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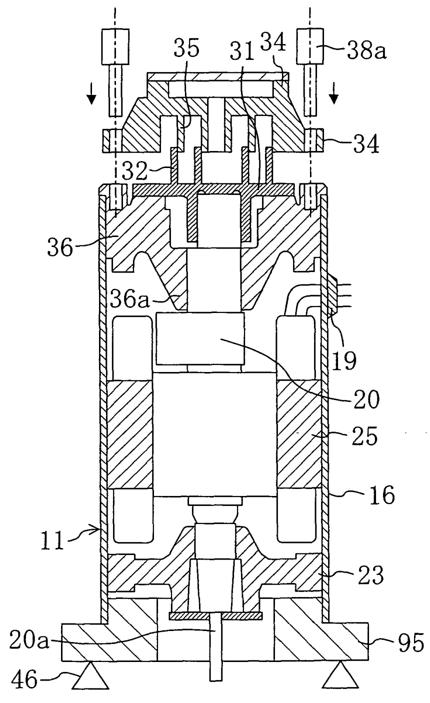
(54) METHOD OF POSITIONING FIXED SCROLL

(57) In positioning a fixed scroll **(34)** in assembling a scroll fluid machinery, in order to position the fixed scroll **(34)** in the θ direction accurately in a short period of time and in order to prevent a positioning mechanism from being complicated, an orbiting scroll **(31),** a crank shaft **(20)** engaged with the orbiting scroll **(31),** and a housing member **(36)** forming a bearing for the crank shaft **(20)** are combined, and then, a first positioning step and a second positioning step are performed. In the first positioning step, the fixed scroll **(34)** is positioned in the θ direction to the housing member **(36)** by means of a positioning pin **(38a).** In the second positioning step, the fixed scroll **(34)** is positioned in the X-axis direction and the Y-axis direction after the first positioning step.

FIG. 14



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Description

Technical Field

[0001] The present invention relates to a method for positioning a fixed scroll in assembling a scroll fluid machinery.

Background Art

[0002] Conventionally, scroll fluid machineries have been widely used in compressors and the like for compressing refrigerant in refrigerant circuits in air conditioners and the like. In the scroll fluid machineries, spiral wraps are provided to a fixed scroll and an orbiting scroll so that the fixed scroll wrap and the orbiting scroll wrap are meshed with each other to form fluid chambers. In the scroll fluid machineries, the orbiting scroll revolves to cause change in volume of the fluid chambers. For example, in a scroll compressor, after the fluid is sucked into fluid chambers before the fluid chambers are in a closed state, the fluid chambers in the closed state reduce in their volume to compress and then discharge the fluid in the fluid chambers fluid.

[0003] As described above, in the scroll fluid machineries, the orbiting scroll revolves with the wrap thereof meshed with the fixed scroll wrap. If the orbiting scroll wrap strikes the fixed scroll wrap hard when the orbiting scroll revolves, the orbiting scroll moves awkwardly. Therefore, for moving the orbiting scroll smoothly, it is necessary to arrange the fixed scroll accurately at a position where the wrap of the revolving orbiting scroll strikes the fixed scroll wrap not so hard (a position where a minute clearance that allows a film of the lubricant oil to form between the wraps is formed all the time when the orbiting scroll revolves). For this reason, it is required to position the fixed scroll accurately in assembling a scroll fluid machinery. For accurately positioning the fixed scroll, methods are disclosed, for example, in Patent Document 1.

[0004] In the second embodiment of the positioning method disclosed in Patent Document 1, a θ table for fixing the fixed scroll and an XY table on which the θ table is placed are prepared and the orbiting scroll is fixed to a drive shaft. After a standard position in the θ direction relative to the orbiting scroll fixed to the drive shaft is obtained with the fixed scroll rotated in the θ direction, standard positions in the X-axis and Y-axis directions are obtained with the fixed scroll moved in the X-axis direction and the Y-axis direction in this order, thereby positioning the fixed scroll at the center.

[0005] Further, the first embodiment of Patent Document 1 discloses a simple positioning method in which only the standard positions in the X-axis direction and the Y-axis direction thereof are obtained with no standard position in the θ direction thereof obtained.

Patent Document 1: Japanese Unexamined Patent Application Publication 2-221693

Summary of the Invention

Problems that the Invention is to Solve

[0006] The method of the second embodiment in Patent Document 1, however, necessitates a mechanism for rotating the fixed scroll in the θ direction for obtaining the standard position in the θ direction, which complicates the structure and elongates the cycle time required for centering. Further, the method of the first embodiment in Patent Document 1 performs no positioning in the θ direction of the fixed scroll, which invites inaccurate positioning of the fixed scroll.

[0007] The present invention has been made in view of the foregoing and has its object of achieving, in positioning a fixed scroll in assembling a scroll fluid machinery, highly accurate positioning of the fixed scroll in the θ direction in a short period of time and preventing a mechanism for positioning from being complicated.

[0008] A first aspect of the present invention is a method for positioning, in a process for assembling a scroll fluid machinery **(10),** a fixed scroll **(34)** on the basis of a positional relationship between a wrap **(35)** of the fixed scroll **(34)** and a wrap **(31)** of an orbiting scroll **(31).**

[0009] The fixed scroll positioning method includes: a first positioning step of positioning, after the orbiting scroll **(1),** a crank shaft **(20)** engaged with the orbiting scroll **(31),** and a housing member **(36)** forming a bearing for the crank shaft **(20)** are combined, the fixed scroll **(34)** in a θ direction to the housing member **(36)** by means of a positioning pin **(38a);** and a second positioning step of positioning the fixed scroll**(34)** in an X-axis direction and a Y-axis direction after the first positioning step. In general, the X-axis direction and the Y-axis direction are set at a right angle with each other. While in the above arrangement, they may be set inexactly at a right angle with each other.

[0010] In the first aspect, the fixed scroll **(34)** is placed on the housing member **(36)** supporting the crank shaft **(20)** engaged with the orbiting scroll **(31),** so that the wrap **(35)** of the fixed scroll **(34)** and the wrap **(32)** of the orbiting scroll **(31)** are meshed with each other. After the fixed scroll **(34)** is placed on the housing member **(36),** the fixed scroll **(34)** is temporarily positioned in the X-axis and Y-axis directions by means of the positioning pin **(38a).** Referring to each hole **(34c, 36c)** for receiving the positioning pin **(38a),** a clearance of about several tens microns is provided. Even if the fixed scroll **(34)** is displaced in the rotational direction (θ direction) due to the presence of the clearance, the displacement ranges only several ten microns with respect to 360°, which is ignorable substantially. Accordingly, the fixed scroll **(34)** is positioned by the positioning pin **(38a)** in the θ direction conclusively in the first positioning step. Then, in the second positioning step, the fixed scroll **(34)** is positioned in the X-axis and Y-axis directions. Positioning thereof in the X-axis and Y-axis directions may be performed respectively after the center on the X-axis of the fixed scroll **(34)** and the center on the Y-axis thereof are obtained, for example.

[0011] Referring to a second aspect of the present invention, in the first aspect, the positioning pin **(38a)** includes at least two positioning pins **(38a)** at an outer peripheral part of the fixed scroll **(34).**

[0012] In the second aspect, provision of the positioning pins **(38a)** at the outer peripheral part of the fixed scroll **(34)** reduces the influence of the displacement in the θ direction of the fixed scroll **(34),** which is caused due to the presence of the clearance, when compared with the case where the positioning pins **(38a)** are provided in the inner peripheral part thereof.

[0013] A third aspect of the present invention is the first or second aspect, wherein the first positioning step includes a setup step of fixing the fixed scroll **(34)** to the housing member **(36)** by means of fastening means **(38b)** and taking off the positioning pin **(38a)** after the fixed scroll **(34)** is positioned in the θ direction to the housing member **(36)** by means of the positioning pin **(38a),** and the second positioning step includes a centering step of releasing the fixing by the fastening means **(38)** with the fixed scroll **(34)** pressed to the housing member **(36)** and centering the fixed scroll **(34)** in the X-axis direction and the Y-axis direction.

[0014] In the third aspect, in the first positioning step, after the fixed scroll **(34)** is positioned in the θ direction to the housing member **(36)** by means of the positioning pin **(38a),** the fixed scroll **(34)** is fixed to the housing member **(36)** by means of the fastening means **(38b),** such as a bolt and the positioning pins **(38a)** are taken off. Then, in the second positioning step, fixing by the fastening means **(38b)** is released with the fixed scroll **(34)** pressed to the housing member **(36)** and the fixed scroll **(34)** is positioned in the X-axis direction and the Y-axis direction

[0015] A fourth aspect of the present invention is the first, second, or third aspect, wherein in the second positioning step, the fixed scroll **(34)** is positioned with a phase or a rotation position of the orbiting scroll **(31)** detected by a phase detection mechanism **(90).**

[0016] In the fourth aspect, in the second positioning step, the fixed scroll is positioned in the X-axis direction and the Y-axis direction with the phase of the orbiting scroll **(31)** detected.

[0017] A fifth aspect of the present invention is the fourth aspect, wherein a notch **(34b)** allowing an outer peripheral part of the orbiting scroll **(31)** to be observed from outside is formed in the fixed scroll **(34),** and in the second positioning step, the phase of the orbiting scroll **(31)** is detected by detecting a to-be-detected part **(31b)** provided at an outer peripheral part of the orbiting scroll **(31)** through the notch **(34b).**

[0018] In the fifth aspect, in the second positioning step, the phase of the orbiting scroll **(31)** is detected by detecting the to-be-detected part **(31b)** at the outer peripheral part of the orbiting scroll **(31)** through the notch **(34b)** of the fixed scroll **(34).**

[0019] A sixth aspect of the present invention is any one of the first to fifth aspects, wherein in the second positioning step, the fixed scroll **(34)** is moved by applying impact force to the fixed scroll **(34)** with the fixed scroll **(34)** pressed to the housing member **(36).**

[0020] In the sixth aspect, in the second positioning step, the fixed scroll **(34)** is positioned in the X-axis direction and the Y-axis direction in such a manner that the fixed scroll **(34)** is pressed to the housing member **(36)** to exert static friction and the impact force is applied in the X-axis direction and the Y-axis direction against the friction. This moves the fixed scroll **(34)** slightly to adjust the position of the fixed scroll **(34).**

Effects of the Invention

[0021] In the present invention, the first positioning step of positioning the fixed scroll (34) in the θ direction to the housing member **(36)** by means of the positioning pin **(38a)** and the second positioning step of positioning the fixed scroll **(34)** in the X-axis direction and the Y-axis direction after the first positioning step are performed simply, wherein the fixed scroll **(34)** is positioned in the θ direction simply by means of the positioning pin **(38a).** The clearance between the positioning pin **(38a)** and positioning holes **(34c, 36c)** for the positioning pin **(38a)** causes less or no influence of displacement in the θ direction, and accordingly, the fixed scroll **(34)** can be positioned sufficiently accurately in the θ direction. Thereafter, positioning in the X-axis direction and the Y-axis direction is performed to thus achieve accurate mounting of the fixed scroll **(34).** The positioning in the θ direction can be performed by the simple method using the positioning pin **(38a),** thereby preventing elongation of the cycle time required for positioning and preventing the mechanisms from being complicated.

[0022] In the second aspect of the present invention, the positioning pins **(38a)** are provided in the outer peripheral part of the fixed scroll **(34)** to reduce the influence of displacement in the θ direction of the fixed scroll **(34),** which is caused due to the presence of the clearance, when compared with the case with the positioning pins **(38a)** provided in the inner peripheral part thereof. Thus, the positioning accuracy increases. Further, the two positioning pins **(38a)** rather than three positioning pins facilitate positioning of the fixed scroll **(34),** and even at least two positioning pins **(38a)** can achieve definite positioning.

[0023] In the third aspect of the present invention, in the first positioning step, the fixed scroll **(34)** is positioned in the θ direction to the housing member **(36)** by means of the positioning pin **(38a),** and then, the fixed scroll **(34)** is fixed to the housing member **(36)** by means of the fastening means, such as a bolt and the positioning pin **(38a)** is taken off. Then, in the second positioning step, fixing by the fastening member **(38b)** is released with the fixed scroll **(34)** pressed to the housing member **(36),** and then, the fixed scroll **(34)** is positioned in the X-axis direction and the Y-axis direction. In this method, setting of the fixed scroll **(34)** to the housing member **(36)** by means of the positioning pin **(38a)** can be performed manually as a setup step. In contrast, automation of all the steps complicates the facilities to increase the cost. In the present invention, however, facility complication and cost increase can be prevented. Manual setting of the positioning pin **(38a)** in a facility requires alternate operations of manual operation and operation by the facility, which causes waiting time for the operator and waiting time for the facilities to lower the productivity. The present invention, however, prevents lowering of the productivity.

[0024] In the fourth aspect of the present invention, in the second positioning step, the fixed scroll **(34)** is positioned in the X-axis direction and the Y-axis direction with the phase of the orbiting scroll **(31)** detected, thereby enabling more accurate positioning of the fixed scroll **(34).**

[0025] In the fifth aspect of the present invention, in the second positioning step, the phase of the orbiting scroll **(31)** is detected by detecting the to-be-detected part **(31b)** at the outer peripheral part of the orbiting scroll **(31)** through the notch **(34b)** of the fixed scroll **(34).** In other words, the phase of the orbiting scroll **(34)** can be detected during positioning to eliminate the need for phase detection prior to the positioning, thereby facilitating the method.

[0026] In the sixth aspect of the present invention, in the second positioning step, the impact force is applied to the fixed scroll **(34)** with the fixed scroll **(34)** pressed to the housing member **(36)** to move the fixed scroll **(34).** This achieves positioning by fine adjustment of the position of the fixed scroll **(34).** Hence, the positioning accuracy increases.

Brief Description of the Drawings

[0027]

[FIG. **1**] FIG. **1** is a vertical sectional view of a scroll compressor in accordance with an embodiment of the present invention.

[FIG. **2**] FIG. **2** is a transverse sectional view of a compression mechanism.

[FIG. **3**] FIG. **3** is a constructional diagram of a positioning apparatus in accordance with the embodiment of the present invention.

[FIG. **4**] FIG. **4** is a perspective view showing an X-Y guide of the positioning apparatus.

[FIG. **5**] FIG. **5** is a layout diagram of striking units in the positioning apparatus.

[FIG. **6**] FIG. **6** is a constructional diagram of the striking units.

[FIG. **7**] FIG. **7** is a block diagram showing control of the positioning apparatus.

[FIG. **8**] FIG. **8** is a plan view of an assembly before a fixed scroll is mounted thereto.

