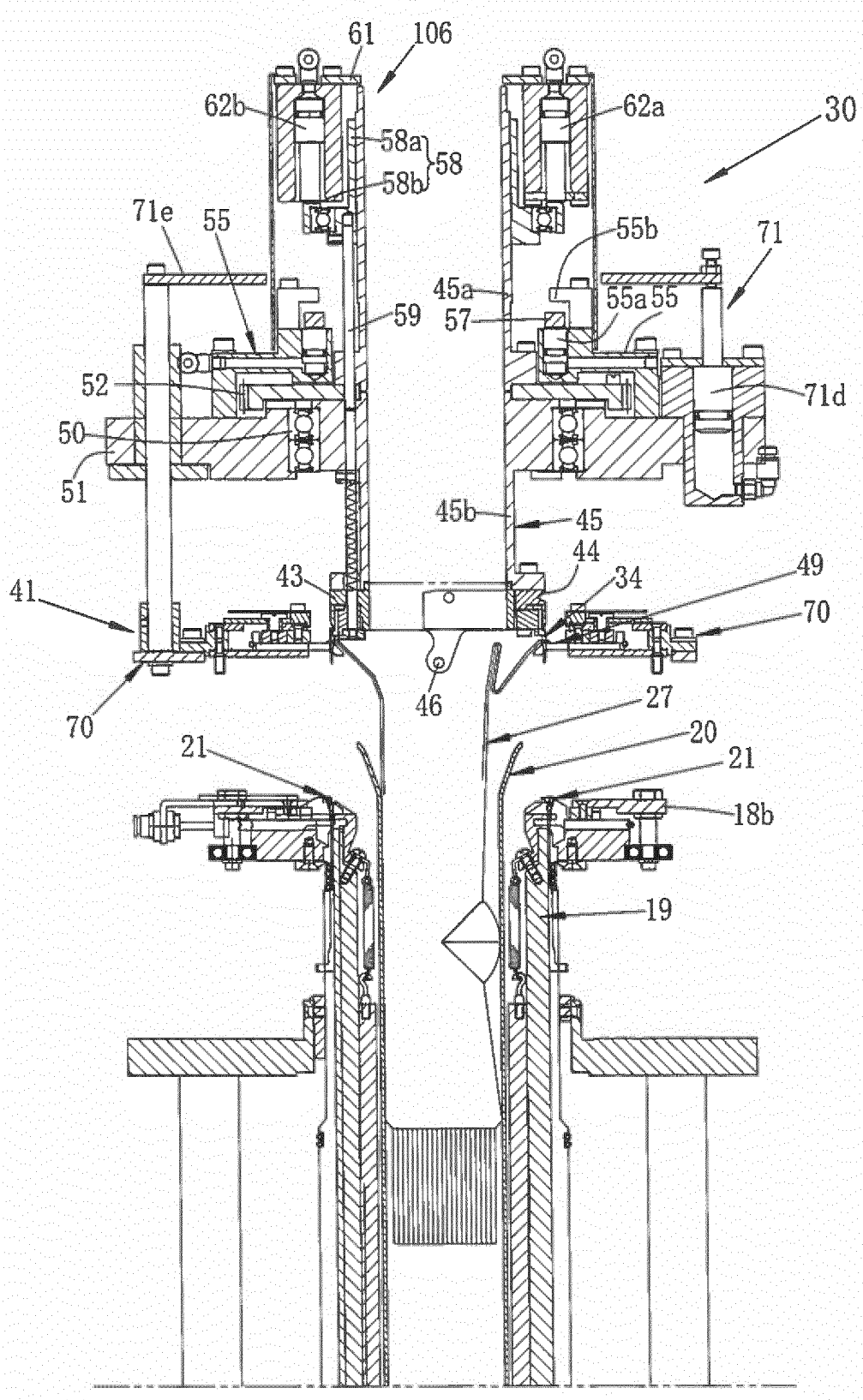

61
106
62b
62a
30
58a
58
58b
71e
55
55b
71
45a
55a
55
59
57
52
71d
50
51
45b
45
44
43
34
49
41
70
46
27
70
20
21
21
18b
19

FIG.29

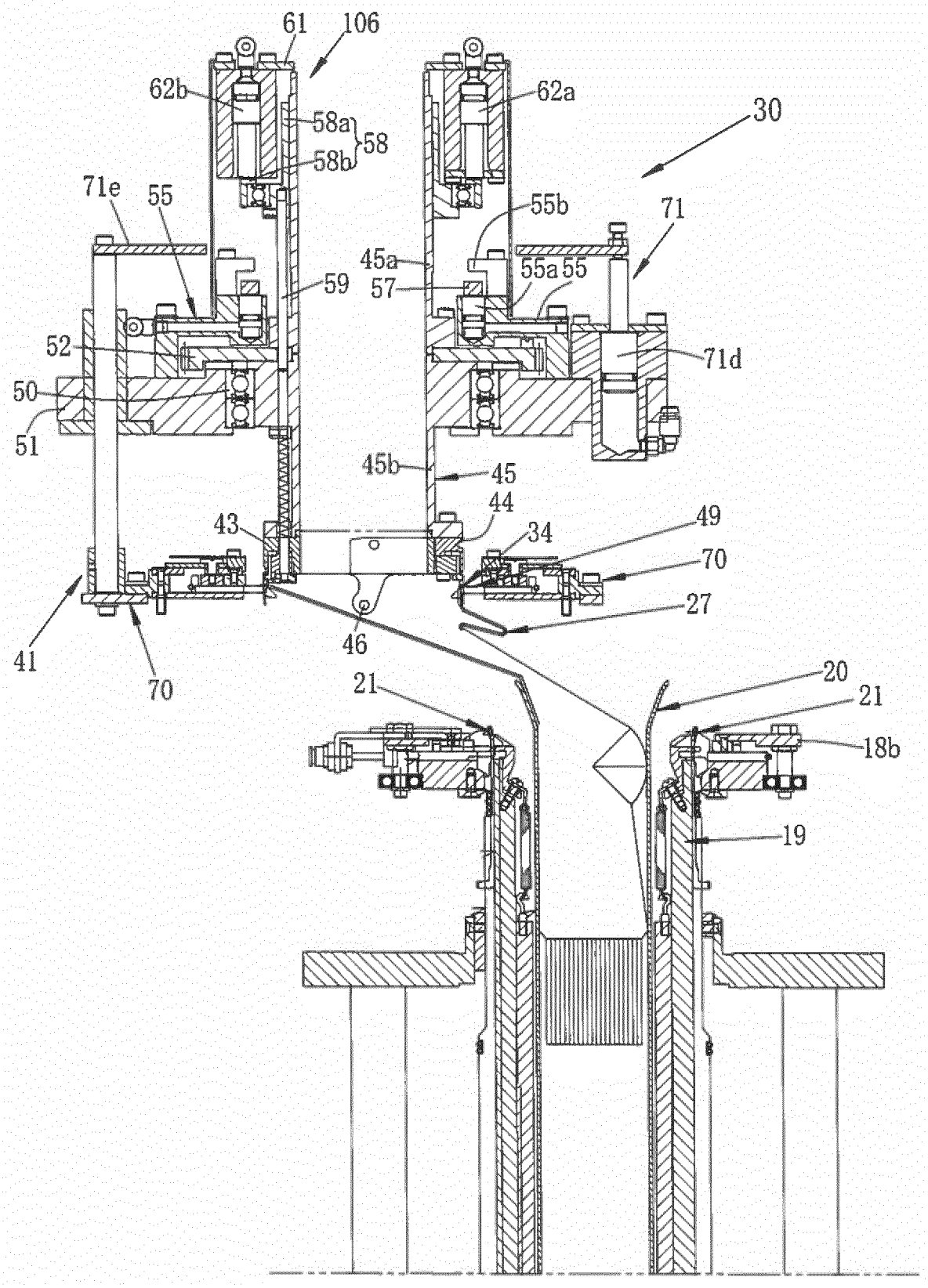

61
106
62b
62a
58a
58
58b
30
71e
55
55b
71
45a
55a
55
59
57
52
71d
50
51
45b
45
44
43
34
49
70
27
46
41
70
21
20
21
18b
19

FIG.30

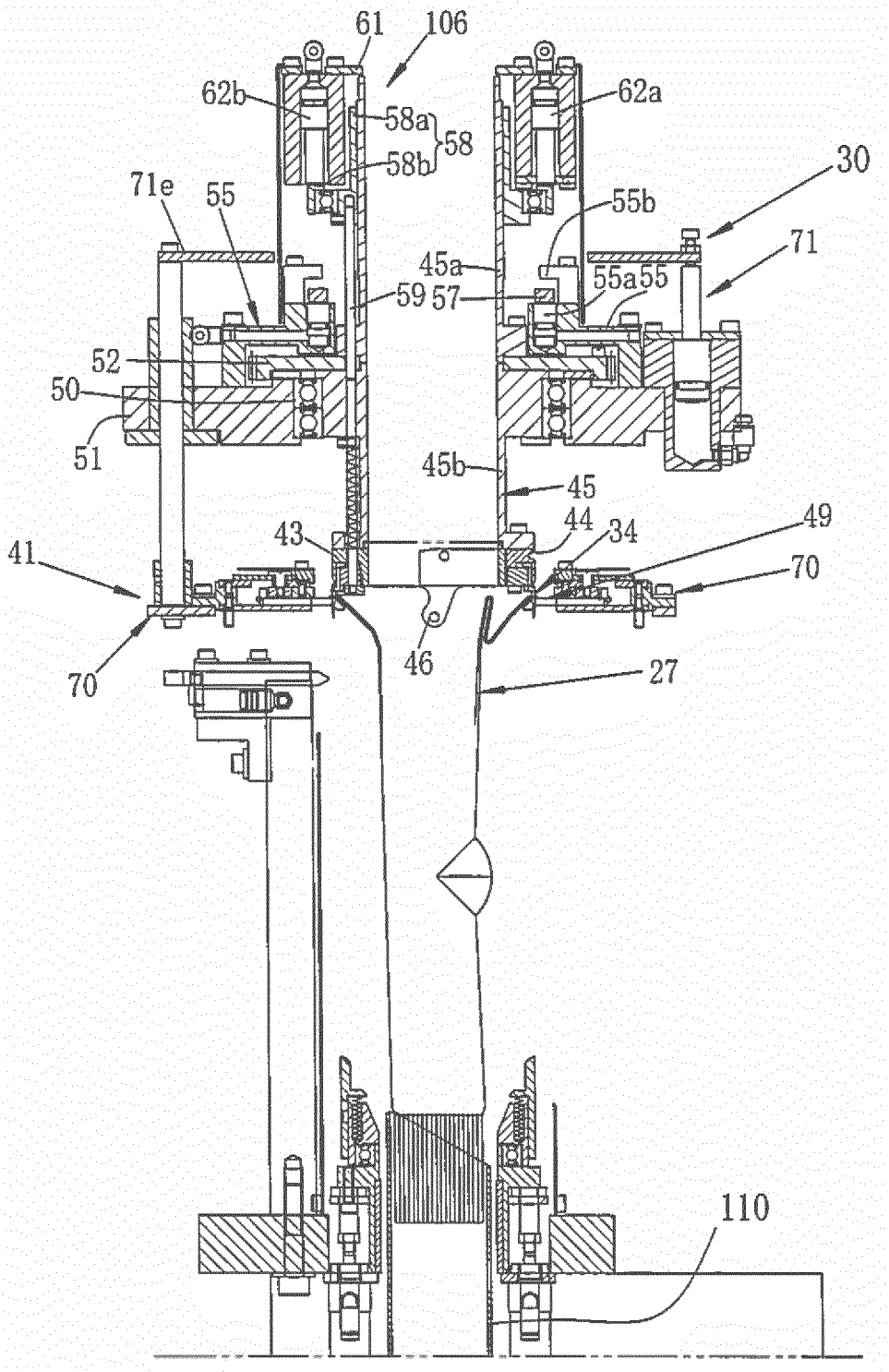

61
106
62b
62a
58a
58
58b
30
71e
55
55b
71
45a
55a
55
59
57
52
50
51
45b
45
44
49
43
34
41
70
70
46
27
110

FIG.31

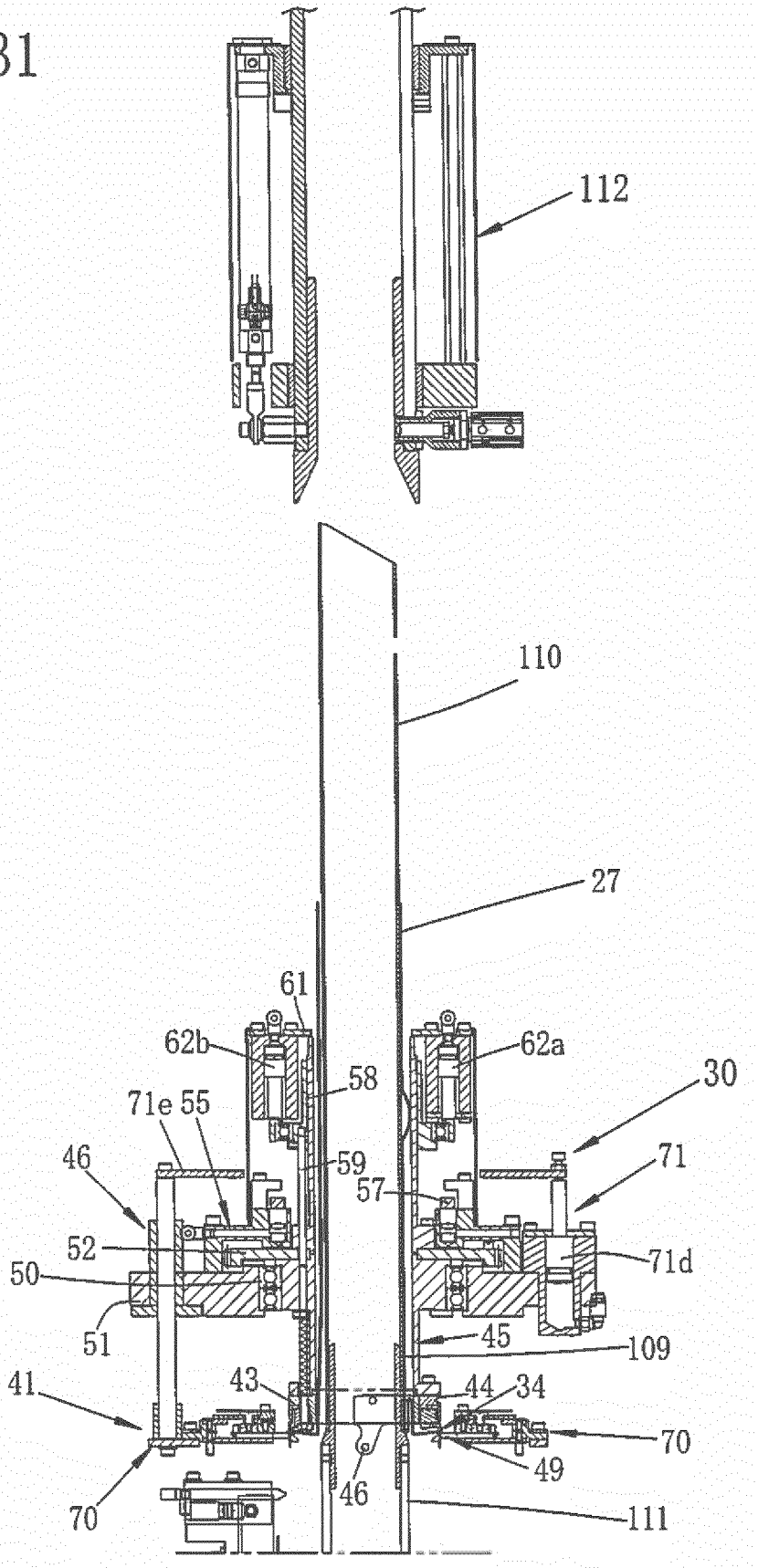

112
110
27
61
62b
62a
58
30
71e
55
46
59
57
71
52
71d
50
51
45
109
41
43
44
34
70
49
46
70
111

FIG.32

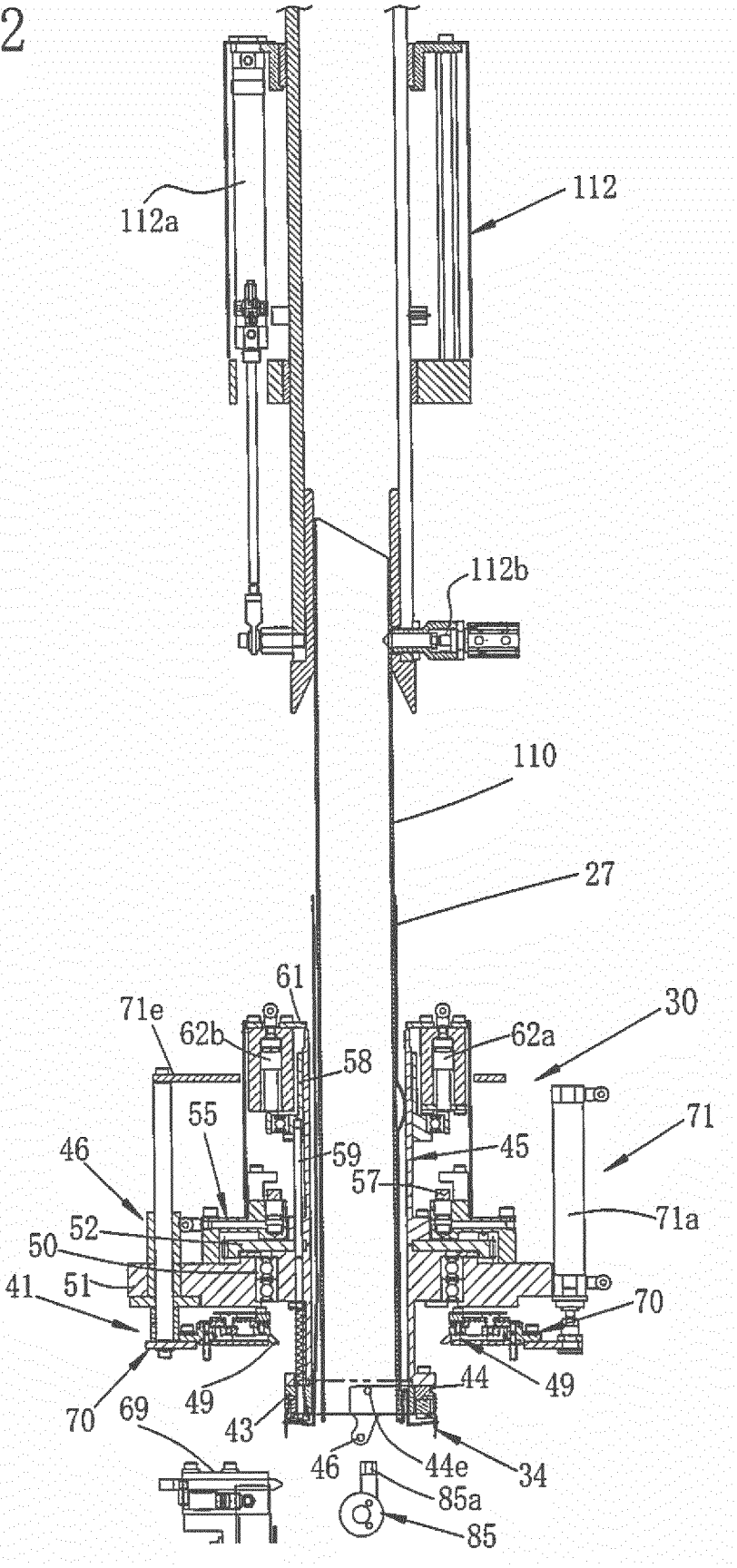

112a
112
112b
110
27
61
71e
62b
62a
30
58
55
71
46
59
45
57
71a
52
50
41
51
70
49
44
49
70
69
43
46
44e
34
85a
85

FIG.33

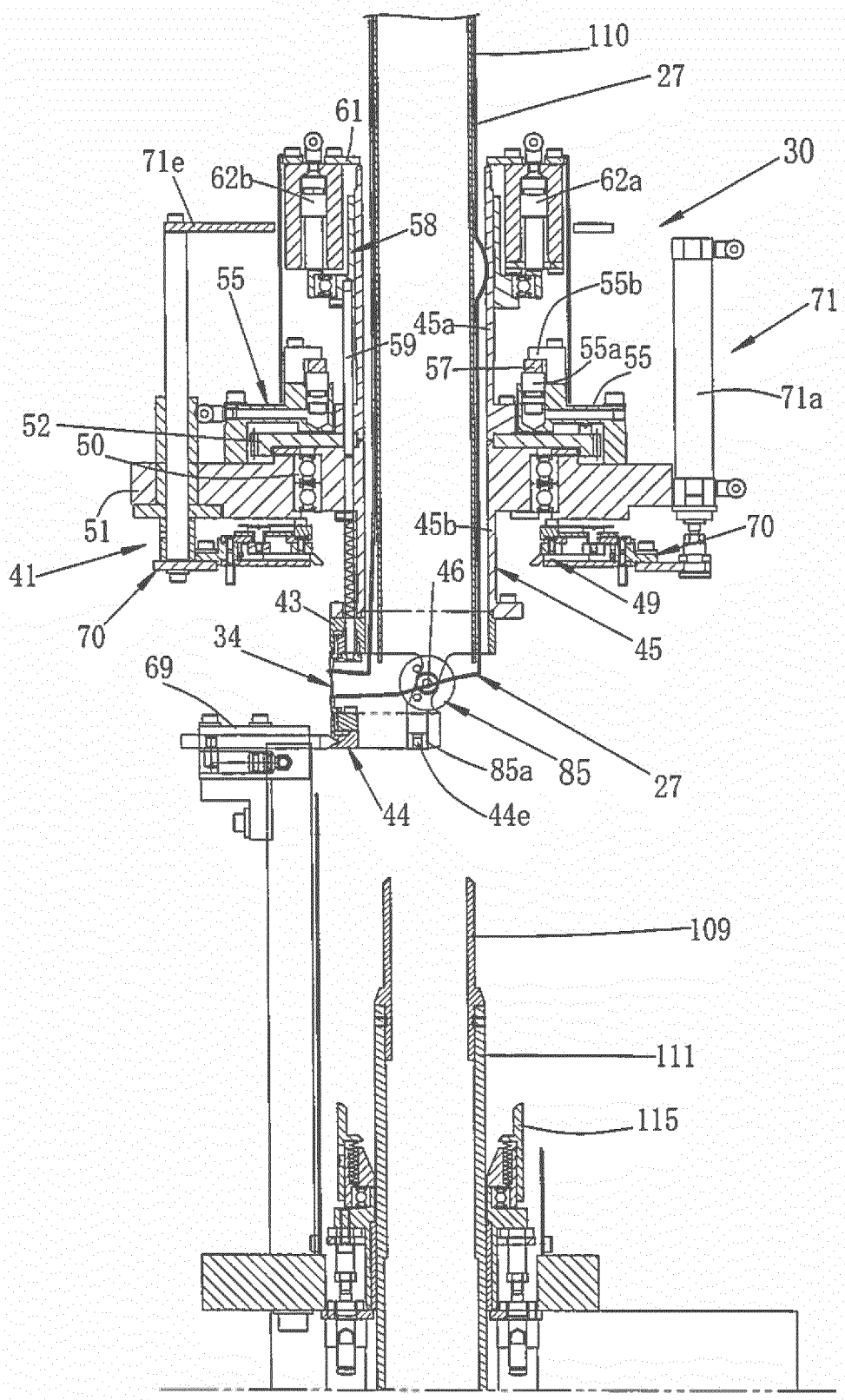

110
27
61
71e
62b
62a
30
58
55
55b
71
45a
59
55a
55
57
71a
52
50
51
45b
70
41
46
49
43
45
70
34
69
85a
85
27
44
44e
109
111
115