[FIG. **9**] FIG. **9** is a plan view of the assembly after the fixed scroll is mounted thereto.

[FIG. **10**] FIG. **10** is a plan view of an orbiting scroll.

[FIG. **11**] FIG. **11** is a plan view of the fixed scroll.

[FIG. **12**] FIG. **12** shows a first setup step of a positioning method in accordance with the present invention.

[FIG. **13**] FIG. **3** shows a second setup step of the positioning method in accordance with the present invention.

[FIG. **14**] FIG. **14** shows a third setup step of the positioning method in accordance with the present invention.

[FIG. **15**] FIG. **15** shows a fourth setup step of the positioning method in accordance with the present invention.

[FIG. **16**] FIG. **16** shows a fifth setup step of the positioning method in accordance with the present invention.

[FIG. **17**] FIG. **17** shows a step of conveying the assembly to the positioning apparatus.

[FIG. **18**] FIG. **18** shows a first centering step of the positioning method in accordance with the present invention.

[FIG. **19**] FIG. **19** shows a second centering step of the positioning method in accordance with the present invention.

[FIG. **20**] FIG. **20** shows a third centering step of the positioning method in accordance with the present invention.

[FIG. **21**] FIG. **21** shows a fourth centering step of the positioning method in accordance with the present invention.

[FIG. **22**] FIG. **22** shows a fifth centering step of the positioning method in accordance with the present invention.

[FIG. **23**] FIG. **23** shows a sixth centering step of the positioning method in accordance with the present invention.

[FIG. **24**] FIG. **24** shows a seventh centering step of the positioning method in accordance with the present invention.

[FIG. **25**] FIG. **25** is a plan view showing the relationship between the position of the fixed scroll and the striking unit.

[FIG. **26**] FIG. **26** is a plan view showing the relationship between the position of the fixed scroll and the striking units.

[FIG. **27**] FIG. **27** shows an eighth centering step of the positioning method in accordance with the present invention.

[FIG. **28**] FIG. **28** shows a ninth centering step of the positioning method in accordance with the present invention.

[FIG. **29**] FIG. **29** shows a step of conveying the assembly out from the positioning apparatus.

Explanation of Reference Numerals

[0028]

10	scroll fluid machinery (scroll compressor)
20	crank shaft
31	orbiting scroll
31b	outer peripheral protrusion (to-be-detected part)
32	wrap
34	fixed scroll
34b	notch
35	wrap
36	housing (housing member)
38a	positioning pin
38b	bolt (fastening mans)
90	phase detection mechanism

Best mode for Carrying out the Invention

[0029] An embodiment of the present invention will be described below in detail with reference to the accompanying drawings. Wherein, the construction of a scroll compressor (10) assembled with the use of a positioning apparatus (40) that performs a positioning method in accordance with the present invention will be described first, followed by description of the positioning apparatus **(40)** and the positioning method in accordance with the present embodiment.

-Construction of Scroll Compressor-

[0030] As shown in FIG. **1**, the scroll compressor **(10)** is of generally-called hermetic type. The scroll compressor **(10)** includes a casing **(15)** formed of an oblong hermetic container. The casing **(15)** is composed of one body member **(16)** formed in an oblong cylindrical shape and cup-shaped heads **(17, 18)** mounted at the upper end and the lower end of the body member **(16).**

[0031] Inside the casing **(15),** a lower bearing member **(23),** a compressor motor **(25),** a compression mechanism **(30)** are arranged in this order from the bottom to the above. A vertically extending crank shaft **(20)** is also provided inside the casing **(15).**

[0032] A suction pipe **(11)** passing through the upper head **(17)** is fixed at the casing, **(15)** so as to communicate with the suction port of the compression mechanism **(30).** Further, a discharge pipe **(12)** passing through the body member **(16)** is provided at a part of the casing **(15)** between the compression mechanism **(30)** and the compressor motor **(25).** Low-pressure gas is sucked into the compression mechanism **(30)** through the suction pipe **(11),** is compressed in the compression mechanism **(30)** to be high-pressure gas, fills the space in the lower part of the compression mechanism **(30)** in the casing **(15),** and is then discharged from the discharge pipe **(12).** Inside of the casing **(15),** the upper space **(S1)** of the compression mechanism **(20)** serves as a low-pressure space while the lower space **(S2)** thereof serves as a high-pressure space.

[0033] The crank shaft **(20)** includes a main shaft portion **(21)** and an eccentric portion **(22).** The main shaft portion **(21)** has an upper end part of which diameter is slightly larger than that of the lower part thereof. The eccentric portion **(22)** is in a column shape having a diameter smaller than that of the upper end part of the main shaft portion **(21)** and stands on the upper end face of the main shaft portion **(21).** The axial center of the eccentric portion **(22)** is eccentric from the axial center of the main shaft part (21).

[0034] The lower bearing member **(23)** is fixed in the vicinity of the lower end of the body member **(16)** of the casing **(15).** A sliding bearing **(23a)** is formed at the central part of the lower bearing member **(23)** to support the lower end of the main shaft portion **(21)** rotatably.

[0035] The compressor motor **(25)** is a generally-called brushless DC motor. The compressor motor **(25)** includes a stator **(26)** and a rotor **(27)** to compose a driving motor. The stator **(26)** is fixed to the body member **(16)** of the casing **(15).** The stator **(26)** is connected electrically to a feeder terminal **(19)** mounted at the body member **(16)** of the casing **(15).** On the other hand, the rotor **(26)** is arranged inside the stator **(26)** so as to be fixed to the main shaft portion **(21)** of the crank shaft **(20).**

[0036] The compression mechanism **(30)** includes an orbiting scroll **(31),** a fixed scroll **(34),** and a housing **(36)** as a housing member **(36).**

[0037] The housing **(36)** is in a comparatively thick disc shape of which central part is recessed, wherein the outer peripheral part thereof is joined to the upper end of the body member **(16).** The main shaft portion **(21)** of the crank shaft **(20)** is inserted in the central part of the housing **(36).** The housing **(36)** composes a bearing **(36a)** rotatably supporting the main shaft portion **(21)** of the crank shaft **(20).**

[0038] The orbiting scroll **(31)** includes an orbiting scroll end plate **(31a),** an orbiting scroll wrap **(32)** in a spiral shape standing on the front face thereof (the upper face in FIG. **1),** and a cylindrical protrusion **(33)** protruding from the back face thereof (the lower face in FIG. **1).** Though not shown in FIG. **1,** the orbiting scroll **(31)** is placed on the upper face of the housing **(36)** with an Oldham ring **(39)** shown in FIG. **13** interposed. The eccentric portion **(22)** of the crank shaft **(20)** is inserted in the protrusion **(33)** of the orbiting scroll **(31).** In other words, the orbiting scroll **(31)** is engaged with the crank shaft **(20).**

[0039] The fixed scroll **(34)** is in a comparatively thick disc shape and includes a fixed scroll end plate **(34a).** A fixed scroll wrap **(35)** in a spiral shape is provided at the central part of the fixed scroll **(34).** The fixed scroll wrap **(35)** is formed by engraving the fixed scroll **(34)** from the lower face thereof.

[0040] As shown in FIG. **2,** the fixed scroll wrap **(35)** of the fixed scroll **(34)** and the orbiting scroll wrap **(32)** of the orbiting scroll **(31)** are meshed with each other in the compression mechanism **(30).** Meshing of the fixed scroll wrap **(35)** and the orbiting scroll wrap **(32)** with each other forms a plurality of compression chambers **(37)** between the outer peripheral face of the fixed scroll wrap **(35)** and the inner peripheral face of the orbiting scroll wrap **(32)** and between the inner peripheral face of the fixed scroll wrap **(35)** and the outer peripheral face of the orbiting scroll wrap **(32).**

-Fixed Scroll Positioning Apparatus-

[0041] The positioning apparatus **(40)** of the present embodiment is provided for positioning the fixed scroll **(34)** on the basis of the positional relationship between the fixed scroll wrap **(35)** and the orbiting scroll wrap **(32)** in a process of assembling the scroll compressor **(10).** Specifically, the positioning apparatus **(40)** appropriates the positional relationship between the fixed scroll **(34)** and the orbiting scroll **(31)** by adjusting the position of the fixed scroll **(34)** in mounting the fixed scroll **(34)** to a later-described assembly **(11)** prepared in the process of assembling the scroll compressor **(10).**

[0042] The assembly **(11)** is an assembled integration of the body member **(16),** the housing **(36),** the compressor motor **(25),** the lower bearing member **(23),** the crank shaft **(20),** and the orbiting scroll **(31).** In the assembly **(11),** the housing **(36),** the compressor motor **(25),** and the lower bearing member **(23)** are fixed to the body member **(16),** and the orbiting scroll **(31)** engaged with the crank shaft **(20)** is placed on the housing **(36).** The stator **(26)** of the compressor motor **(25)** is connected electrically to the feeder terminal **(19)** in the assembly **(11).**

[0043] The construction of the positioning apparatus **(40)** will be described with reference to FIG. **3.** The positioning apparatus **(40)** includes a first frame **(45)** and a second frame **(60).**

[0044] The first frame **(45)** includes one pedestal **(46),** one upper plate **(47),** and four poles **(48).** The pedestal **(46)** is formed in a rectangular shape and is arranged substantially horizontally. The poles **(48)** stand at the corners of the pedestal **(46).** The poles **(48)** pass through the pedestal **(46)** and protrude at the lower ends thereof downward from the pedestal **(46).** The upper plate **(47)** is fixed at the upper ends of the four standing poles **(48).**

[0045] A cylindrical guide member **(50)** protrudes from the central part of the upper face of the pedestal **(46).** The guide member **(50)** is provided for guiding the body member **(16)** to a predetermined point when the assembly **(11)** is placed on the pedestal **(46),** and has an inner diameter slightly larger than the outer diameter of the body member **(16).** A through hole **(52)** is formed at the center of the pedestal **(46).** The through hole **(52)** is a circular hole formed coaxially with the guide member **(50)** and passes through the pedestal **(46).**

[0046] A rotary encoder **(53)** is mounted at the lower face of the pedestal **(46)** through a bracket **(54).** The rotary encoder **(53)** is arranged under the through hole **(52)** and has a rotating shaft **(53a)** extending upward toward the through hole **(52).** A coupling **(55)** is mounted at the rotating shaft **(53a)** of the rotary encoder **(53).** The coupling **(55)** joins the rotating shaft **(53a)** of the rotary encoder **(53)** and a part of an oil pickup **(20a)** at the lower end of the crank shaft **(20)** which protrudes downward from the through hole **(52).** Though not shown in FIG. **1,** the oil pickup **(20a)** is formed integrally with the crank shaft **(20),** as shown in FIG. **3.** The oil pickup is fitted to an oil pump (not shown) to supply a lubricant oil to bearings and sliding elements of the compression mechanism **(30)** through an oil supply passage (not shown) vertically extending in the central part of the crank shaft **(20).**

[0047] A pressing mechanism **(56)** for pressing the fixed scroll **(34)** downward is mounted at the upper plate **(47).** The pressing mechanism **(56)** includes a downwardly extending rod **(57a)** and is arranged substantially at the center of the upper plate **(47).** A pressing member **(58)** larger in sectional area than the rod **(57a)** is mounted at the lower end of the rod **(57a).** A guide **(41),** which will be described later, is mounted at the lower face of the pressing member **(58).** The pressing mechanism **(58)** feeds the rod **(57a)** by an air cylinder **(57)** or the like to move the pressing member **(58)** and the guide **(41)** downward to apply the pressing force to the fixed scroll **(34).**

[0048] The guide **(41)** will be described with reference to FIG. **4.** The guide **(41)** includes a base plate **(59),** an X-axis rail **(49a)** and a Y-axis rail **(49b)** intersected at a right angle with each other, linear motion bearings **(51)** engaged with the X-axis rail **(49a)** and the Y-axis rail **(49b),** and three presser rods **(28)** provided at the lower face of the base plate **(59)** as shown in FIG. **3.**

[0049] the X-axis rail **(49a)** includes two rail members having the same length. The two rail members of the X-axis rail **(49a)** are arranged and fixed in parallel to each other with a predetermined space left on the upper face of the base plate **(59).** The Y-axis rail **(49b)** includes two rail members having the same length. The two rail members of the Y-axis rail **(49b)** are arranged and fixed in parallel to each other with a predetermined space left on the lower face of the pressing member **(58).**

[0050] A spike **(28a)** for inhibiting rotation of the fixed scroll **(34)** is formed at each lower end of the presser rods **(28).** The presser rods **(28)** inhibit sliding of the fixed scroll **(34)** on the guide **(41)** when the fixed scroll **(34)** is moved in the state that the guide **(41)** applies the pressing force to the fixed scroll **(34).** Provision of the spike **(28a)** at each lower end of the presser rods **(28)** generates, at the contact face between the presser rods **(28)** and the fixed scroll **(34),** larger frictional force than the frictional force generated at the contact face between the fixed scroll **(34)** and the housing **(36).**

[0051] The respective linear motion bearings **(51)** are provided at the parts where the X-axis rail **(49a)** and the Y-axis rail **(49b)** are intersected with each other. In other words, the guide **(41)** is provided with the linear motion bearings **(51)** of which number is four in total. The linear motion bearings **(51)** are substantially in a cubic shape having a lower face in which a groove in the X-axis direction is formed and an upper face in which a groove in the Y-axis direction is formed. The X-axis rail **(49a)** is fitted in the groove in each lower face of the linear motion bearings **(51)** while the Y-axis rail **(49b)** is fitted in the groove in each upper face thereof. The linear motion bearings **(51)** are prevented from falling off in the Z-axis direction (the direction at a right angle with respect to the plane of the base plate **(59)**). Multiple ball members not shown are embedded in the grooves in the X-axis direction and the Y-axis direction of the linear motion bearings **(51).** Each linear motion bearing **(51)** is in contact with the X-axis rail **(49a)** and the Y-axis rail **(49b)** with the multiple ball members interposed so as to have a rolling guide structure that moves straight along the rails. Whereby, the guide **(41)** allows the parallel movement of the fixed scroll **(34)** in the X-axis direction and the Y-axis direction that are right-angled to each other while restricting rotation of the fixed scroll **(34)** under the state where the pressing force is applied to the fixed scroll **(34).**

[0052] The second frame **(60)** includes one frame member **(61)** and four poles **(62)** and is fixed on the pedestal **(46).** The length of the poles **(62)** is slightly shorter than the height of the body member **(16)** composing the assembly **(11).** The four poles **(62)** stand around the guide member **(50)** at regular intervals on the pedestal **(46).** The frame member **(61)** is in a rectangular or circular frame shape and is placed on the four poles **(62).** The frame member **(61)** is fixed to the poles **(62)** so as to surround the upper part of the assembly **(11).**

[0053] The frame member **(61)** is provided with a cramp mechanism **(63)** for fixing the assembly **(11).** The cramp mechanism **(63)** serves as a fixing member. The cramp mechanism **(63)** includes a plurality of movable cramp heads **(64)** protruding inward from the frame member **(61).** The cramp mechanism **(63)** allows the cramp heads **(64)** to push the outer peripheral face of the body member **(16)** composing the assembly **(11)** to clip the sides of the assembly **(11)** in the radial direction of the body member **(16),** thereby holding the assembly **(11).** Favorably, four cramp heads **(64)** in total are provided on the radial lines in the X-axis direction and the Y-axis direction, for example.