FIG.34

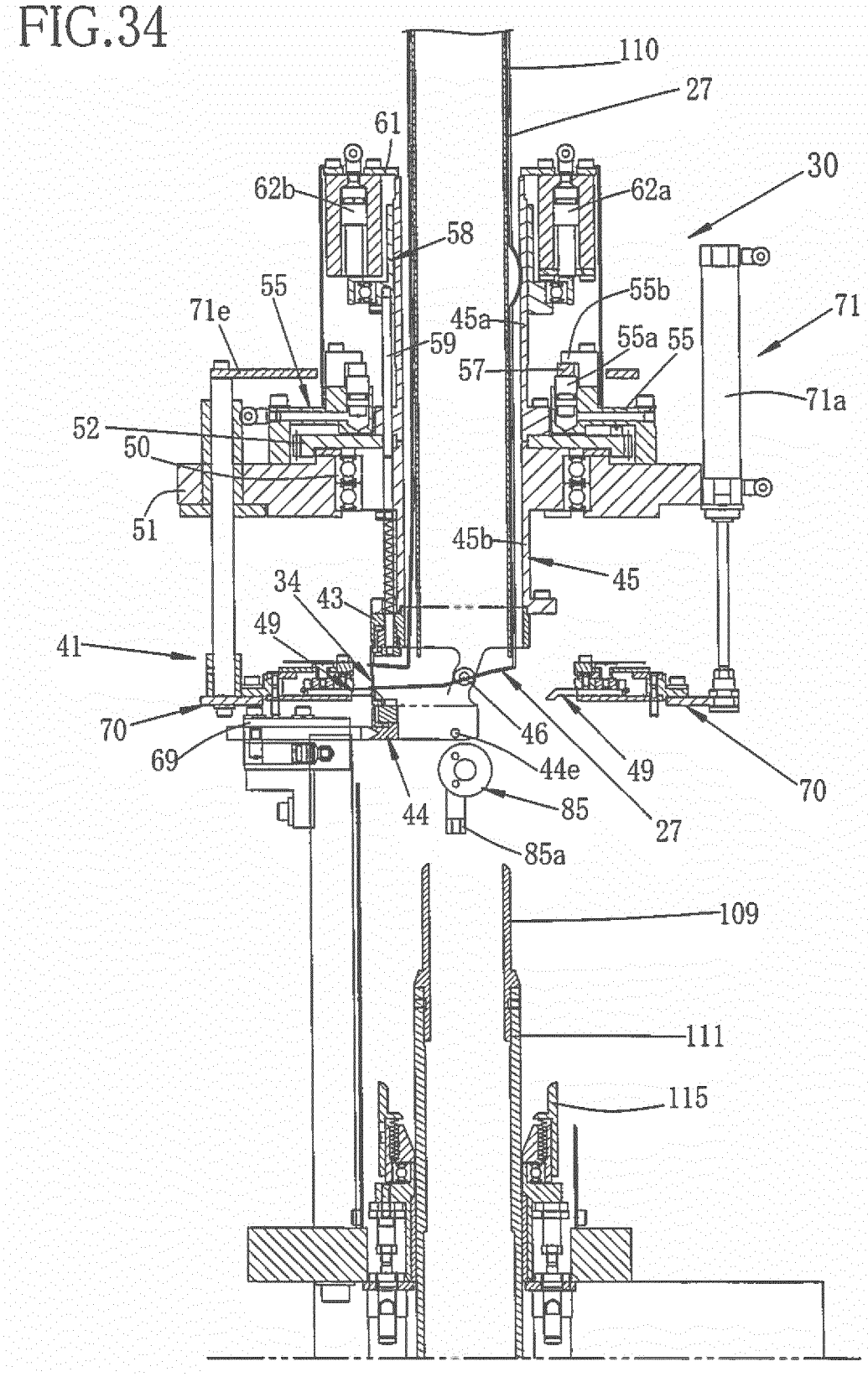

110
27
61
62b
62a
30
58
55
71e
55b
71
45a
59
55a
55
57
71a
52
50
51
45b
45
34
43
49
41
70
69
46
44e
49
70
44
85
27
85a
109
111
115

FIG.35

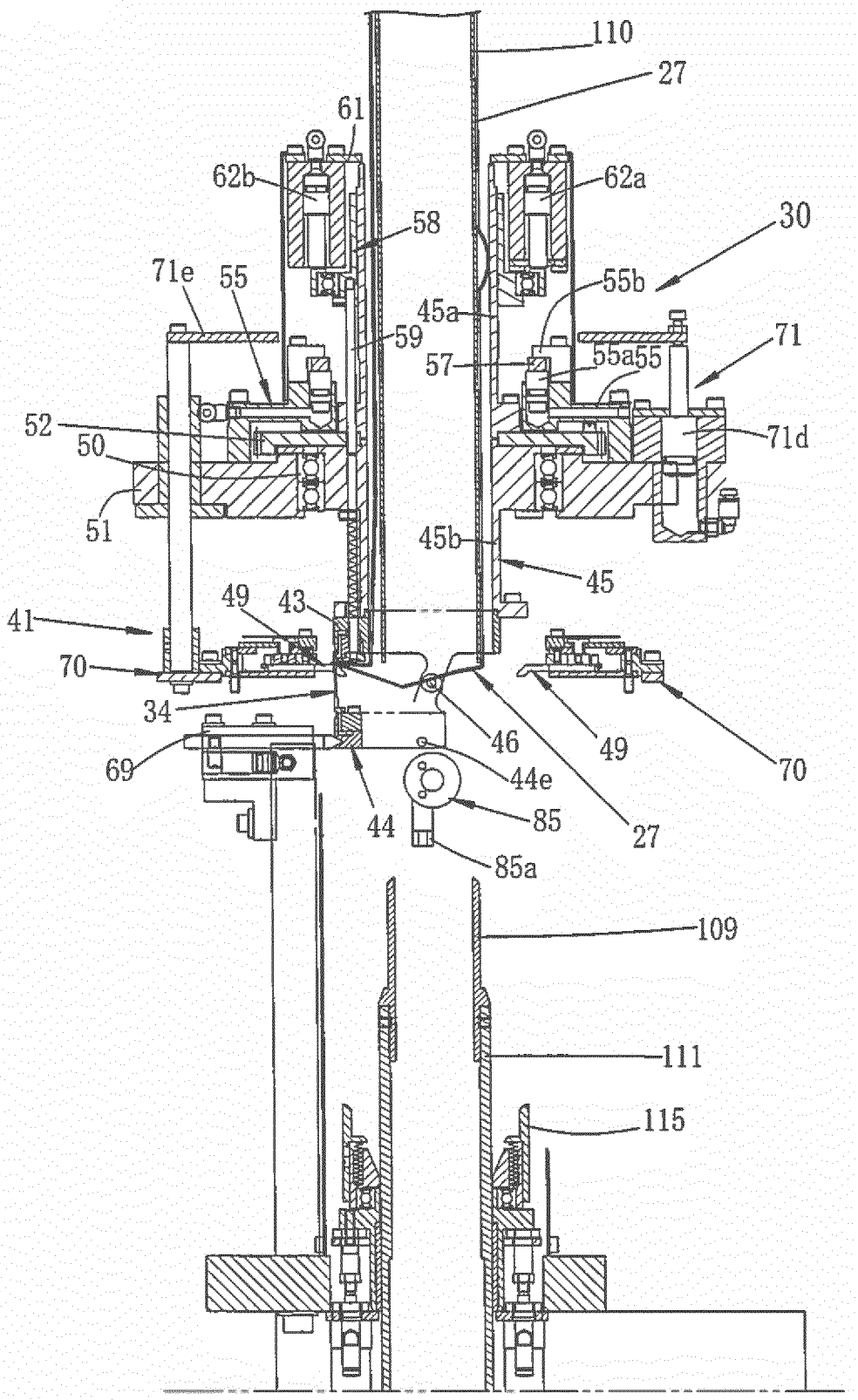

110
27
61
62b
62a
58
30
71e
55
55b
45a
59
57
55a55
71
52
71d
50
51
45b
45
49
43
41
70
34
46
49
70
69
44e
44
85
27
85a
109
111
115

FIG.36

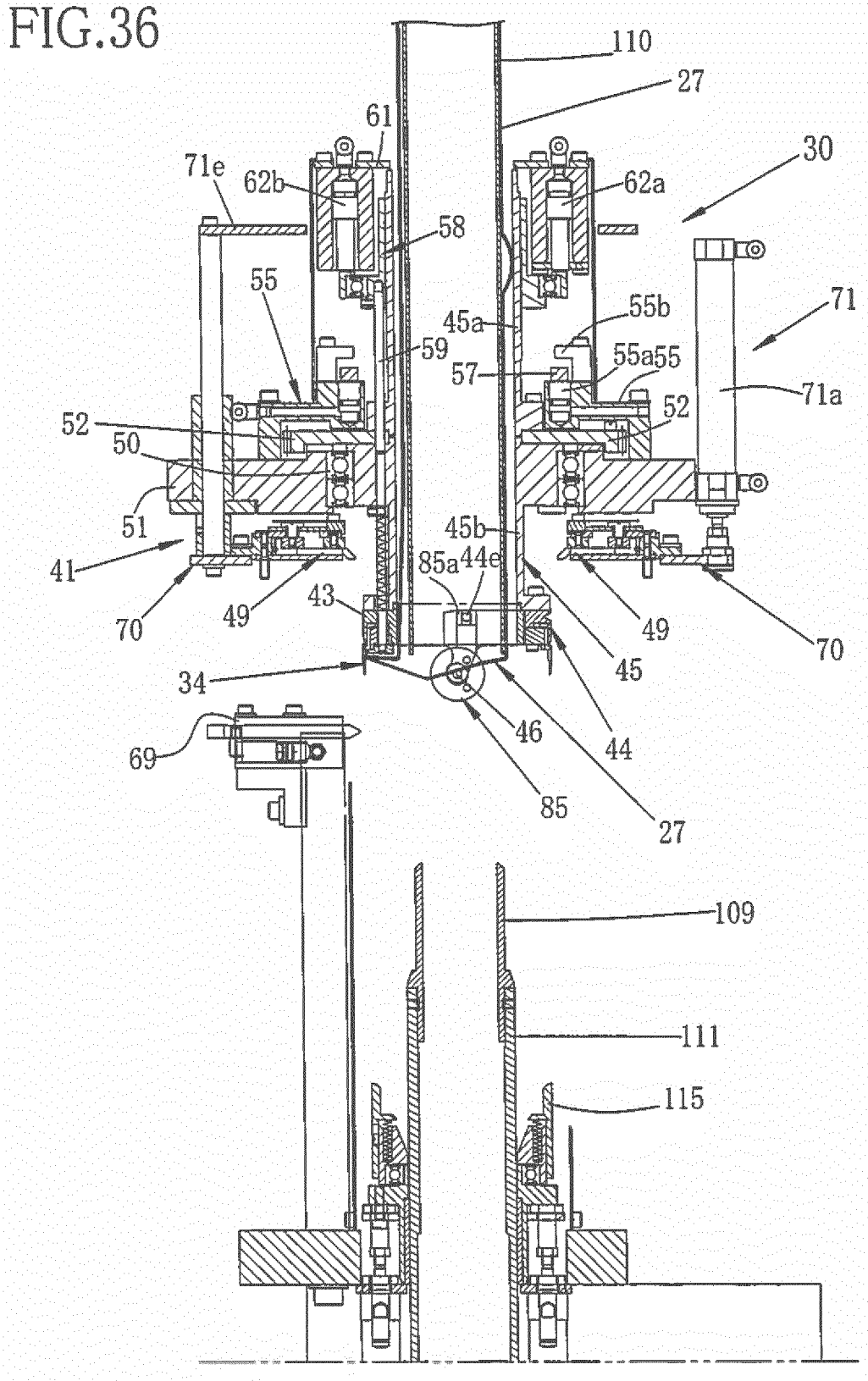

110
27
61
71e
62b
62a
30
58
55
55b
45a
71
59
55a55
57
71a
52
52
50
51
45b
41
85a44e
43
49
49
70
70
45
34
46
44
69
85
27
109
111
115

FIG.37

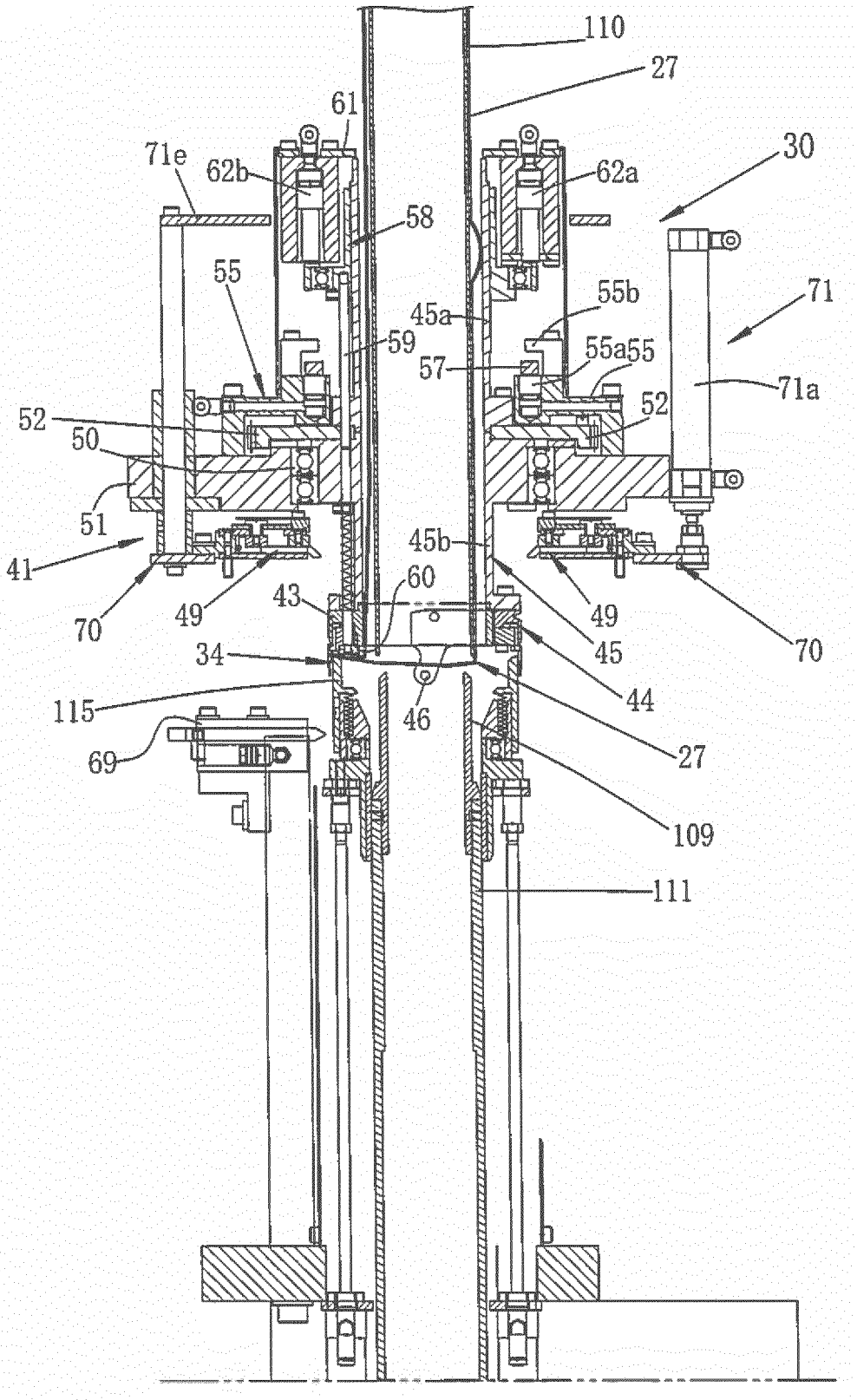

110
27
61
71e
62b
62a
30
58
55
55b
71
45a
59
57
55a55
71a
52
52
50
51
41
45b
60
43
49
49
70
70
34
45
44
115
46
27
69
109
111

FIG.38

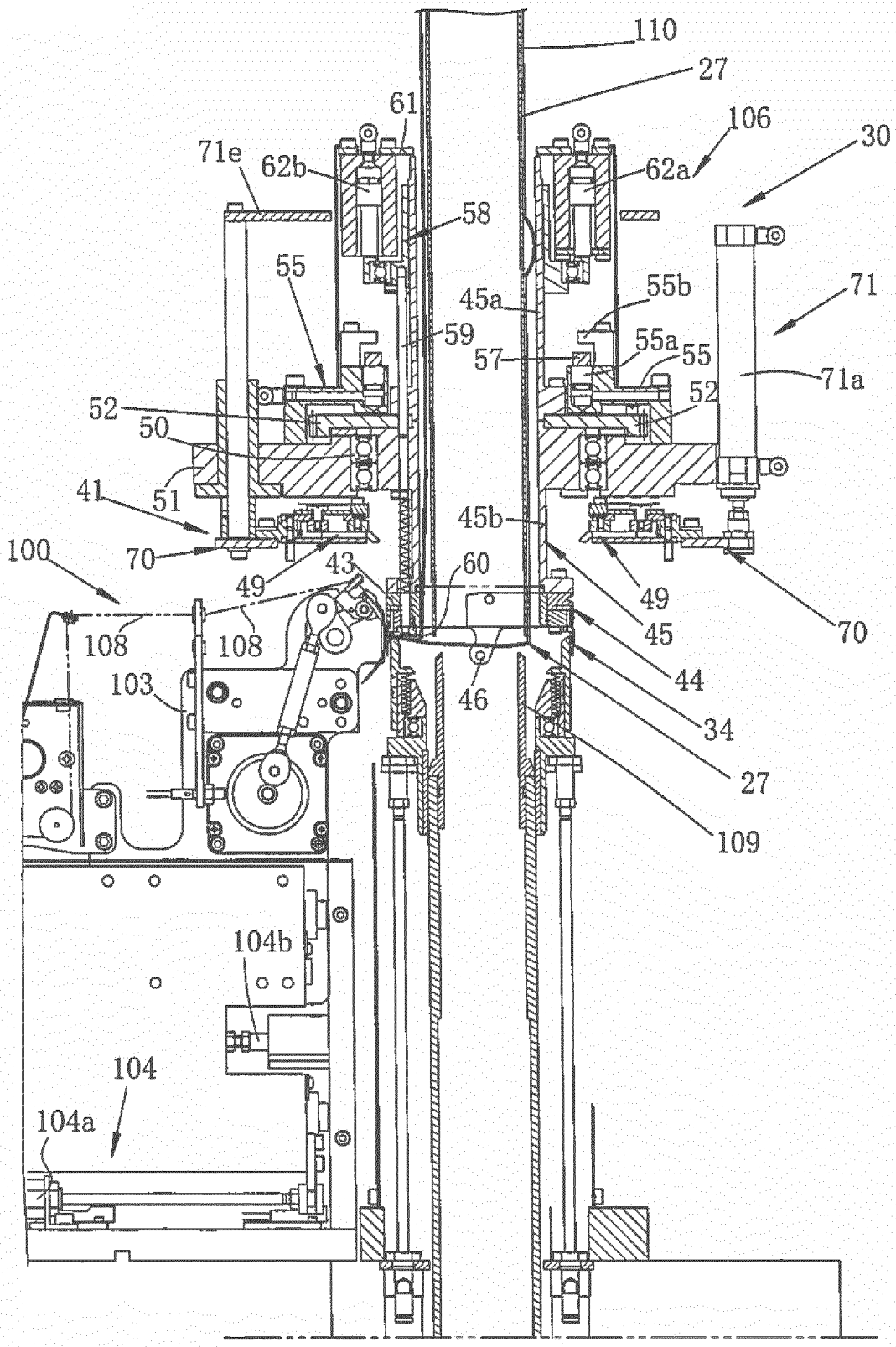

110
27
61
106
30
71e
62b
62a
58
55
55b
71
45a
59
55a
57
55
71a
52
52
50
41
51
45b
100
70
43
60
49
49
70
108
108
45
44
103
46
34
27
109
104b
104
104a