[0054] On the frame member **(61),** there are provided two position detection mechanisms **(65)** for detecting the position of the fixed scroll **(34)** in the X-axis direction and the Y-axis direction and four striking units **(70)** arranged two by two on the X-axis and the Y-axis. Electric micrometers **(66),** for example, may be used as the position detection mechanisms **(65).** The electric micrometers **(66)** measure the position and the dimension of a measurement target by utilizing an electric signal. As the position detection mechanisms **(65),** any other position measuring tools, such as laser displacement gauges or the like may be used rather than the electric micrometers **(66).** The laser displacement gauges measure displacement of the fixed scroll **(34)** from reflected light of a laser beam irradiated on the fixed scroll **(34).**

[0055] The striking units **(70)** are in a circular column shape and each include a head **(74)** at the extreme end at which a projection is formed (see FIG. **6).** The four striking units **(70)** serve as a moving mechanism **(75)** for moving the fixed scroll **(34)** by applying impact force to the fixed scroll **(34).**

[0056] As shown in FIG. **5,** the four striking units **(70)** are arranged radially at the intervals of 90 degrees with the fixed scroll **(34)** on the housing **(36)** of the assembly **(11)** as a center. In other words, two striking units **(70)** are arranged along a first radial direction (the X-axis direction) of the fixed scroll **(34)** while the other two striking units **(70)** are arranged along a second radial direction (the Y-axis direction) intersected at a right angle with the first radial direction. The projection of the head **(74)** of each striking unit **(70)** faces the fixed scroll **(34).** Namely, each two striking units **(70)** arranged along one of the radial directions faces each other with the fixed scroll **(34)** interposed.

[0057] The first radial direction is parallel to the X-axis direction of the guide **(41).** The second radial direction is parallel to the Y-axis direction of the guide **(41).** Namely, the X-axis direction and the Y-axis direction in which the guide **(41)** allows the movement of the fixed scroll **(34)** agree with the directions of the impact force that the striking units **(70)** apply to the fixed scroll **(34).** When one of the striking units **(70)** applies the impact force in the X-axis direction to the fixed scroll **(34),** the X-axis rail **(49a)** is guided to the grooves in the X-axis direction of the linear motion beatings **(51),** thereby moving the fixed scroll **(34)** in the X-axis direction. On the other hand, when one of the striking units **(70)** applies the impact force in the Y-axis direction to the fixed scroll **(34),** the Y-axis rail **(49b)** is guided to the grooves in the Y-axis direction of the linear motion beatings **(51),** thereby moving the fixed scroll **(34)** in the Y-axis direction.

[0058] A construction of the striking units **(70)** will be described with reference to FIG. 6. Each striking unit **(70)** includes one main body **(1)** and one air cylinder **(100).** The main body **(71)** and the air cylinder **(100)** have cylindrical outer shapes and are arranged coaxially with each other.

[0059] The main body **(71)** includes a base part **(72),** a piezoelectric element **(72),** and a head **(74)** and is formed into a column shape as a whole. Specifically, in the main body **(71),** the base part **(72)** and the head **(74),** both of which are formed in column shapes are arranged coaxially with each other, and the piezoelectric element **(73)** is interposed between the base part **(72)** and the head **(74).** The projection is formed at the tip end (on the side opposite to the piezoelectric element **(73))** of the head **(74).** In the main body **(71),** when voltage is applied to the piezoelectric element **(73),** the piezoelectric element **(73)** extends in the axial direction of the main body **(71)** to push out the head **(74)** (see FIG. **6B).** When the electric conduction to the piezoelectric element **(73)** is stopped, the piezoelectric element **(73)** returns to have the original length, thereby returning the head **(74)** (see FIG. **6(A)**).

[0060] The air cylinder **(100)** includes a cylinder **(102),** a piston **(102),** and a rod **(103).** The cylinder **(101)** has a hollowed cylindrical shape. The piston **(102)** is inserted in the cylinder **(101)** so as to be movable in the axial direction of the cylinder **(101).** The rod **(103)** is arranged coaxially with the cylinder **(101).** The rod **(103)** is connected at the base end thereof to the piston **(102)** while extending at the tip end thereof outside the cylinder **(101).** The tip end of the rod **(103)** is joined to the end face of the base part **(72)** of the main body **(71).** The inside of the cylinder **(101)** is divided by the piston **(102)** into a first air chamber **(104)** and the a second air camber **(105).** A first air pipe **(106)** is connected to the first air chamber **(104)** located on the opposite side to the rod **(103)** while a second air pipe **(107)** is connected to the second air chamber **(105)** located on the rode **(103)** side.

[0061] In each of the striking units **(70),** when the air is supplied from the first air pipe **(106)** to the first air chamber **(104)** while at the same time the air is discharged from the second air chamber **(105)** to the second air pipe **(107),** the piston **(102)** moves toward the second air chamber **(105)** to send out the main body **(71)** toward the tip end of the striking unit **(70)** (leftward in FIG. **6).** In reverse, when the air is supplied from the second air pipe **(107)** to the second air chamber **(105)** while at the same time the air is discharged from the first air chamber **(104)** to the first air pipe **(106),** the piston **(102)** moves toward the first air chamber **(104)** to return the main body **(71)** backward toward the base end of the striking unit **(70)** (rightward in FIG. **6).**

[0062] As shown in FIG. **7,** the positioning apparatus **(40)** includes an inverter **(81),** a driver **(82)** for the inverter **(81),** and a controller (control means) **(80).** The inverter **(81)** and the driver **(82)** compose feeding means **(83).**

[0063] The inverter **(81)** is connected at the input side thereof to a commercial power source **(85)** while being connected at the output side thereof to the feeder terminal **(19)** of the assembly **(11).** The driver **(82)** receives an output signal from the rotary encoder **(53).**

[0064] The positioning apparatus **(40)** includes, though not shown in FIG. **7,** a laser displacement gauge **(91)** for measuring the phase of the crank shaft **(20)** (see FIG. **18).** The laser displacement gauge **(91)** for phase measurement measures the phases of the crank shaft **(20)** and the orbiting scroll **(31)** and composes a phase detection mechanism **(90)** in the present invention in combination with the rotary encoder **(53).**

[0065] The driver **(82)** computes the rotation angle and the angular velocity of the crank shaft **(20)** on the basis of the output signal of the rotary encoder **(53)** and sets, according thereto, an instruction value in relation to the output current value and the output frequency of the inverter **(81).** The driver **(82)** then outputs an instruction, such as switching timing or the like to the inverter **(81)** so that the output of the inverter **(81)** corresponds to the instruction value. The inverter **(81)** is operated in accordance with the instruction from the driver **(82)** to supply the alternating current to the compressor motor **(25)** of the assembly **(11).** The controller **(80)** receives an instruction value in relation to the output current of the inverter **(81)** and information on the rotation angle of the crank shaft **(20)** from the driver **(82).**

[0066] While allowing the rotary encoder **(53)** to detect a predetermined rotation point (phase) of the orbiting scroll **(31)** during the time when the crank shaft **(20)** is rotated, the controller **(80)** determines the direction in which the fixed scroll **(34)** is to be moved on the basis of the phase or the rotation angle of the orbiting scroll **(31).** Further, the controller **(80)** allows the striking units **(70)** to move the fixed scroll **(35)** by a predetermined distance (about several microns to ten microns) in the direction in which the outer peripheral face of the fixed scroll wrap **(35)** separates from the inner peripheral face of the orbiting scroll wrap **(32)** in a predetermined part of the fixed scroll **(34)** and performs then control for inverting the orbiting scroll **(31)** by approximately 180°. In so doing, the outer peripheral face of the orbiting scroll wrap **(32)** is in contact with the inner peripheral face of the fixed scroll wrap **(35)** to cause the fixed scroll **(34)** to shift by the repulsive force of the orbiting scroll wrap **(32).** Upon detection of the shift of the fixed scroll **(34)** by the electric micrometers **(66),** the position of the predetermined part thereof is recognized as a limit point of a movable range of the fixed scroll **(34).** On the other hand, when the fixed scroll **(34)** does not shift when the orbiting scroll **(31)** is inverted after striking of the fixed scroll **(34),** which means that the wraps **(32, 35)** are out of contact with each other yet and the fixed scroll **(34)** does not reach the limit point of the movable range, striking of the fixed scroll **(34)** and inversion of the orbiting scroll **(31)** are repeated until the wraps **(31, 35)** are in contact with each other.

[0067] When the above operation is performed in the plus direction (first direction) and the minus direction (second direction) on the X-axis, each end of the movable range on the X-axis of the fixed scroll **(34)** can be detected. Then, the fixed scroll **(34)** is moved to the center on the X-axis of the movable range thereof. Next, after the same operation is performed in the plus direction and the minus direction on the Y-axis, the fixed scroll **(34)** is moved to the center on the Y-axis of the movable range thereof. At this time point, the fixed scroll **(34)** is positioned almost at the center though the first centering operation in the X-axis direction was performed with no center on the Y-axis determined. Therefore, in order to perform more precise centering, in the present embodiment, control is performed so that the same operation is performed in the plus direction and the minus direction on the X-axis again for setting the fixed scroll **(34)** at the center of the movable range thereof.

[0068] The detailed control of the striking units **(70)** is followed. When the direction in which the fixed scroll **(34)** is to be moved is determined from the singal of the phase detection mechanisms **(90),** the controller **(80)** controls a striking unit **(70)** corresponding to the determined direction. Specifically, the controller **(80)** first allows the first air pipe **(106)** to supply the air to the first air chamber

(104) while allowing the second air chamber **(105)** to discharge the air to the second air pipe **(107)** to move the main body **(71)** so that the projection of the head **(74)** of the striking unit **(70)** is in contact with the fixed scroll **(34).** After the striking unit **(70)** is moved, the controller **(80)** applies pulse voltage to the piezoelectric element **(73)** of the striking unit **(70).** Upon application of the pulse voltage to the piezoelectric element **(73)** of the striking unit **(70),** the piezoelectric element **(73)** extends and contracts according to the pulse waveform. Accordingly, the inertia force of the head **(74)** pushed out by the extension of the piezoelectric element **(73)** works on the fixed scroll **(34)** to move the fixed scroll **(34)** slightly (by about several microns to ten microns). Movement of the fixed scroll **(34)** results in separation of the head **(74)** from the fixed scroll **(34).** Accordingly, the striking unit **(70)** is moved so that the projection of the head **(74)** is in contact with the fixed scroll **(34)** again, and the pulse voltage is applied again to the piezoelectric element **(73)** of the striking unit **(70)** to move the fixed scroll **(34)** slightly by extension and contraction of the piezoelectric element **(73).** Repetition of this operation moves the fixed scroll **(34)** pressed to the housing **(36)** little by little. After the movement of the fixed scroll **(34)** is terminated, the controller **(80)** allows the second air pipe **(107)** to supply the air to the second air chamber **(105)** while allowing the first air chamber **(104)** to discharge the air to the first air pipe **(106)** to return the striking unit **(70)** to the original position.

[0069] This operation of the controller **(80)** will be described with reference to FIG. 5. The terms in this paragraph, "right," "left," "up," and "down (lower)" correspond to those in FIG. **5.** For example, for moving the fixed scroll **(34)** leftward (or rightward) on the X-axis, the controller **(80)** controls the right (or left) striking unit **(70).** Specifically, the controller **(80)** adjusts the air amounts in the first air chamber **(104)** and the second air chamber **(105)** of the air cylinder **(100)** for moving the main body **(71)** and supplies the pulse voltage to the piezoelectric element **(73)** of the main body **(71)** for applying the leftward (or rightward) impact force to the fixed scroll **(34).** For moving the fixed scroll **(34)** downward (or upward) on the Y-axis, the controller **(80)** controls the upper (or lower) striking unit **(70).**

-Structures of Fixed Scroll and Orbiting Scroll-

[0070] FIG. **8** is a plan view showing the assembly **(11)** obtained by assembling the body member **(16),** the housing **(36),** the compressor motor **(25),** the lower bearing member **(23),** the crank shaft **(20),** and the orbiting scroll **(31),** and FIG. **9** is a plan view of the assembly **(11)** to which the fixed scroll **(34)** is set. FIG. **10** is a plan view of the orbiting scroll **(31),** and FIG. **11** is a plan view of the fixed scroll **(34).**

[0071] The orbiting scroll **(31)** includes at three parts on the outer peripheral face of the orbiting scroll end plate **(31a)** outer peripheral protrusions **(31b)** protruding outward in the radial direction for dynamic balance. Notches **(34b)** for weight reduction are formed at three parts on the outer peripheral edge of the fixed scroll end plate **(34a)** of the fixed scroll **(34).**

[0072] As shown in FIG. **8,** the housing **(36)** is provided with four mounting parts **(36b)** for mounting the fixed scroll **(34).** In each of the mounting parts **(36b),** there are formed two housing positioning pin holes **(36c)** receiving positioning pins **(38a)** (see FIG. **14)** for positioning the fixed scroll **(34)** and five bolt holes **(36d)** for fastening the fixed scroll **(34)** by means of bolts **(38b)** as fastening means (see FIG. **15).**

[0073] In the fixed scroll **(34),** there are formed two fixed scroll positioning pin holes **(34c)** at points corresponding to the housing positioning pin holes **(36c)** and five bolt holes **(34d)** at points corresponding to the bolt holes **(36d)** of the housing **(36).** The fixed scroll **(34)** is positioned provisionally by the positioning pins **(38a)** to the housing **(36)** and is then fixed to the housing **(36)** by means of the bolts **(38b).** FIG. **9** shows this state.

[0074] In the state shown in FIG. **9,** movement of the outer peripheral protrusions **(31b)** as to-be-detected parts can be observed as rotation of the orbiting scroll **(31)** through the notches **(34b)** of the fixed scroll **(34).** The outer peripheral protrusions **(31b)** of the orbiting scroll **(31)** are observed through the notches **(34b)** of the fixed scroll **(34)** in this way for phase detection of the orbiting scroll **(31).** Specifically, a sensor **(92)** (see FIG. **18)** of the laser displacement gauge **(91)** composing the phase detection mechanism **(90)** is arranged above the notches **(34b)** for detecting the outer peripheral protrusions **(31b)** of the orbiting scroll **(31),** and the phase of the crank shaft **(20),** that is, the phase of the orbiting scroll **(31)** during rotation of the compressor motor **(25)** is detected on the basis of the detected positions of the outer peripheral protrusions **(31b)** and the rotation position signal of the rotary encoder **(53).**

[0075] The positioning pin holes **(34c, 36c)** are formed in the outer peripheral parts of the housing **(36)** and the fixed scroll **(34),** respectively. The clearance of the positioning pin holes **(34c, 36c)** is set precisely in the range of, for example, 30 μm $\pm$ 10 μm with respect to the diameter of the positioning pins **(38a).** Suppose that the pitch diameter of the positioning pin holes **(34c, 36c)** is φ130 mm, displacement in the rotation (θ) direction is approximately 1.5 μm or smaller though it differs slightly according to the base circle diameter, and accordingly, sufficient position accuracy can be achieved in the θ direction.

-Method for Poisoning Fixed Scroll **(34)-**

[0076] A method for positioning the fixed scroll **(34)** which the positioning apparatus **(40)** performs will be described with the method divided into a fixing step (a first positioning step) including setup steps before positioning the fixed scroll **(34)** and a positioning step (a second positioning step) including fixed scroll **(34)** centering steps. The description will be given in this order.

[0077] FIG. **12** to FIG. **16** show the setup steps before positioning the fixed scroll **(34).** In the first setup step shown in FIG. **12,** a refrigerator oil **(96)** used as a lubricant oil is injected to the bearing **(36a)** of the housing **(36)** under the state that the assembly **(11)** before the orbiting scroll **(31)** is fitted to the crank shaft **(20)** is placed on a conveyance pallet **(95)** with the housing **(36)** located up. As the lubricant oil **(96),** a refrigerator oil **(96)** is used which has viscosity lower than the refrigerator oil **(96)** used for the scroll compressor **(10)** after assembled. For example, in the case where the viscosity of the refrigerator oil **(96)** used for a compressor after assembled is VG68, an oil having a low viscosity of VG32, VG22, or the like is used as the lubricant oil **(96)** for the assembling process. An oil having high viscosity is supplied to the bearings non-uniformly especially at low outdoor temperature, so that the oil film formed becomes non-uniform in thickness at low-speed rotation, for example, at the positioning step to invite assembling with the center of the crank shaft **(20)** displaced. In contrast, the use of the oil having such low viscosity prevents displacement of the center of the crank shaft **(20)** in the assembling process. If an oil having low viscosity is supplied to the bearing **(23a)** of the lower bearing member **(32)** in advance, displacement of the center of the crank shaft **(20)** can be prevented further effectively.

[0078] In a second setup step shown in FIG. **13,** the Oldham ring **(39)** and the orbiting scroll **(31)** are mounted to the assembly **(11),** and the lubricant oil **(96)** is injected to the sliding elements. As the lubricant oil **(96),** the refrigerator oil **(96)** is used which has viscosity lower than the refrigerator oil **(96)** for the scroll compressor **(10)** after assembled.

[0079] In a third setup step shown in FIG. **14,** the fixed scroll **(34)** is placed on the housing **(36)** and the orbiting scroll **(31)** so that the fixed scroll wrap **(35)** and the orbiting scroll wrap **(32)** are meshed with each other, and the fixed scroll **(34)** is positioned in the X- and Y-axis directions temporarily with the use of the positioning pins **(38a).** Wherein, according to the relationship as described above between the pitch diameter and the clearance of the positioning pins **(38a),** the fixed scroll **(34)** is positioned in the θ direction sufficiently accurately, and accordingly, the positioning pins **(38a)** serve as final positioning means for positioning in the θ direction.

[0080] In a fourth setup step shown in FIG. **15,** the fixed scroll **(34)** is fastened to the housing **(31)** by means of the bolts **(38b)** with the positioning pins **(38a)** inserted in the positioning holes **(34c, 36c)** to fixed the fixed scroll **(34)** provisionally.

[0081] In a fifth setup step shown in FIG. **16,** the positioning pins **(38a)** are taken off. Thus, all the steps for setup are completed, and then, the assembly **(11)** is conveyed to a centering/assembling facility (the positioning apparatus **(40)**), as shown in FIG. **17.** In FIG. **17,** the centering/assembling facility **(40)** is simplified.

[0082] Steps for centering will be described next.

[0083] FIG. **18** shows the state where the assembly **(11)** is conveyed to the centering/assembling facility **(40).** Suppose that this state serves as a first centering step. In the first centering step, the assembly **(11)** is placed on the pedestal **(46)** together with the conveyance pallet **(95)** with the housing **(36)** located up (the conveyance pallet **(95)** is omitted in FIG. **3** and FIG. **7),** and various members are on standby around the assembly **(11),** such as the pressing mechanism **(56),** the cramp mechanism **(63),** the striking units **(70),** the rotary encoder **(53)** and the coupling **(55),** the position detection mechanisms **(65),** and the phase detection mechanism **(90).** A nut runner **(97),** the feeder connector **(42),** and the like (not shown in FIG. **3)** are on standby therearound in addition. The drawings following FIG. **18** show operation images of the respective steps and have no difference in function from FIG. **3** and FIG. **7** though detailed specific structures of the cramp mechanism **(63),** the striking units **(70),** and the like are slightly different from those in FIG. **3** and FIG. **7.** Therefore, the operation will be described below with reference to the images.

[0084] In the state that the assembly **(11)** is placed on the pedestal **(46),** the lower end of the body member **(16)** (or the conveyance pallet **(95))** is fitted inside the guide member **(50)** so as to position the lower end face of the crank shaft **(20)** above the through hole **(52)** and so as to allow the oil pickup **(20a)** to protrude downward from the through hole **(52),** as shown in FIG. **3** and FIG. **7.**

[0085] In a second centering step shown in FIG. **19,** the cramp head **(64)** of the cramp mechanism **(63)** is allowed to push the outer peripheral face of the main body **(16)** of the assembly **(11)** to fix the assembly **(11)** from the surrounding thereof, and the feeder terminal **(19)** is connected to the feeder connecter **(42).** The rotating shaft **(53a)** of the rotary encoder **(53)** is connected to the oil pickup **(20a)** of the crank shaft **(20)** by means of the coupling **(55),** and the air cylinder **(57)** of the pressing mechanism **(56)** is operated to press the fixed scroll **(34)** to the housing **(36)** of the assembly **(11).**

[0086] In a third centering step shown in FIG. **20,** the nut runner **(97)** is lowered to loosen the bolts **(38b).** Because, with the bolts **(38b)** fastened, the striking units **(70)** cannot move the fixed scroll **(34)** (for position adjustment) thereafter.

[0087] After the bolts **(38b)** are loosened, a fourth centering step shown in FIG. 21 is performed. In the fourth step, the nut runner **(97)** is raised, and the laser displacement gauge **(91)** of the phase detection mechanism **(90)** advances. In this time point, the sensor **(92)** of the laser displacement gauge **(91)** is located above the notches **(34b)** of the fixed scroll **(34)** (see FIG. **9).**

[0088] Then, in a fifth centering step shown in FIG. **22,** the driver **(82)** shown in FIG. **7** allows the compressor motor **(25)** to be conducted through the inverter **(81)** to cause the crank shaft **(20)** to rotate at a constant low rotation speed, for example, approximately four rotations per one second, and the laser displacement gauge **(91)** detects the outer peripheral protrusions **(31b)** of the orbiting scroll **(31)** through the notches **(34b)** of the fixed scroll **(34).** Then, the driver **(82)** detects the phase of the crank shaft **(20),** that is, the phase of the orbiting scroll **(31)** on the basis of the position of the outer peripheral protrusions **(31b)** and the rotation position signal of the rotary encoder **(53).**

[0089] When detection of the phase of the orbiting scroll **(31)** is finished, a sixth centering step shown in FIG. **23** is performed. In the sixth step, the laser displacement gauge **(91)** of the phase detection mechanism **(90)** is retreated while the striking units **(70)** are allowed to advance. Further, the electric micrometers **(66)** on the X-axis and the Y-axis, which serve as the position detection mechanisms **(65),** are allowed to advance for detection of the location of the fixed scroll **(34).**

[0090] In a next seventh centering step shown in FIG. **24,** the striking units **(70)** moves and positions the fixed scroll **(34)** while the crank shaft **(20)** and the orbiting scroll **(31)** are rotated by the compressor motor **(25).** To do so, a first centering operation, a second centering operation, and a third centering operation are performed in this order, wherein: the first centering operation is performed in such a way that each end of the movable range in the X-axis direction of the fixed scroll **(34)** is once detected and the fixed scroll **(34)** is positioned at the center therebetween; the second centering operation is performed in such a way that each end of the movable range of the fixed scroll **(34)** in the Y-axis direction is detected next and the fixed scroll **(34)** is positioned at the center therebetween; and the third centering operation is performed in such a way that each end of the movable range of the fixed scroll **(34)** in the X-axis direction is detected again and the fixed scroll **(34)** is positioned at the center therebetween.

[0091] In each of the above centering operations, the phase or the rotation angle of the fixed scroll **(34)** has been detected, and accordingly, the fixed scroll **(34)** at a predetermined part thereof (where the fixed scroll wrap **(35)** is close to or in contact with the orbiting scroll wrap **(32))** is moved in the minus direction (or the plus direction) on the X-axis first on the basis of the detected phase so that the outer peripheral face of the fixed scroll wrap **(35)** separates from the inner peripheral face of the orbiting scroll wrap **(32).** As shown in FIG. **25,** when the right striking unit **(70)** is operated in the state where the orbiting scroll **(31)** is located at the end in the plus direction on the X-axis (right end in the drawing), the impact force exceeds the frictional force to invite rotation of the fixed scroll **(34)** even under restriction of the rotation of the fixed scroll **(34)** by the pressing mechanism **(56),** thereby inviting poor positioning accuracy. The above operation is performed for preventing this phenomenon.

[0092] In view of the foregoing, in the present embodiment, the right striking unit **(70)** in the drawing is operated when the orbiting scroll **(31)** is located at the end in the minus direction on the X-axis (left end in the drawing), as shown in FIG. **26.** Then, whether or not the fixed scroll **(34)** shifts upon inversion of the orbiting scroll **(31)** is judged. Unless shift of the fixed scroll **(34)** is detected, which means that the wraps **(32, 35)** are out of contact with each other yet, striking of the fixed scroll **(34)** and the inversion of the orbiting scroll **(31)** are repeated. On the other hand, upon detection of shift of the fixed scroll **(34),** which means that the wraps **(32, 35)** are in contact with each other, the point of the predetermined part is judged as one end of a movable range of the fixed scroll **(34).** The same operation is performed in the plus direction (or the minus direction) on the X-axis to detect the other end of the movable range of the fixed scroll **(34).** In this way, the contact position of the fixed scroll **(34)** is detected at each two (plural) points in the respective minus directions and the respective plus directions on the X-axis and the Y-axis, and the fixed scroll **(34)** is positioned at the respective centers.

[0093] Details of the first to third centering operations are as follows.

[0094] First in the first centering operation, movement of the fixed scroll **(34)** in the minus direction on the X-axis and inversion of the orbiting scroll **(31)** are repeated to set, as a first contact point in the X-axis direction, the point where contact between the fixed scroll wrap **(35)** and the orbiting scroll wrap **(32)** is detected, and then, movement of the fixed scroll **(34)** in the plus direction on the X-axis and inversion of the orbiting scroll **(31)** are repeated to set, as a second contact point in the X-axis direction, the point where contact between the fixed scroll wrap **(35)** and the orbiting scroll wrap **(32)** is detected. Accordingly, the center between the first contact point and the second contact point is set as the center in the X-axis direction.

[0095] Referring to the second centering operation, movement of the fixed scroll **(34)** in the minus direction on the Y-axis and inversion of the orbiting scroll **(31)** are repeated to set, as a first contact point in the Y-axis direction, the point where contact between the fixed scroll wrap **(35)** and the orbiting scroll wrap **(32)** is detected, and then, movement of the fixed scroll **(34)** in the plus direction on the Y-axis and inversion of the orbiting scroll **(31)** are repeated to set, as a second contact point in the Y-axis direction, the point where contact between the fixed scroll wrap **(35)** and the orbiting scroll wrap **(32)** is detected. Accordingly, the center between the first contact point and the second contact point is set as the center in the Y-axis direction.

[0096] Further, in the third centering operation, movement of the fixed scroll **(34)** in the minus direction on the X-axis and inversion of the orbiting scroll **(31)** are repeated to set, as a first contact point in the X-axis direction, the point where contact between the fixed scroll wrap **(35)** and the orbiting scroll wrap **(32)** is detected, and then, movement of the fixed scroll **(34)** in the plus direction on the X-axis and inversion of the orbiting scroll **(31)** are repeated to set, as a second contact point in the X-axis direction, the point where contact between the fixed scroll wrap **(35)** and the orbiting scroll wrap **(32)** is detected. Accordingly, the center between the first contact point and the second contact point is set as the center in the X-axis direction.

[0097] As described above, in the seventh centering step, after each end of the respective movable ranges in the X-axis direction and the Y-axis direction of the fixed scroll **(34)** is detected, the fixed scroll **(34)** is positioned at the respective centers of the movable ranges. Through the first to third centering operations, the center of the fixed scroll **(31)** can be obtained to lead to positioning of the fixed scroll **(34).**

[0098] During the time when the fixed scroll **(34)** is moved by the striking units **(70)** in the seventh centering step, the direction in which the fixed scroll **(34)** is to be moved is restricted to the X-axis direction and the Y-axis direction by the guide **(41)** of the pressing mechanism **(56),** and the impact force is applied in the direction in which the wraps **(32, 35)** separate from each other in the predetermined part of the fixed scroll **(34)** (where the fixed scroll wrap **(35)** is closed to or in contact with the orbiting scroll wrap **(32)).** Accordingly, the fixed scroll **(34)** is moved in parallel without being rotated.