FIG.39

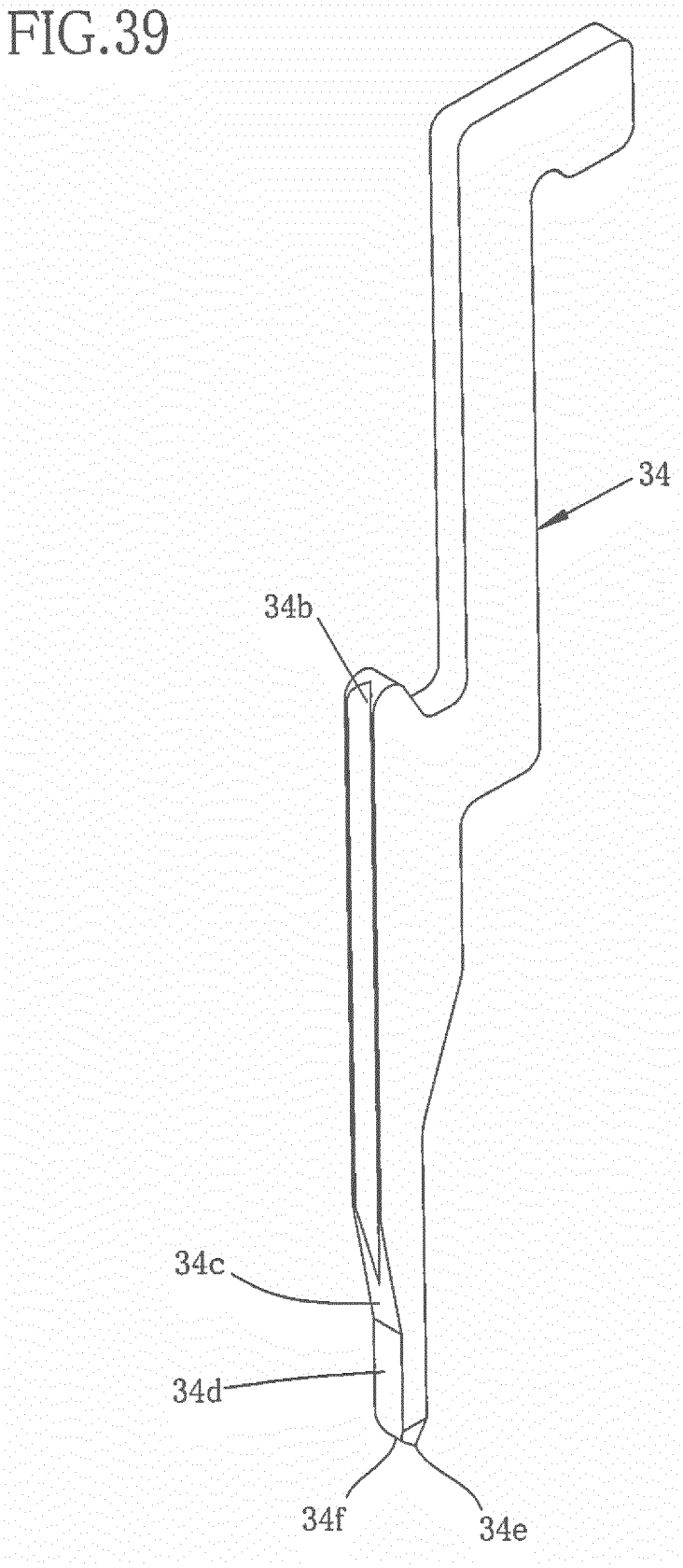


FIG.40

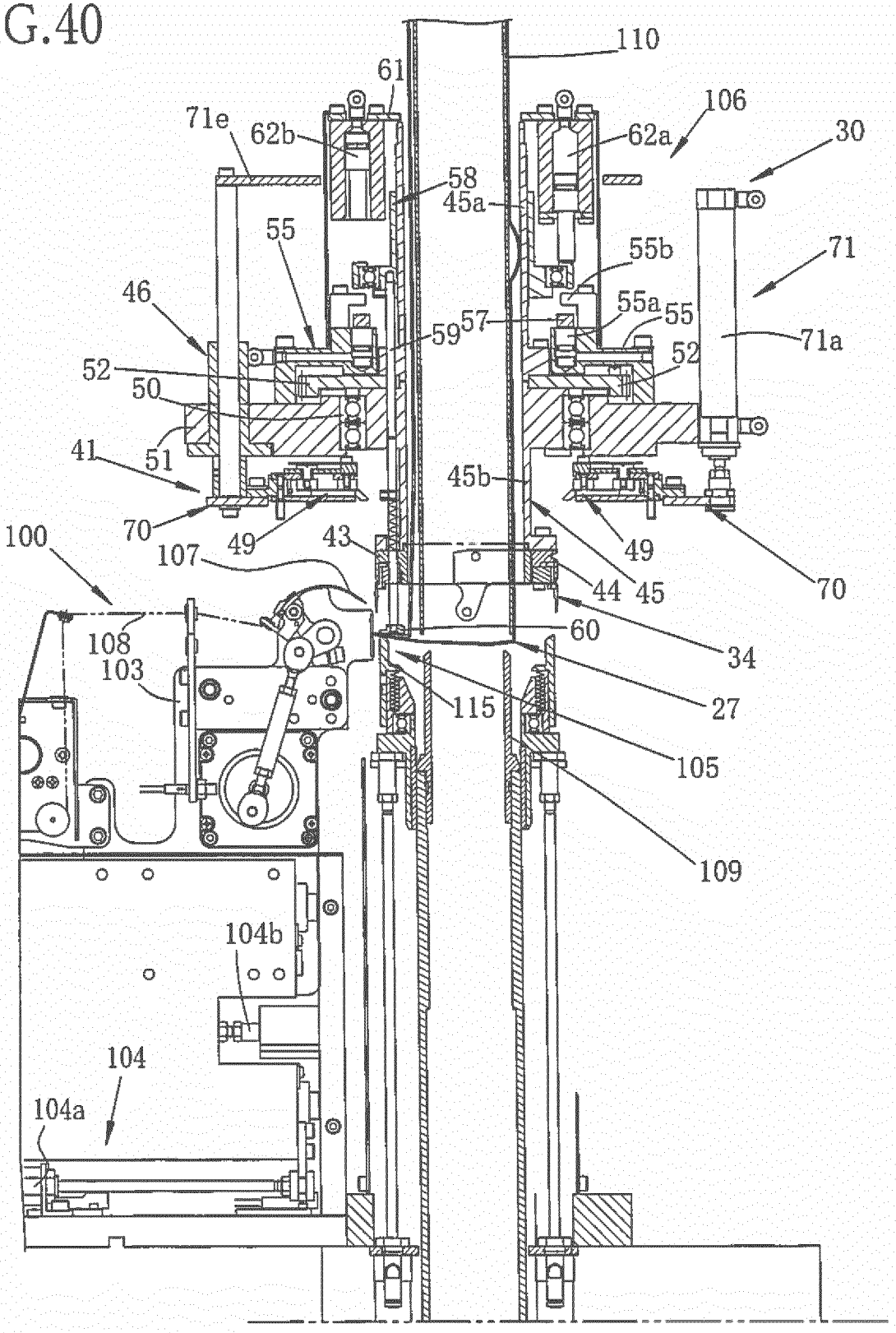

110
61
71e
62b
62a
106
30
58
45a
55
55b
71
46
59
57
55a
55
71a
52
52
50
41
51
45b
70
49
43
49
70
100
107
44
45
108
60
34
103
27
115
105
109
104b
104
104a

FIG.41

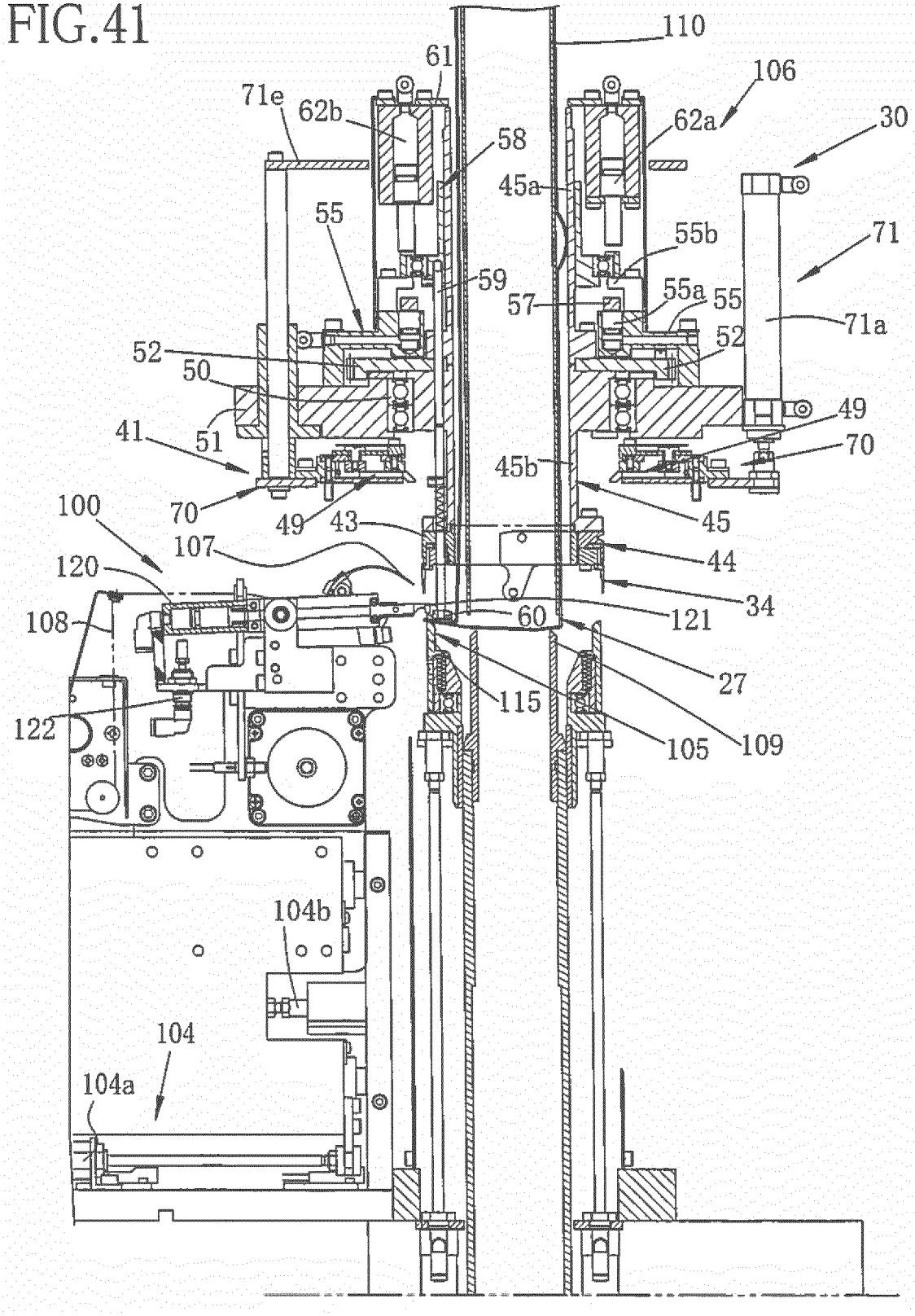

110
61
106
71e
62b
62a
30
58
45a
55
55b
71
59
57
55a
55
71a
52
52
50
49
41
51
70
45b
70
49
43
45
100
107
44
120
34
108
60
121
27
115
122
105
109
104b
104
104a

FIG.42

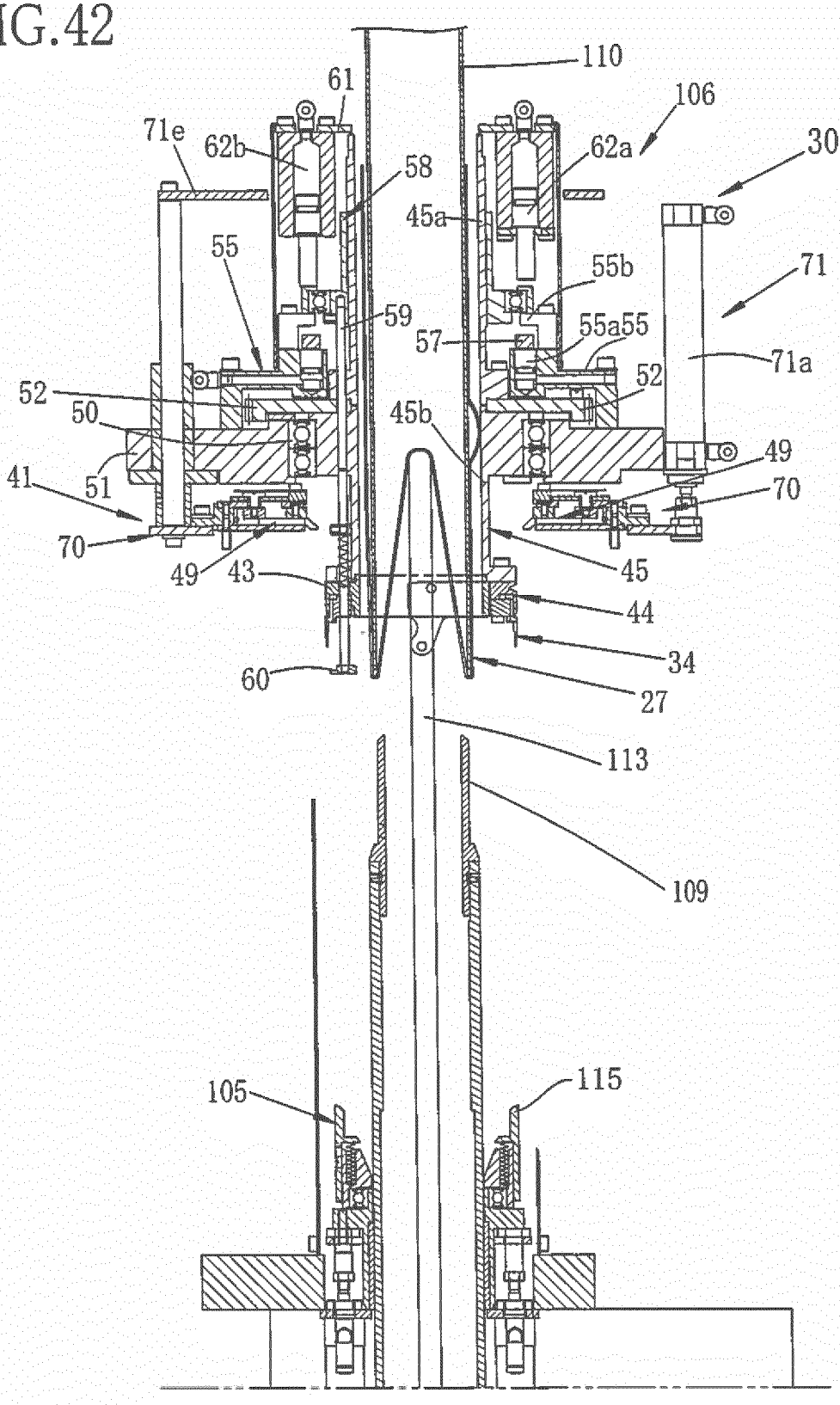

110
61
106
71e
62b
62a
30
58
45a
55
55b
71
59
57
55a55
71a
52
52
50
45b
49
41
51
70
70
49
43
45
44
34
60
27
113
109
105
115

FIG.43

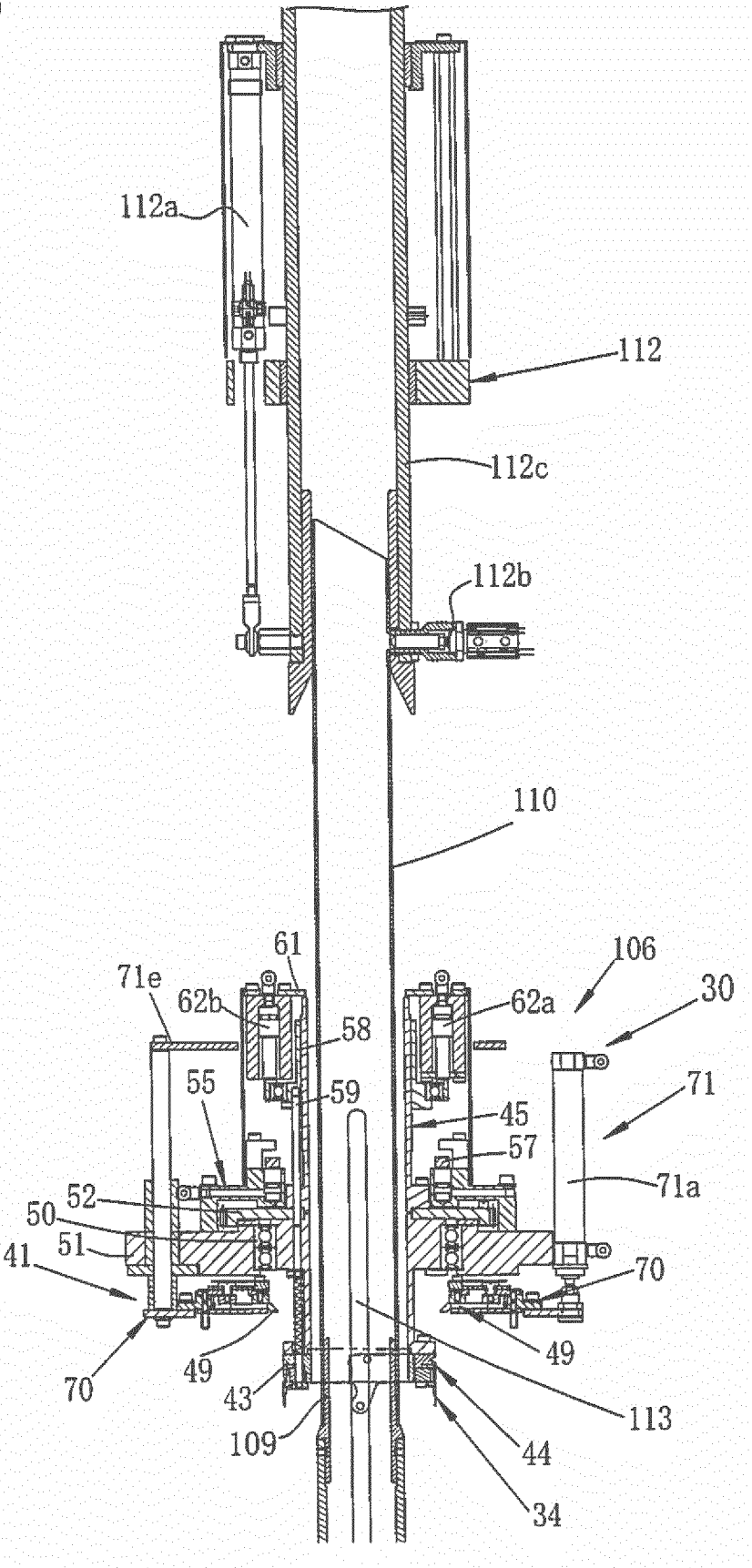
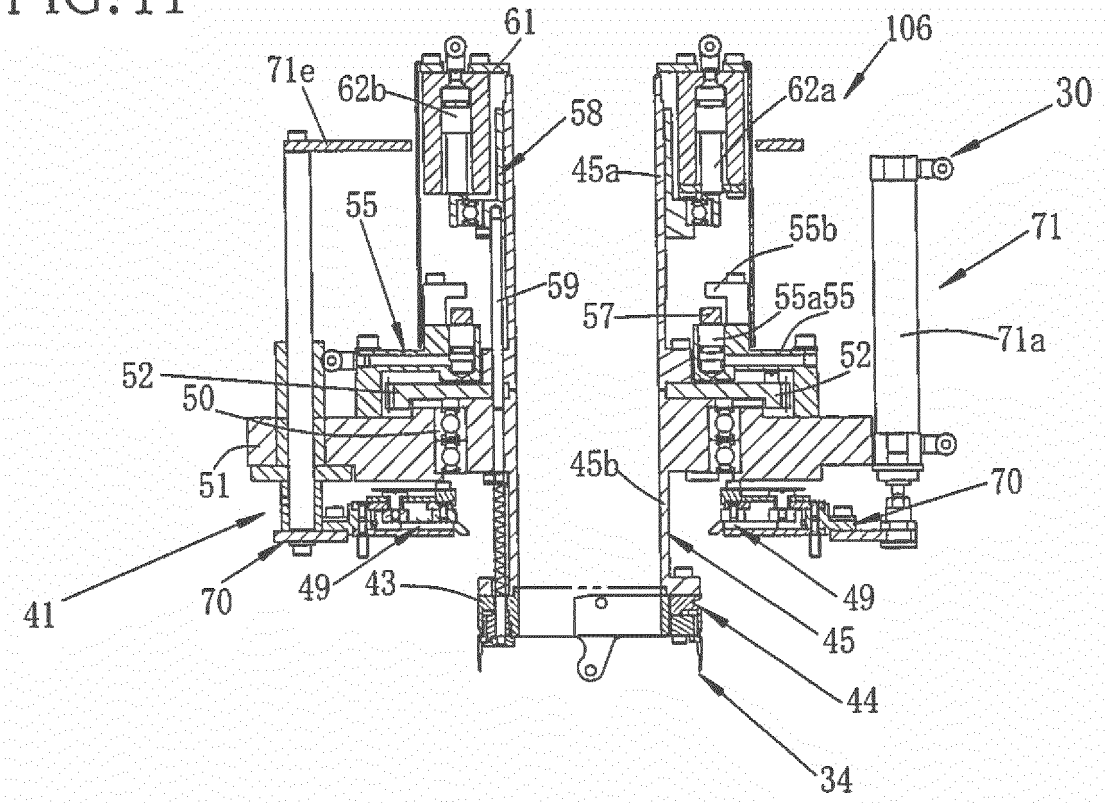

112a
112
112c
112b
110
61
71e
62b
58
55
59
52
50
51
41
70
49
43
109
113
44
34
106
62a
30
71
45
57
71a
70
49

FIG.44


61
71e
62b
58
106
62a
30
45a
55
55b
71
59
57
55a55
71a
52
52
50
51
45b
70
41
70
49
43
49
45
44
34