[0099] After the fixed scroll **(34)** is positioned, an eighth centering step shown in FIG. **27** is performed. In the eighth centering step, the conduction to the compressor motor **(25)** is stopped first to stop each rotation of the crank shaft **(20)** and the orbiting scroll **(34).** Then, the striking units **(70)** and the electric micrometers **(66)** are retreated, and the nut runner **(97)** is lowered to fasten the bolts **(38b),** thereby fastening the fixed scroll **(34)** to the housing **(36).** At the fastening, the fixed scroll **(34)** is positioned accurately.

[0100] Thereafter, the routine proceeds to a ninth centering step shown in FIG. **28.** In the ninth centering step, the nut runner **(97)** is raised, and the rod **(57a)** of the air cylinder **(57)** is retreated to raise the pressing member **(58)** of the pressing mechanism **(56).** Further, the rotary encoder **(53)** and the coupling **(55)** are integrally lowered to be taken off from the oil pickup **(20a)** of the crank shaft **(20).** The cramp mechanism **(63)** is retreated, and the feeder connector **(42)** is retreated to be taken off from the feeder terminal **(19).**

[0101] Whereby, all the steps for positioning the fixed scroll **(34)** are completed. Then, as shown in FIG. **29,** a work conveying step is performed for conveying the assembly **(11)** out from the positioning apparatus **(40)** as the centering/assembling facility.

-Effects of Embodiment-

[0102] In the present embodiment, the first positioning step of positioning the fixed scroll **(34)** in the θ direction to the housing member **(36)** by means of the positioning pin **(38a)** and the second positioning step of positioning the fixed scroll **(34)** in the X-axis direction and the Y-axis direction after the first positioning step are performed simply, wherein the fixed scroll **(34)** is positioned in the θ direction simply by means of the positioning pin **(38a).** The clearance between the positioning pin **(38a)** and positioning holes **(34c, 36c)** for the positioning pin **(38a)** causes less or no influence of displacement in the θ direction, and accordingly, the fixed scroll **(34)** can be positioned sufficiently accurately in the θ direction. Thereafter, positioning in the X-axis direction and the Y-axis direction is performed to thus achieve accurate mounting of the fixed scroll **(34).** The positioning in the θ direction can be performed by the simple method using the positioning pin **(38a),** thereby preventing elongation of the cycle time required for positioning and preventing the mechanisms from being complicated.

[0103] Further, the positioning pins **(38a)** are provided in the outer peripheral part of the fixed scroll **(34)** to reduce the -influence of displacement in the θ direction of the fixed scroll **(34),** which is caused due to the presence of the clearance, when compared with the case with the positioning pins **(38a)** provided in the inner peripheral part thereof. Thus, the positioning accuracy increases. Further, the two positioning pins **(38a)** rather than three positioning pins facilitate positioning of the fixed scroll **(34),** and even at least two positioning pins **(38a)** can achieve definite positioning.

[0104] Furthermore, in the first positioning step, the fixed scroll **(34)** is positioned in the θ direction to the housing member **(36)** by means of the positioning pin **(38a),** and then, the fixed scroll **(34)** is fixed to the housing member **(36)** by means of the bolts **(38b)** and the positioning pin **(38a)** is taken off. Then, in the second positioning step, fixing by the bolts **(38b)** is released with the fixed scroll **(34)** pressed to the housing member **(36),** and then, the fixed scroll **(34)** is positioned in the X-axis direction and the Y-axis direction. In this method, setting of the fixed scroll **(34)** to the housing member **(36)** by means of the positioning pin **(38a)** can be performed manually as a setup step. In contrast, automation of all the steps complicates the facilities to increase the cost. In the present embodiment, however, facility complication and cost increase can be prevented. Manual setting of the positioning pin **(38a)** in a facility requires alternate operations of manual operation and operation by the facility, which causes waiting time for the operator and waiting time for the facilities to lower the productivity. The present embodiment, however, prevents lowering of the productivity.

[0105] Moreover, in the present embodiment, in the second positioning step, the fixed scroll **(34)** is positioned in the X-axis direction and the Y-axis direction with the phase of the orbiting scroll **(31)** detected, thereby enabling more accurate positioning of the fixed scroll **(34).**

[0106] Still further, in the second positioning step, the phase of the orbiting scroll **(31)** is detected by detecting the to-be-detected part **(31b)** at the outer peripheral part of the orbiting scroll **(31)** through the notch **(34b)** of the fixed scroll **(34).** In other words, the phase of the orbiting scroll **(34)** can be detected during positioning to eliminate the need for phase detection prior to the positioning, thereby facilitating the method.

[0107] In addition, in the second positioning step of the present embodiment, the impact force is applied to the fixed scroll **(34)** with the fixed scroll **(34)** pressed to the housing member **(36)** to move the fixed scroll **(34).** This achieves positioning by fine adjustment of the position of the fixed scroll **(34).** Hence, the positioning accuracy increases.

<Other Embodiments>

[0108] The above embodiment may have any of the following aspects.

[0109] For example, in the above embodiment, the air cylinder **(100)** is used for advancing/retreating the head **(74)** of the striking units **(70),** but a crank mechanism or a cam mechanism may be used instead. The striking units **(70)** as means for moving the fixed scroll **(34)** may not necessarily include the piezoelectric elements **(73),** and another elements may be used, such as a moving mechanism **(75)** using a feeding mechanism by means of ball screws. In other words, the moving mechanism **(75)** may be any mechanism only if it can adjust the position of the fixed scroll **(34).**

[0110] Further, the fixed scroll **(34)** is positioned with the orbiting scroll **(31)** rotated in the above embodiment. The fixed scroll **(34)** may be positioned by striking of the fixed scroll **(34)** and inverting the orbiting scroll **(31)** in the X-axis direction and the Y-axis direction with the orbiting scroll **(31)** stopped at a predetermined position.

[0111] In addition, the laser displacement gauge **(91)** detects the phase of the orbiting scroll **(31)** through the notches **(34b)** of the orbiting scroll **(31)** after the fixed scroll **(34)** is mounted to the assembly **(11).** Alternatively, the phase detection mechanism **(90),** such as a laser displacement gauge may detect the eccentric portion **(22)** of the crank shaft **(20)** before the orbiting scroll **(31)** and the fixed scroll **(34)** are mounted to the assembly **(11).**

[0112] In short, the present invention attains simple and accurate positioning of the fixed scroll **(34)** in the θ direction by means of the positioning pins **(38a),** and the other concrete structures may be modified appropriately.

[0113] It should be noted that the above embodiments are essentially preferable examples and are not intended to limit the present invention, the applicable objects thereof, and the usable scope thereof.

Industrial Applicability

[0114] As described above, the present invention is useful for methods for positioning a fixed scroll in assembling a scroll fluid machinery.

Claims

1. A method for positioning, in a process for assembling a scroll fluid machinery **(10),** a fixed scroll **(34)** on the basis of a positional relationship between a wrap **(35)** of the fixed scroll **(34)** and a wrap **(31)** of an orbiting scroll **(31),** comprising:

a first positioning step of positioning, after the orbiting scroll **(31),** a crank shaft **(20)** engaged with the orbiting scroll **(31),** and a housing member **(36)** forming a bearing for the crank shaft **(20)** are combined, the fixed scroll **(34)** in a θ direction to the housing member **(36)** by means of a positioning pin **(38a);** and

a second positioning step of positioning the fixed scroll**(34)** in an X-axis direction and a Y-axis direction after the first positioning step.

2. The fixed scroll positioning method of Claim 1, wherein the positioning pin **(38a)** includes at least two positioning pins **(38a)** at an outer peripheral part of the fixed scroll **(34).**

3. The fixed scroll positioning method of Claim 1, wherein the first positioning step includes a setup step of fixing the fixed scroll **(34)** to the housing member **(36)** by means of fastening means **(38b)** and taking off the positioning pin **(38a)** after the fixed scroll **(34)** is positioned in the θ direction to the housing member **(36)** by means of the positioning pin **(38a),** and

the second positioning step includes a centering step of releasing the fixing by the fastening means **(38)** with the fixed scroll **(34)** pressed to the housing member **(36)** and centering the fixed scroll **(34)** in the X-axis direction and the Y-axis direction.

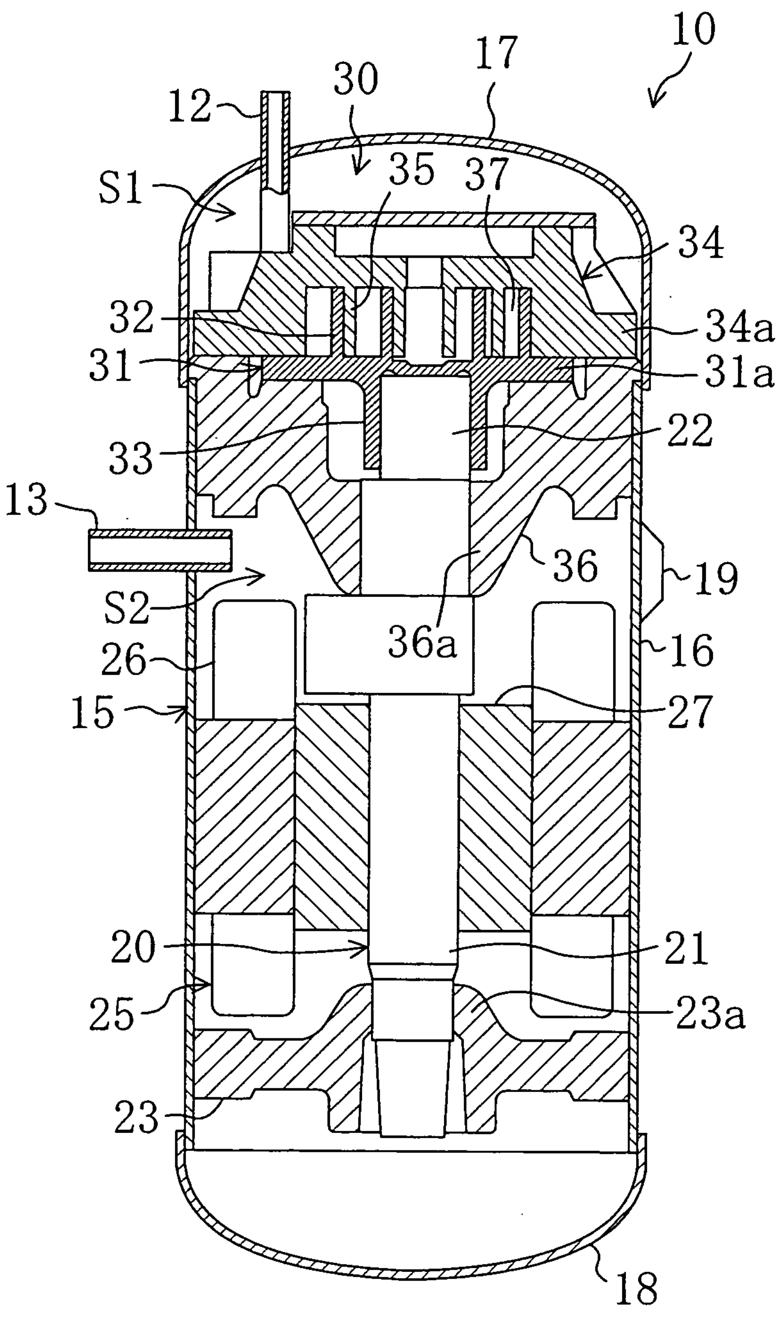
4. The fixed scroll positioning method of Claim 1, wherein in the second positioning step, the fixed scroll **(34)** is positioned with a phase or a rotation position of the orbiting scroll **(31)** detected by a phase detection mechanism **(90).**

5. The fixed scroll positioning method of Claim 4, wherein a notch **(34b)** allowing an outer peripheral part of the orbiting scroll **(31)** to be observed from outside is formed in the fixed scroll **(34),** and

in the second positioning step, the phase of the orbiting scroll **(31)** is detected by detecting a to-be-detected part **(31b)** provided at an outer peripheral part of the orbiting scroll **(31)** through the notch **(34b).**

6. The fixed scroll positioning method of Claim 1, wherein in the second positioning step, the fixed scroll **(34)** is moved by applying impact force to the fixed scroll **(34)** with the fixed scroll **(34)** pressed to the housing member **(36).**

FIG. 1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23a
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18