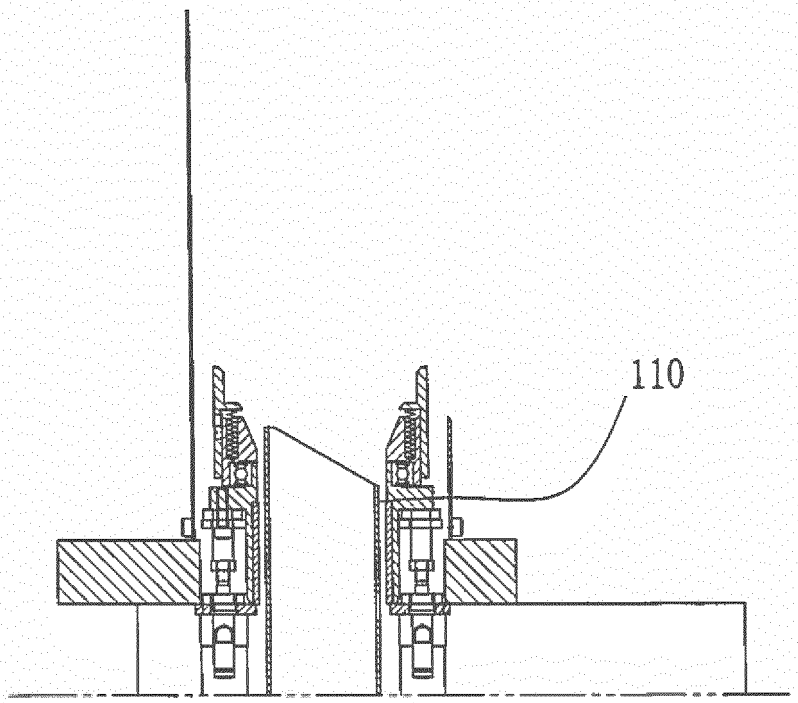

110

FIG.45

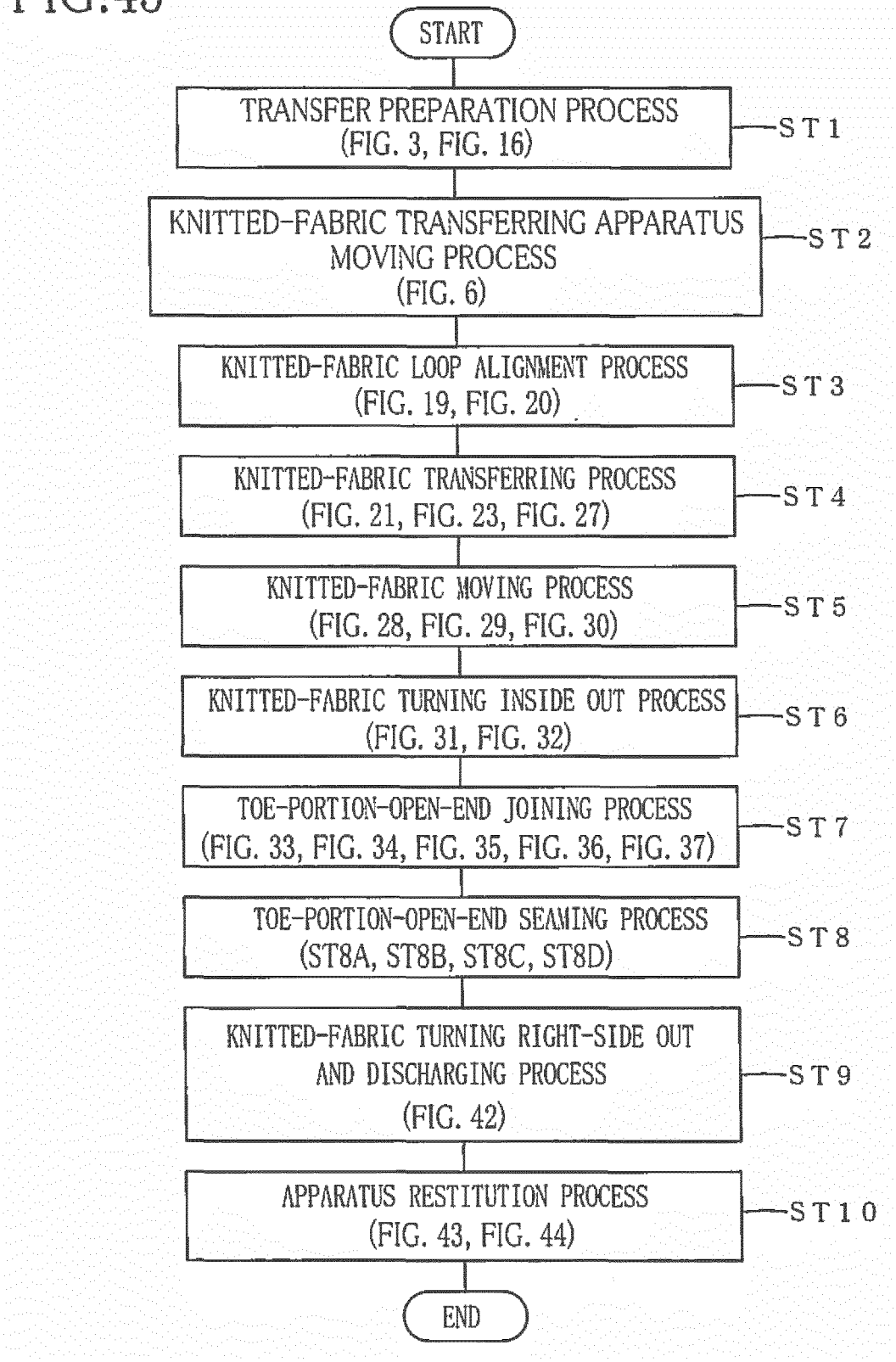

START
TRANSFER PREPARATION PROCESS (FIG. 3, FIG. 16)
ST1
KNITTED-FABRIC TRANSFERRING APPARATUS MOVING PROCESS (FIG. 6)
ST2
KNITTED-FABRIC LOOP ALIGNMENT PROCESS (FIG. 19, FIG. 20)
ST3
KNITTED-FABRIC TRANSFERRING PROCESS (FIG. 21, FIG. 23, FIG. 27)
ST4
KNITTED-FABRIC MOVING PROCESS (FIG. 28, FIG. 29, FIG. 30)
ST5
KNITTED-FABRIC TURNING INSIDE OUT PROCESS (FIG. 31, FIG. 32)
ST6
TOE-PORTION-OPEN-END JOINING PROCESS (FIG. 33, FIG. 34, FIG. 35, FIG. 36, FIG. 37)
ST7
TOE-PORTION-OPEN-END SEAMING PROCESS (ST8A, ST8B, ST8C, ST8D)
ST8
KNITTED-FABRIC TURNING RIGHT-SIDE OUT AND DISCHARGING PROCESS (FIG. 42)
ST9
APPARATUS RESTITUTION PROCESS (FIG. 43, FIG. 44)
ST10
END

FIG.46A

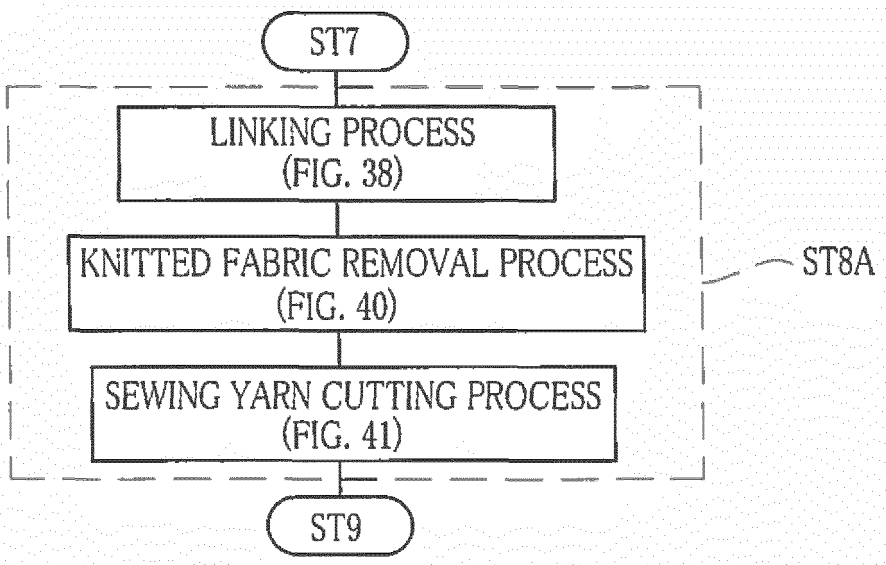


FIG.46B

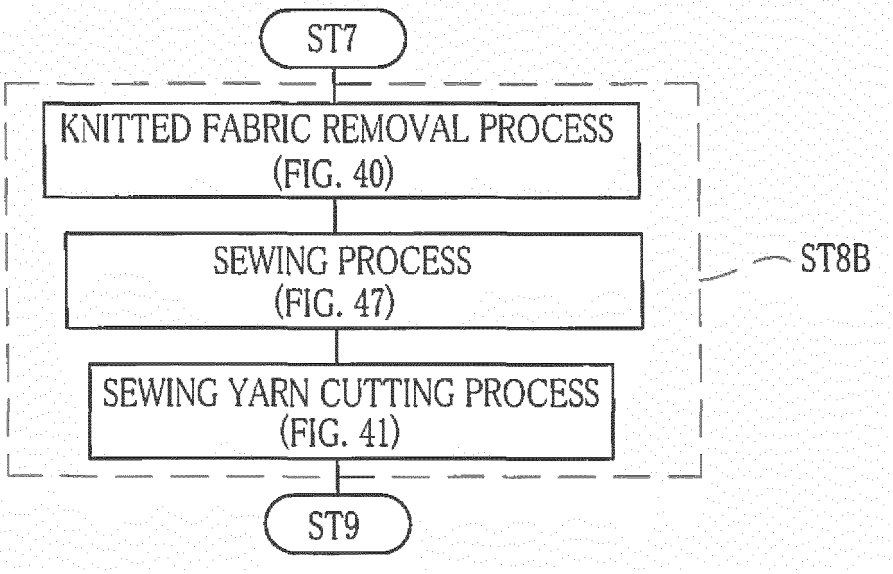


FIG.46C

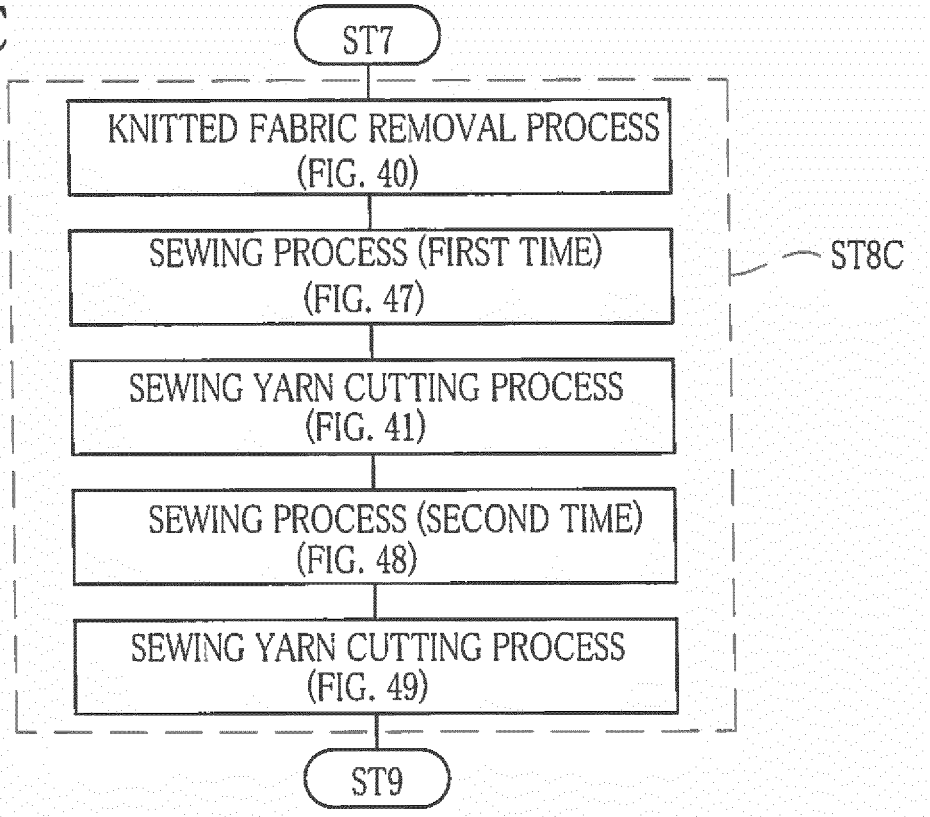


FIG.46D

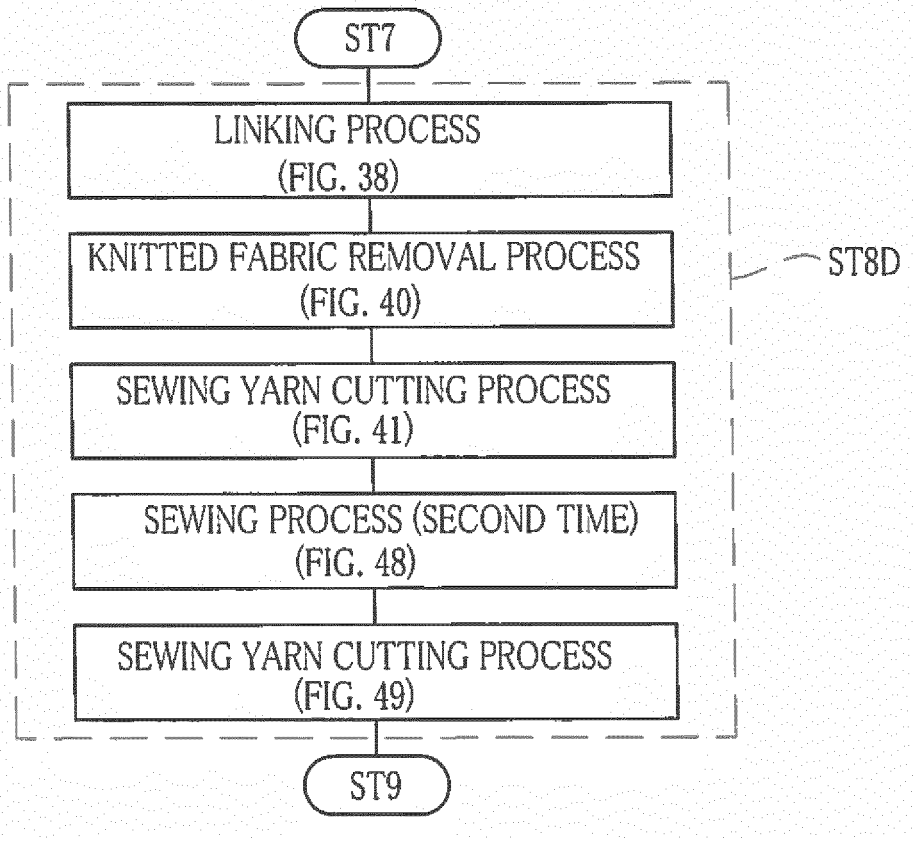


FIG.47

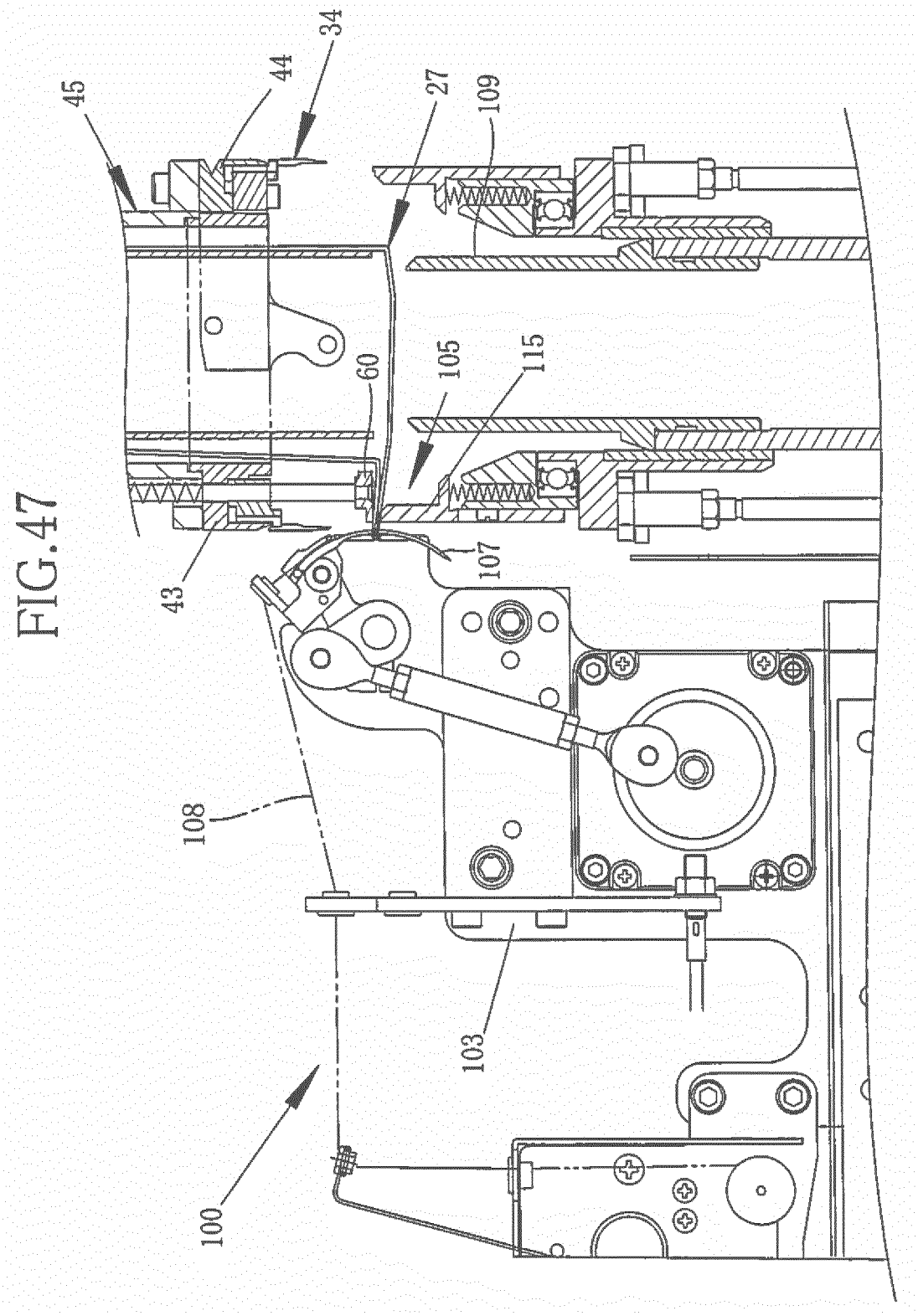


FIG.48

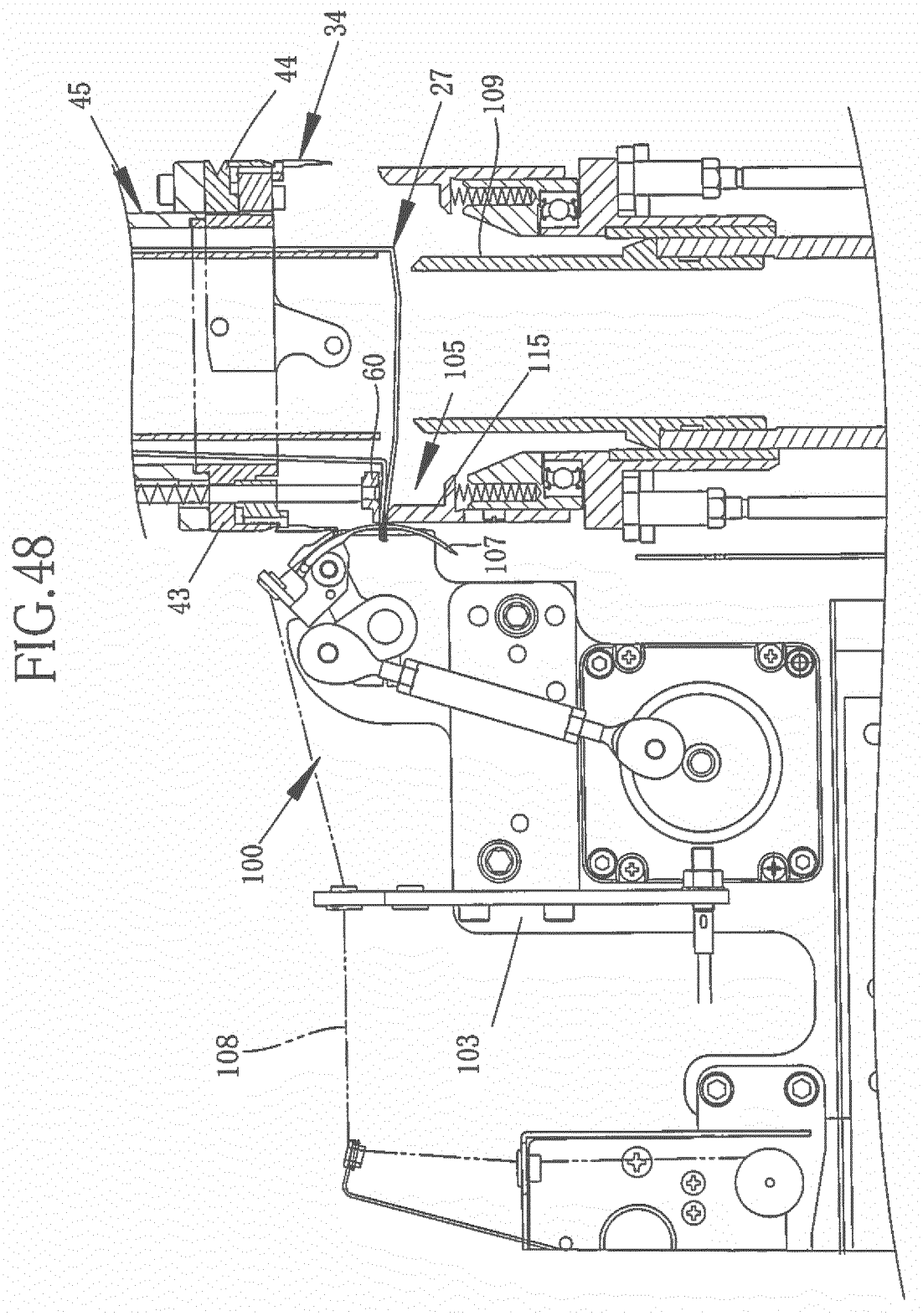
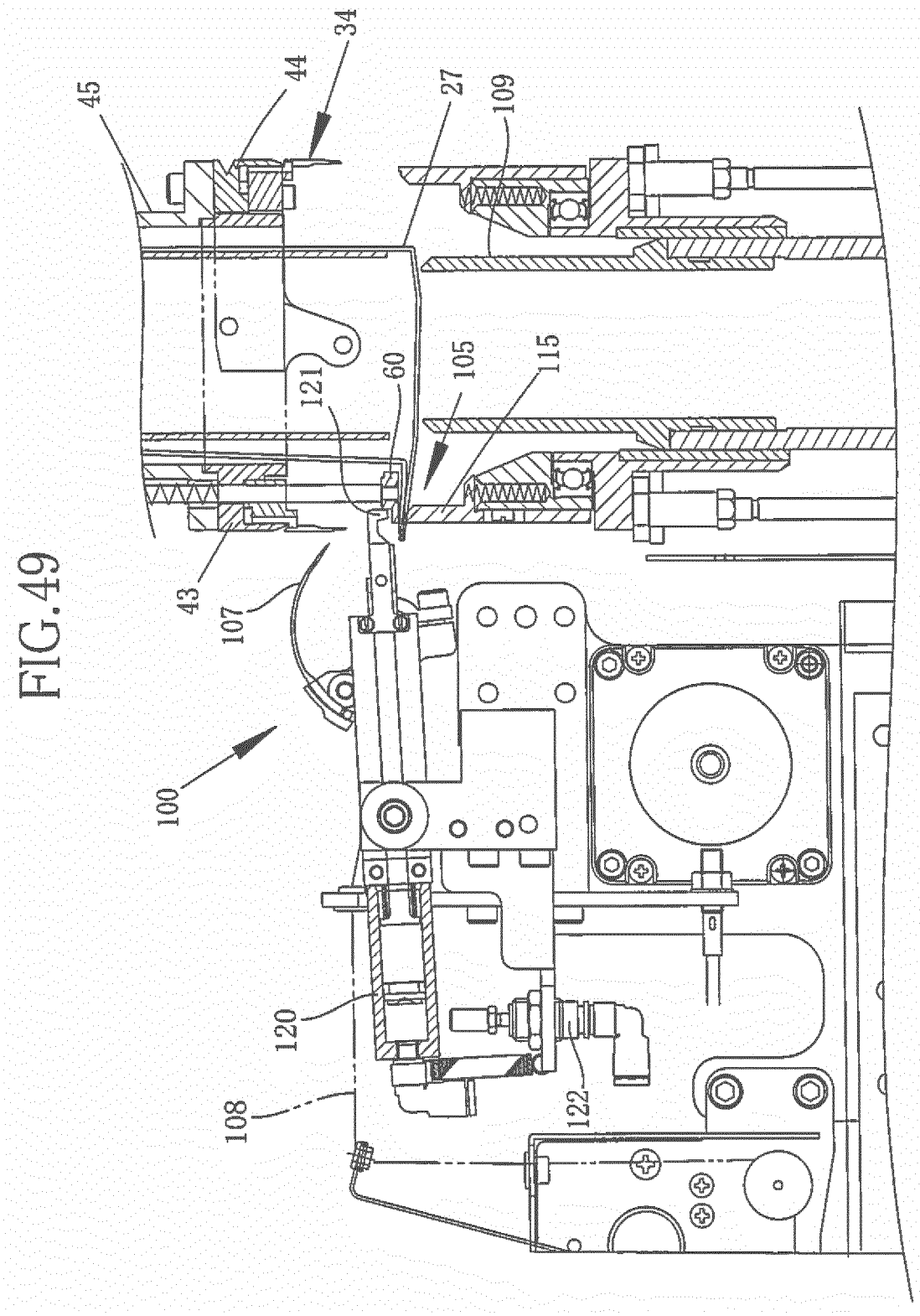


FIG.49



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/058877

A. CLASSIFICATION OF SUBJECT MATTER
D04B15/88(2006.01)i, *D04B9/56*(2006.01)i, *D04B15/02*(2006.01)i, *D04B15/06*(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, D04B9/56, D04B15/02, D04B15/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015
Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2006-503991 A (Fabritex S.r.l.), 02 February 2006 (02.02.2006), claims; fig. 1 to 31, 54 to 88 & US 2006/0144095 A1 & WO 2004/035894 A1 & EP 1579046 A1 & KR 10-2005-0083795 A & CN 1723308 A	1-24
A	JP 2004-143614 A (Nagata Seiki Co., Ltd.), 20 May 2004 (20.05.2004), paragraphs [0014] to [0037]; fig. 1 to 15 (Family: none)	1-24
A	US 2047888 A (Selmer ROINESTAD), 14 July 1936 (14.07.1936), page 1, left column, line 16 to page 2, left column, line 37; fig. 1 to 3 (Family: none)	1-24

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 June 2015 (03.06.15)	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 Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2002266208 A **[0006]**
- US 2008190340 A **[0006]**
- JP 4981675 B **[0006]**
- US 2006144095 A **[0006] [0104]**
- JP 4268136 B **[0006]**
- US 2010313607 A **[0105]**
- JP 5389830 B **[0105]**