FIG. 2

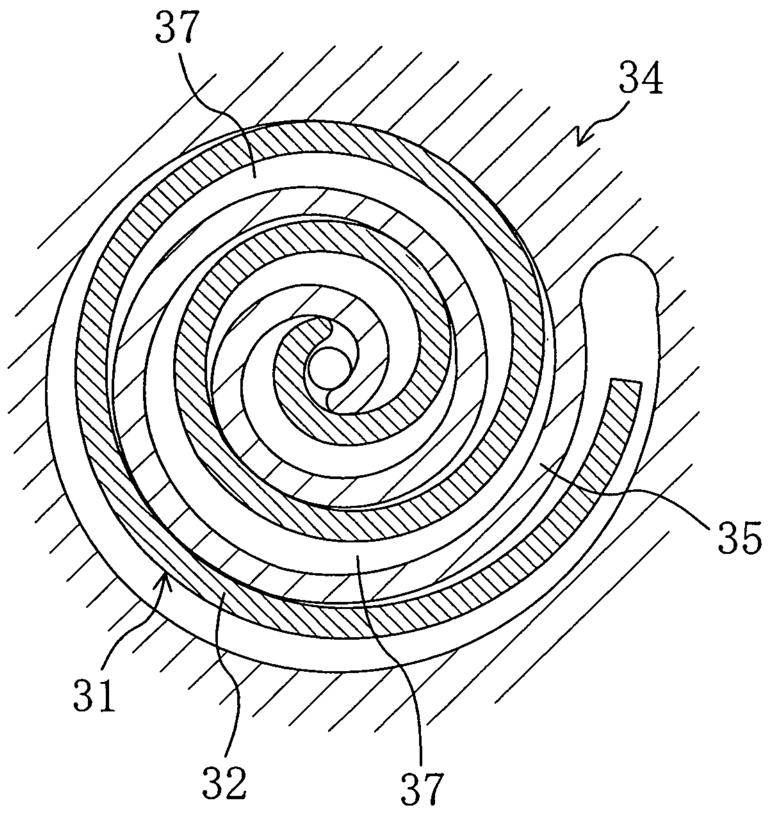
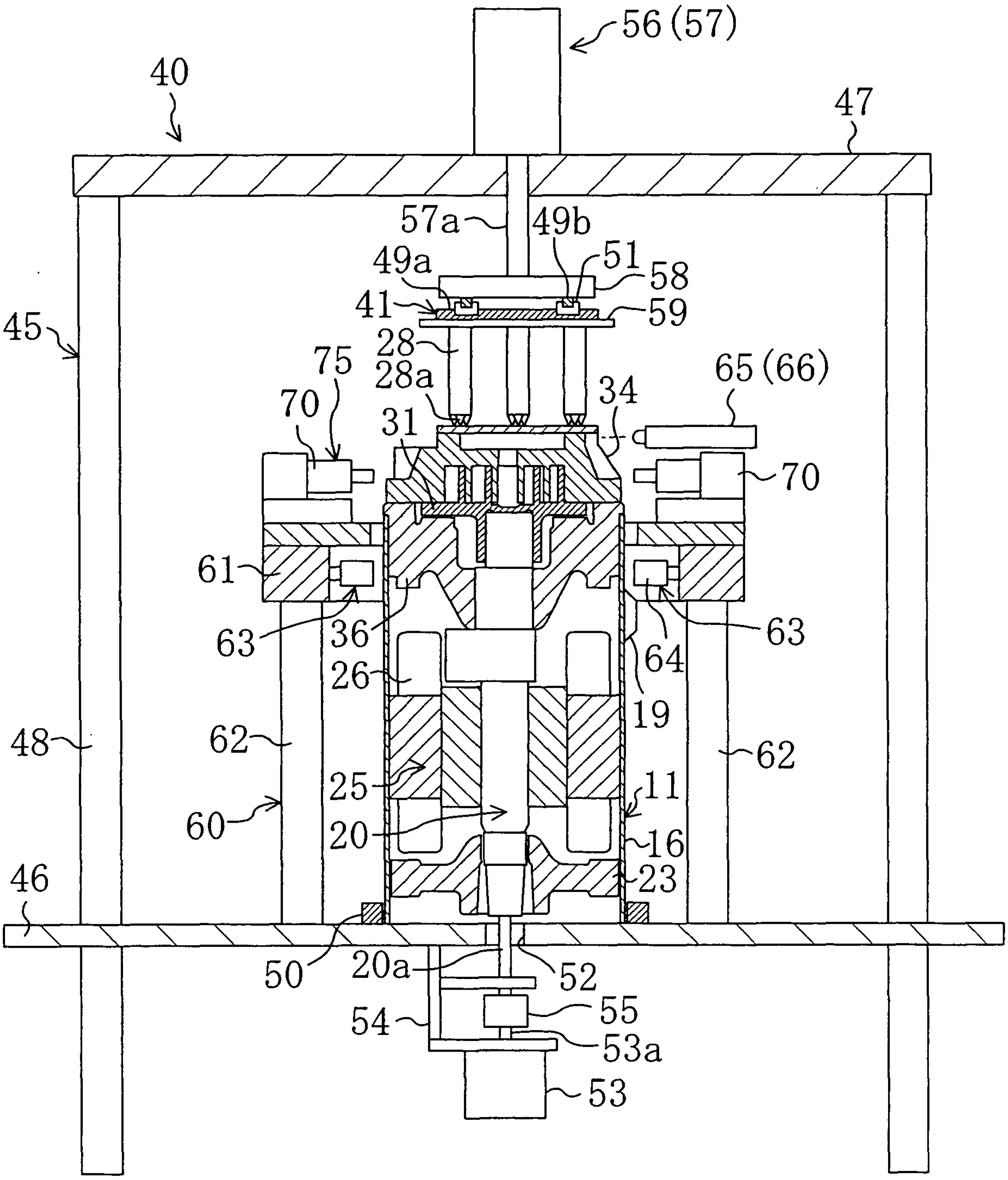


FIG. 3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70
61
63
36
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64
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53a
53

FIG. 4

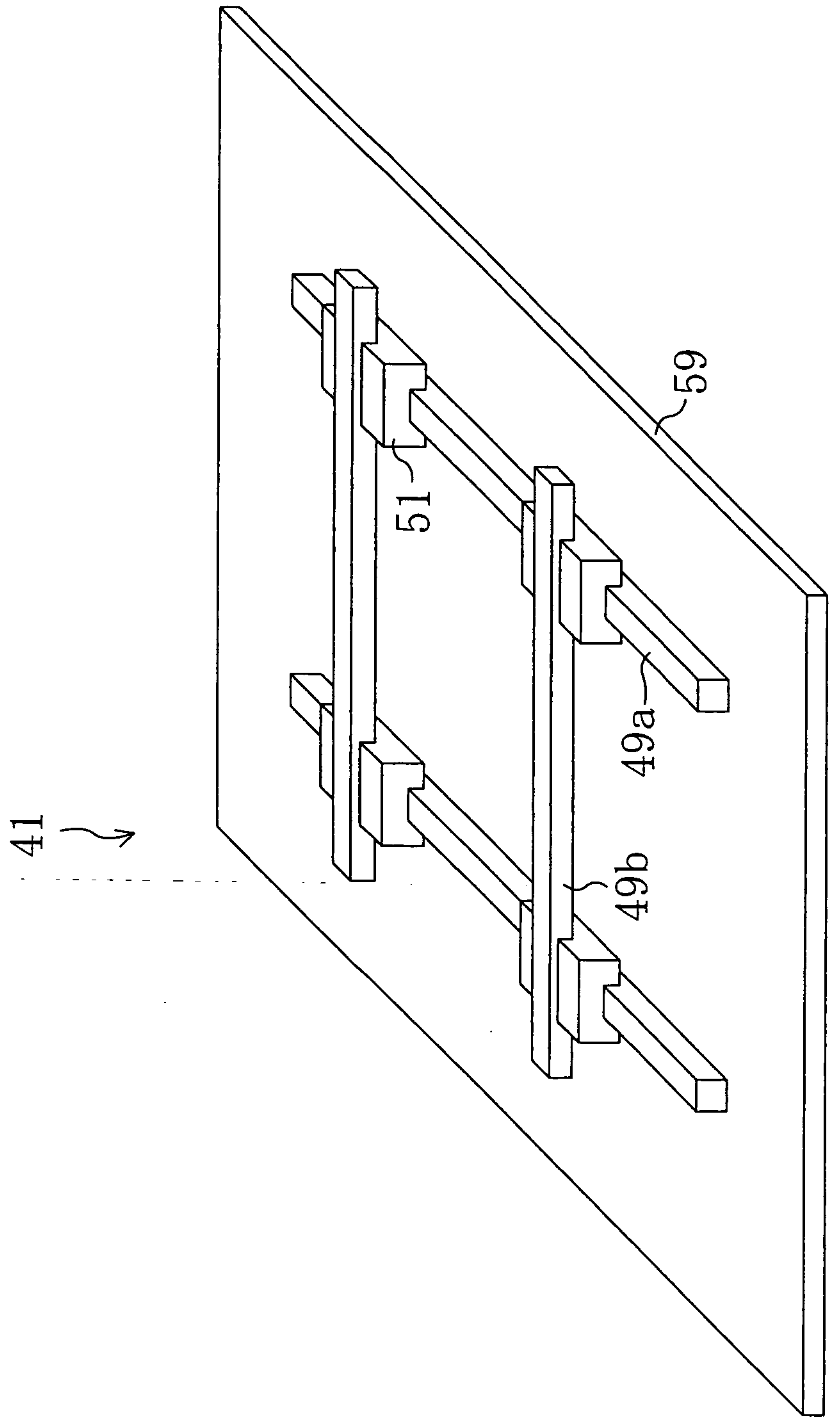


FIG. 5

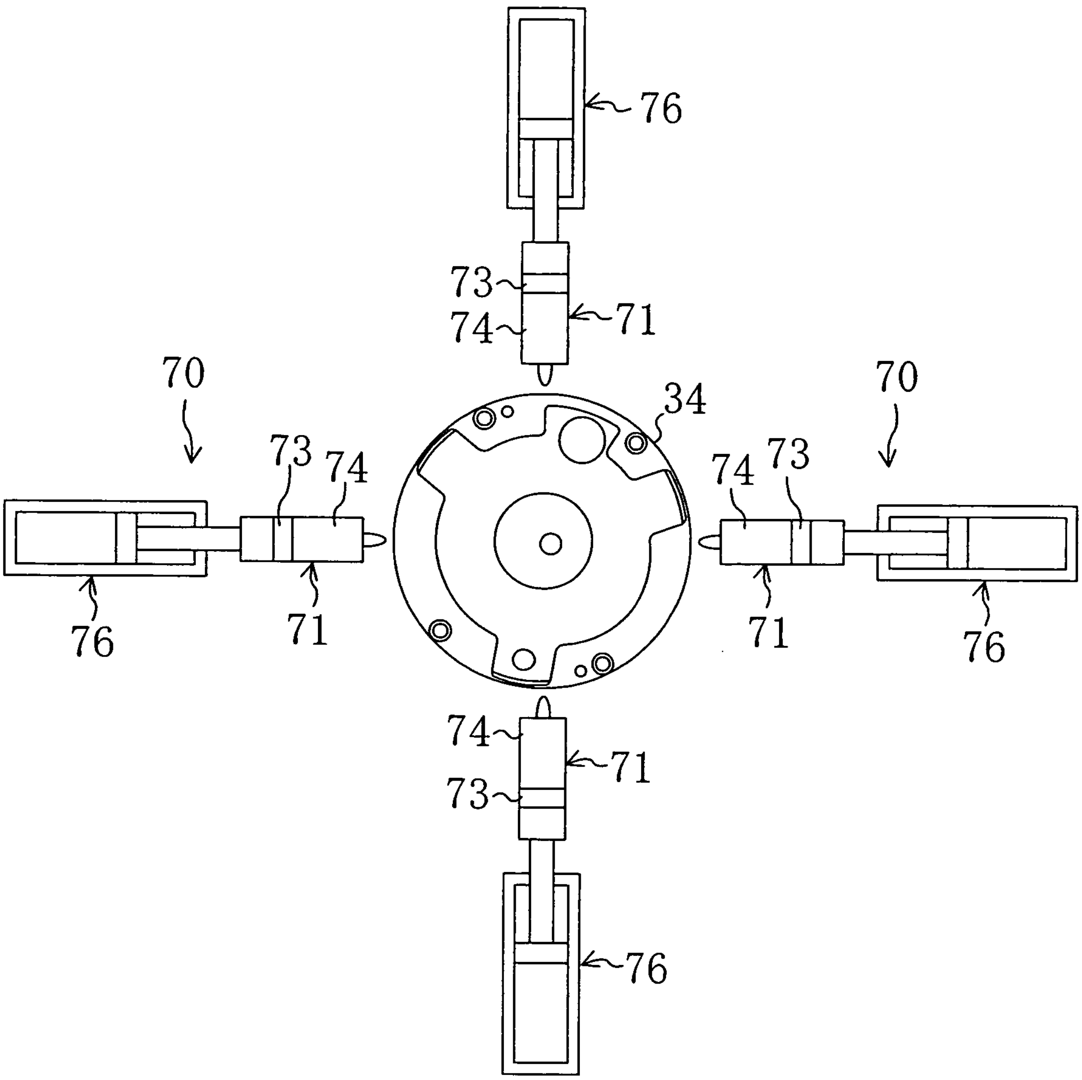
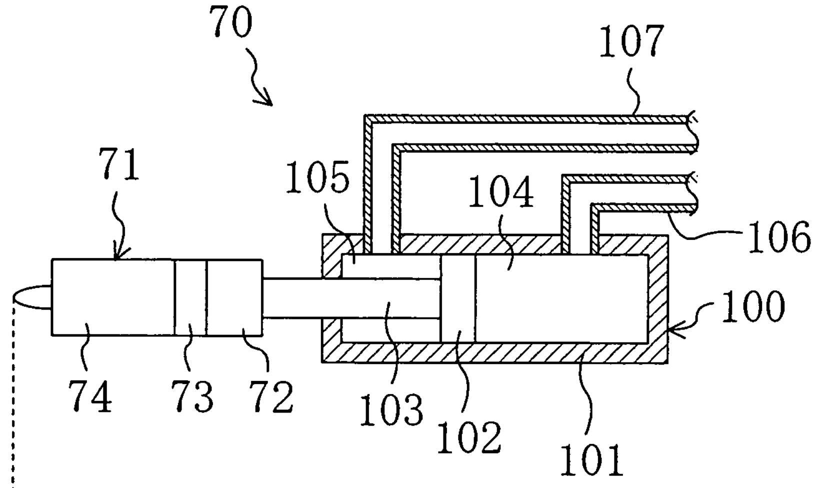


FIG. 6

(A)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102
101

(B)

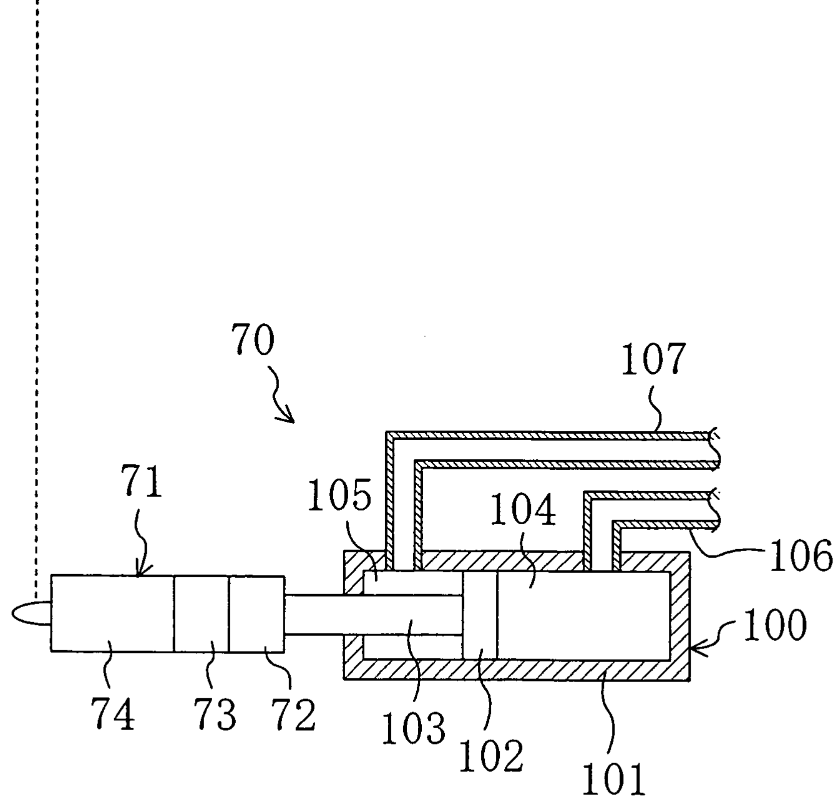
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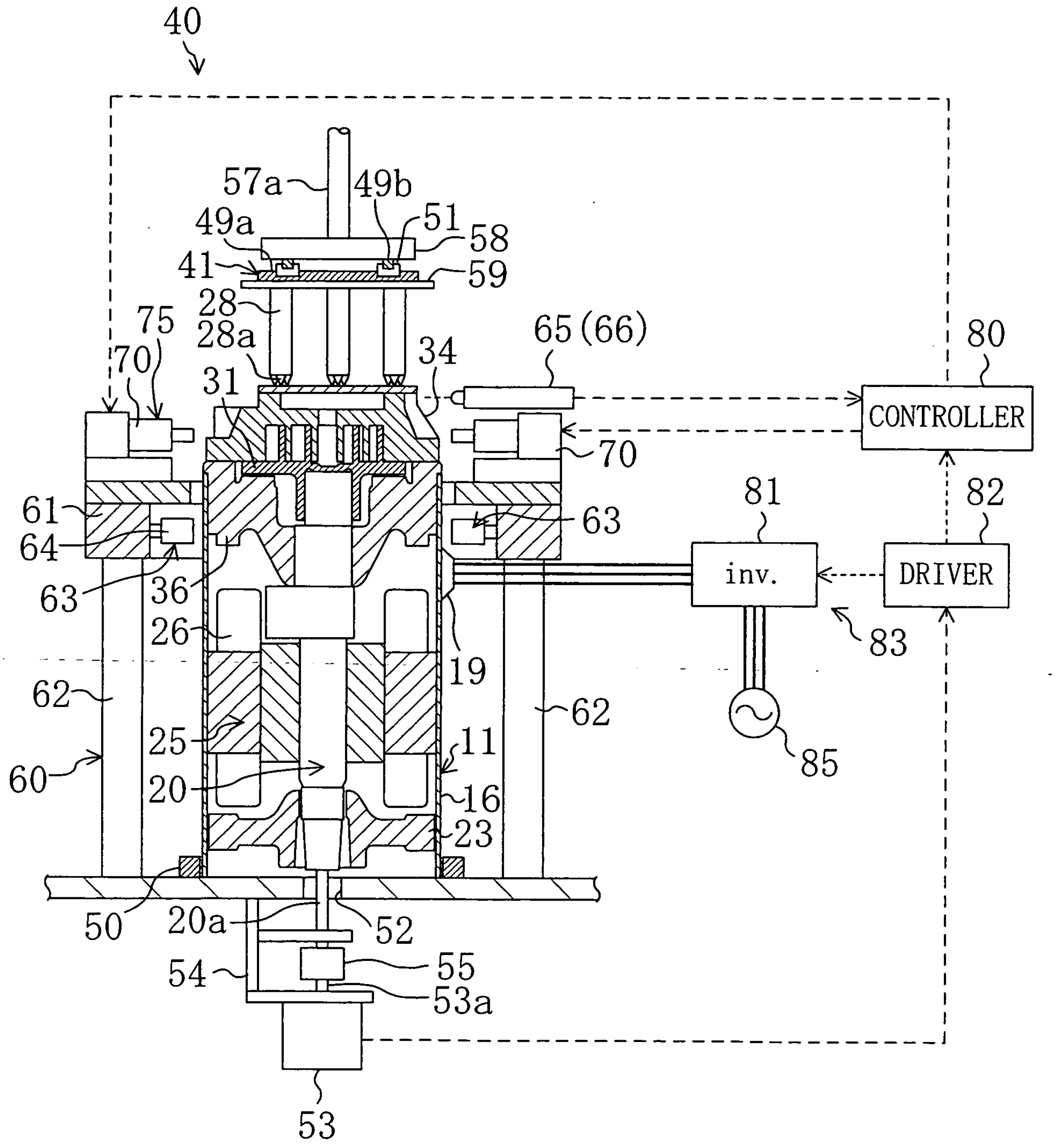
FIG. 7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34
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31
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61
81
82
63
64
inv.
DRIVER
36
63
83
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53a
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FIG. 8

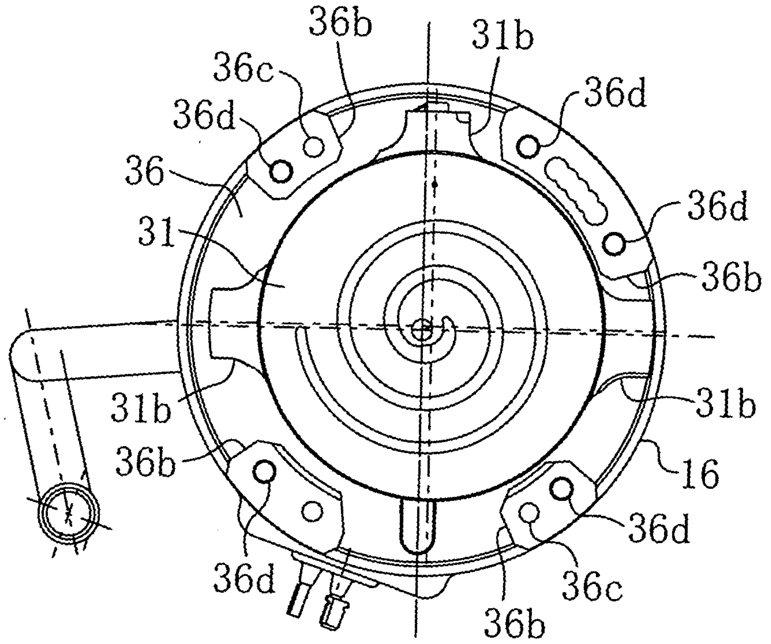
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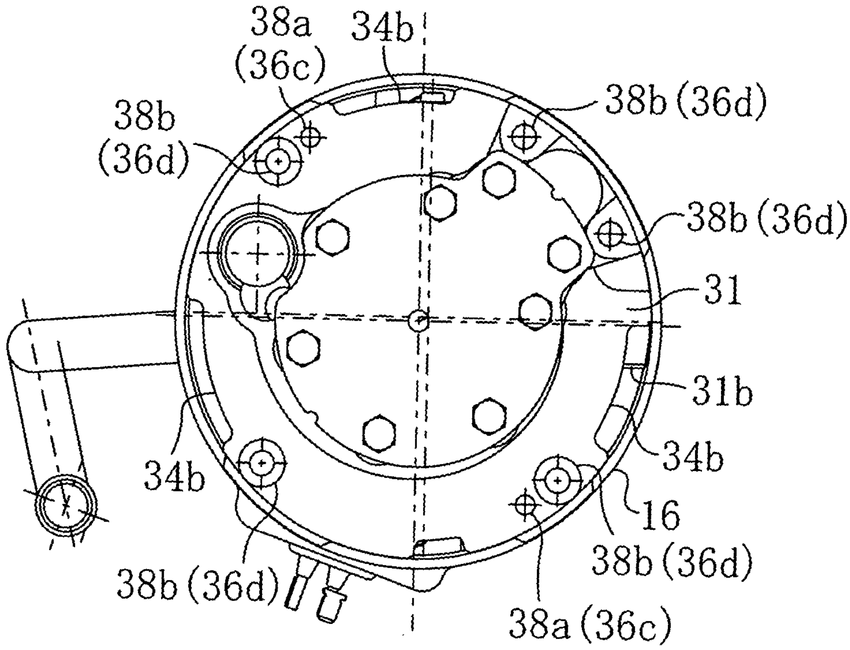
FIG. 9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38b
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38b(36d)
38a(36c)

FIG. 10

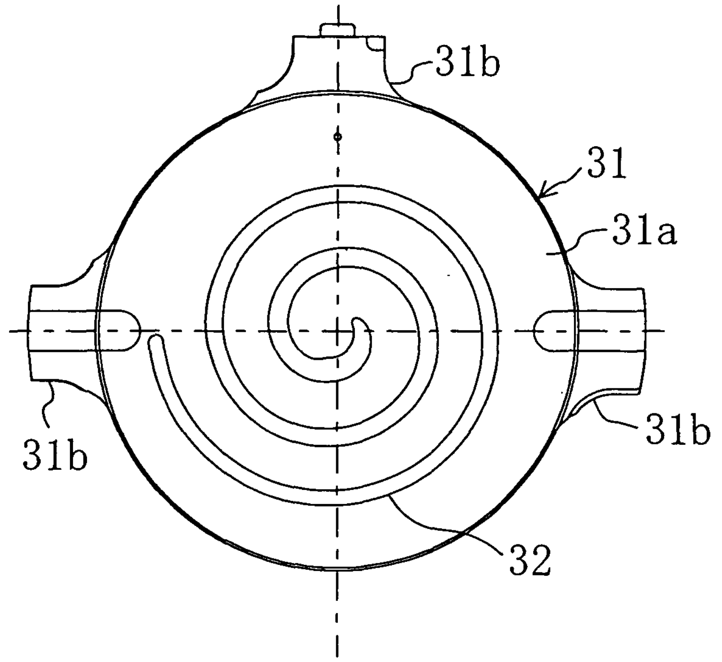
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FIG. 11

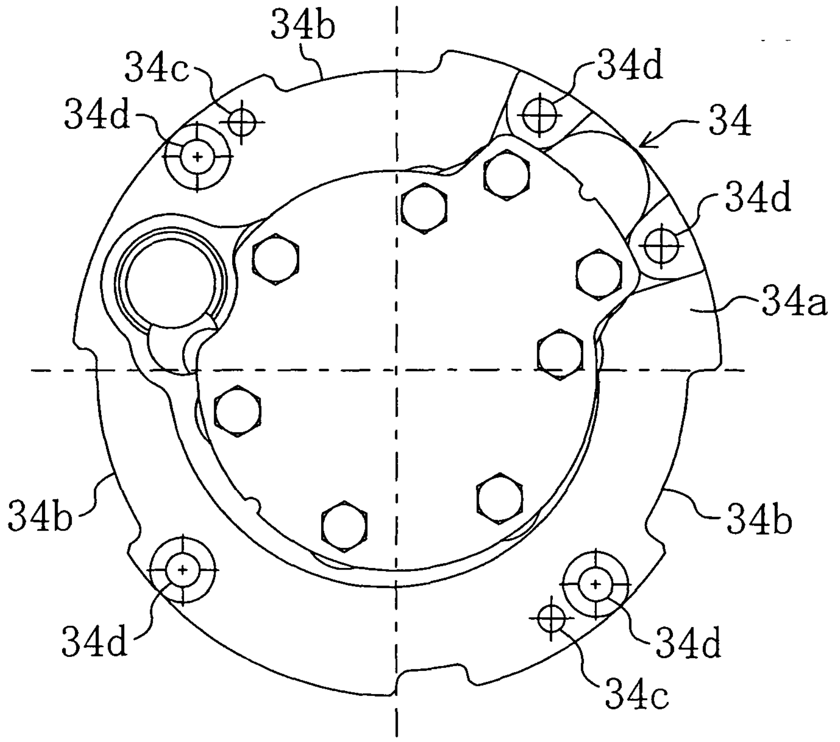
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FIG. 12

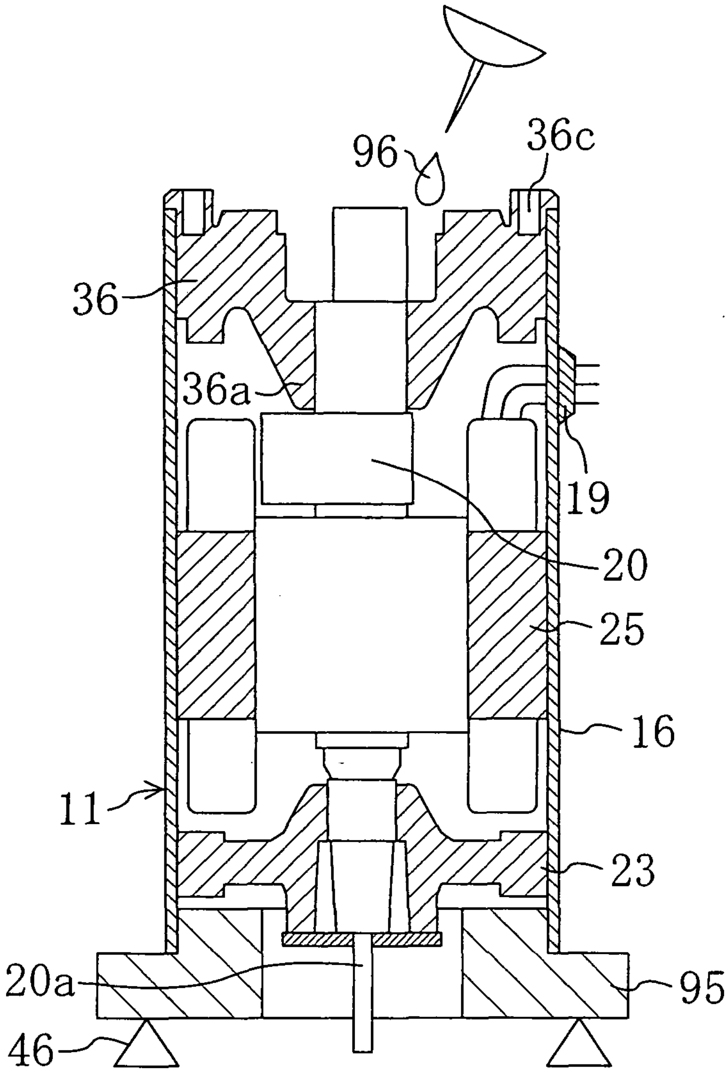


FIG. 13

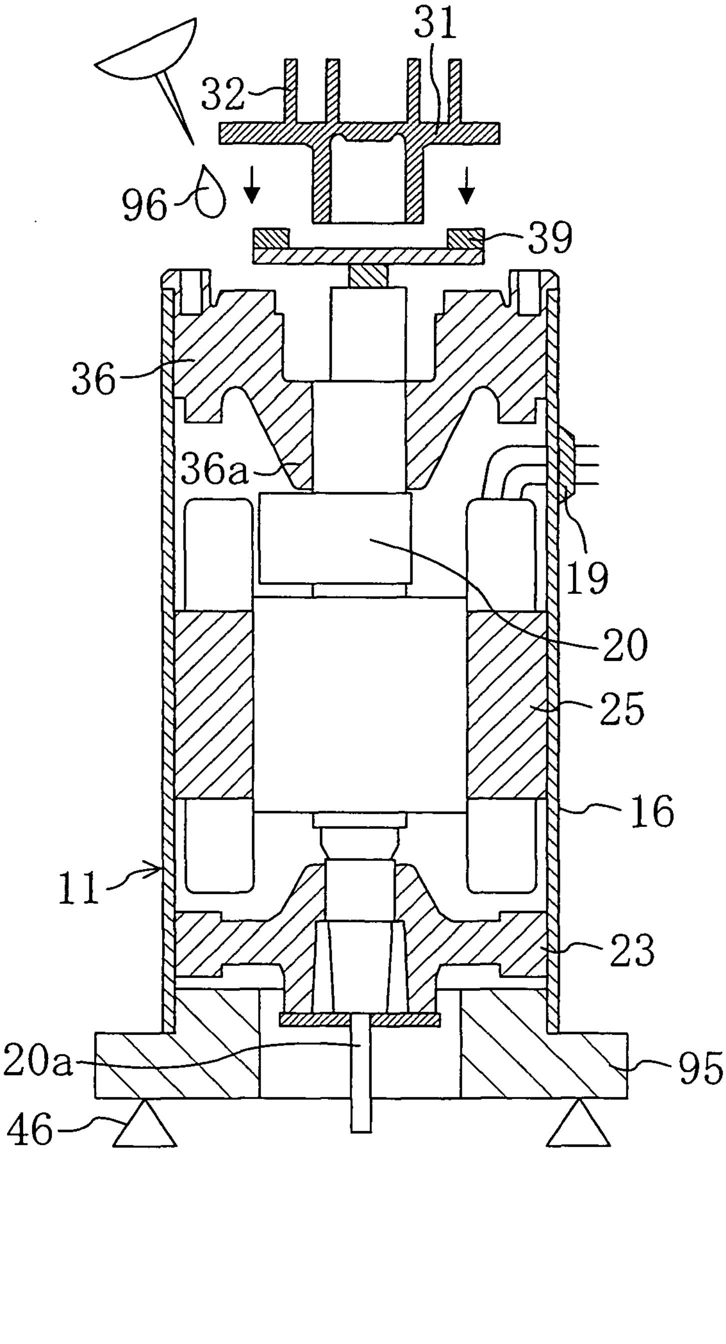


FIG. 14

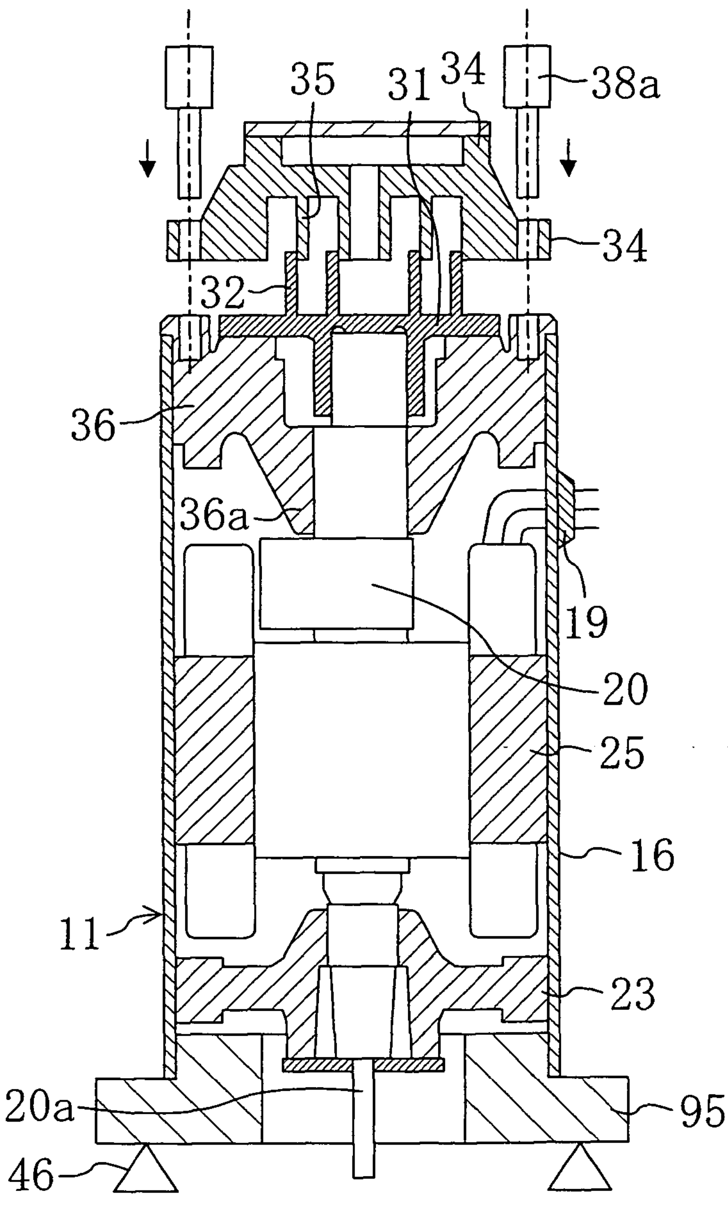


FIG. 15

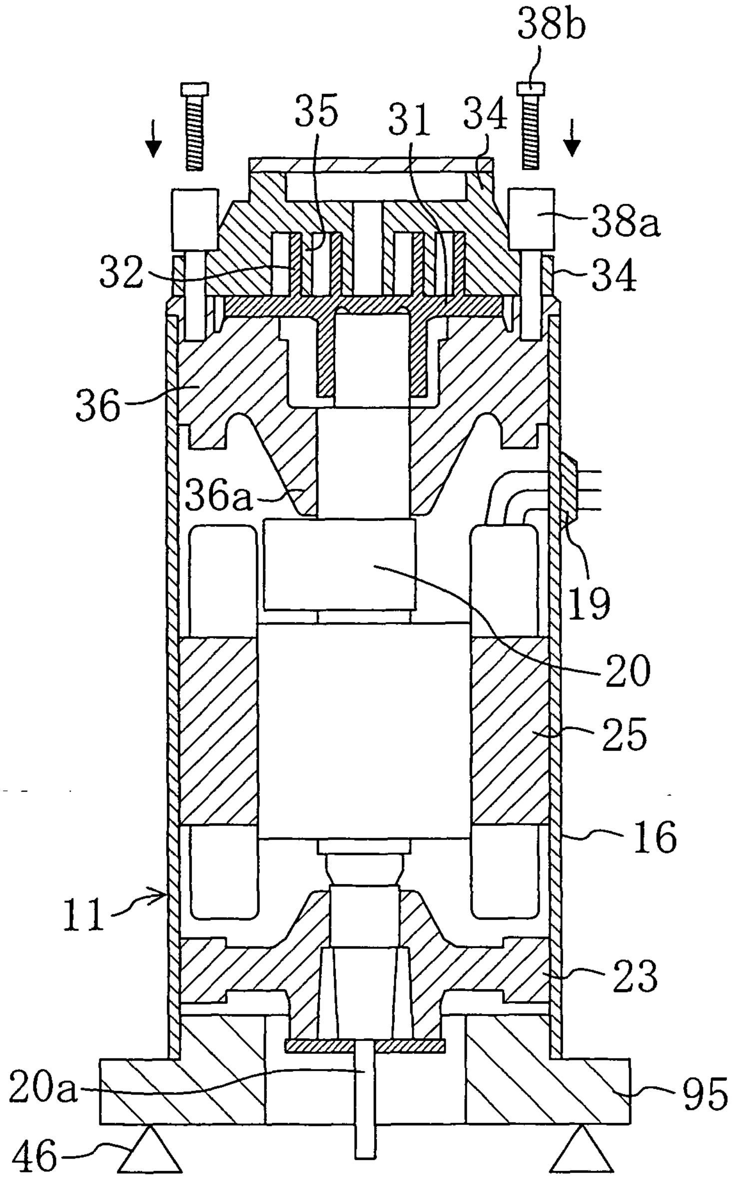
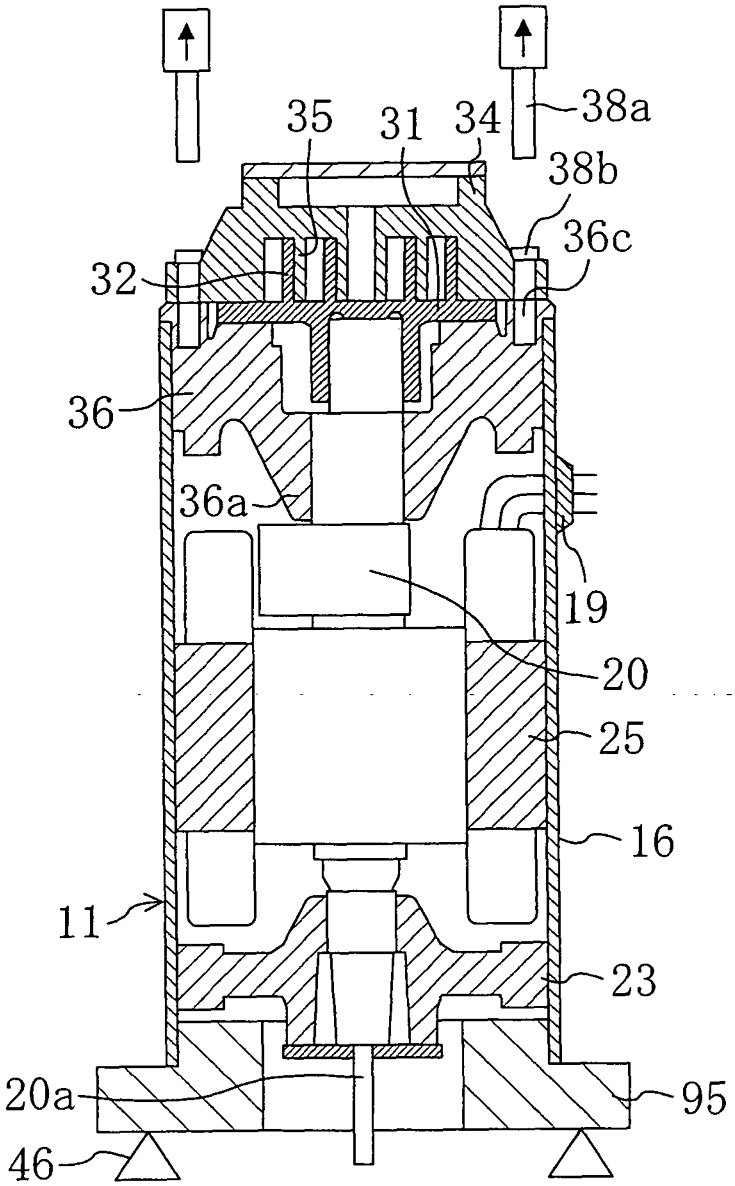


FIG. 16



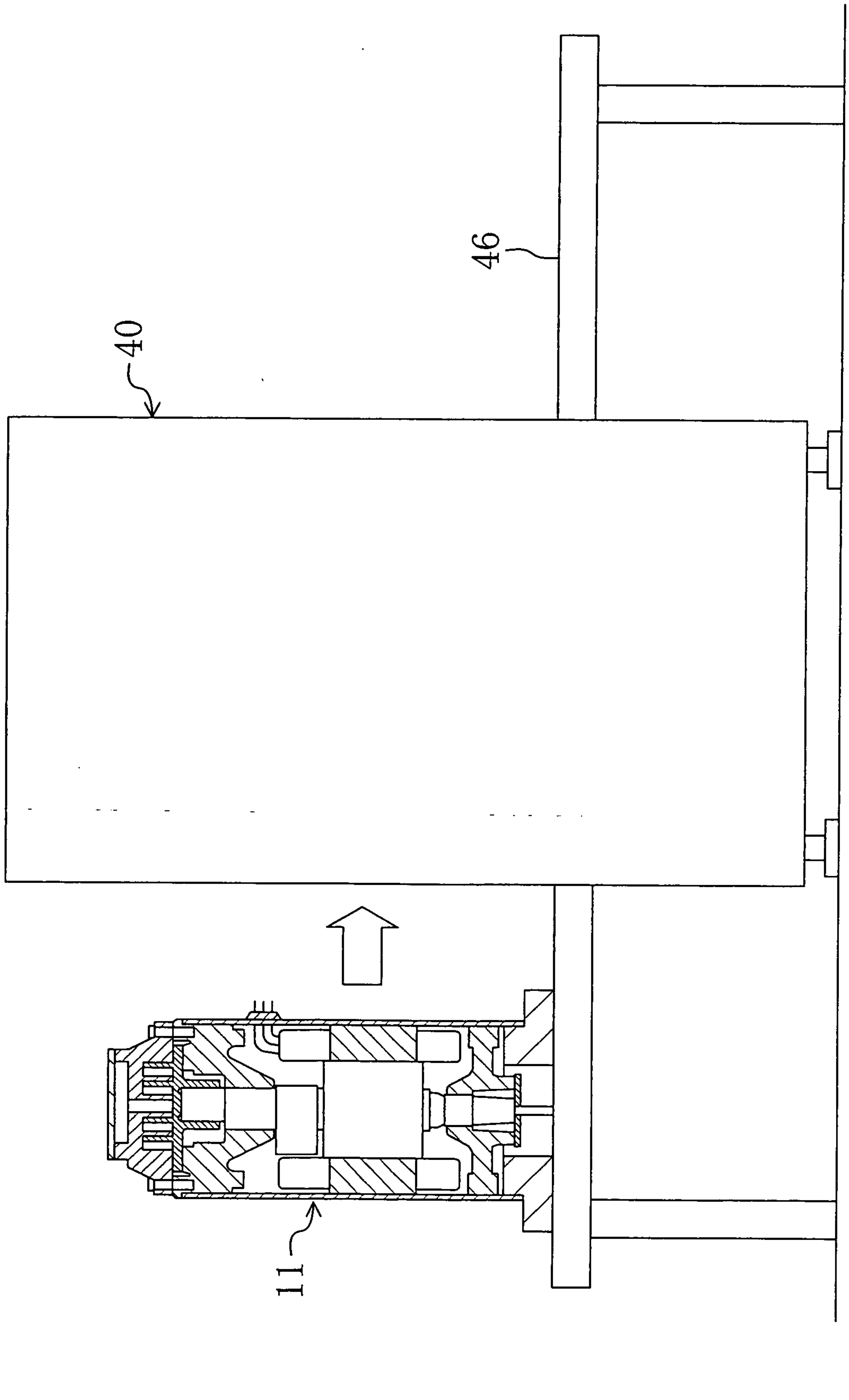


FIG. 17

FIG. 18

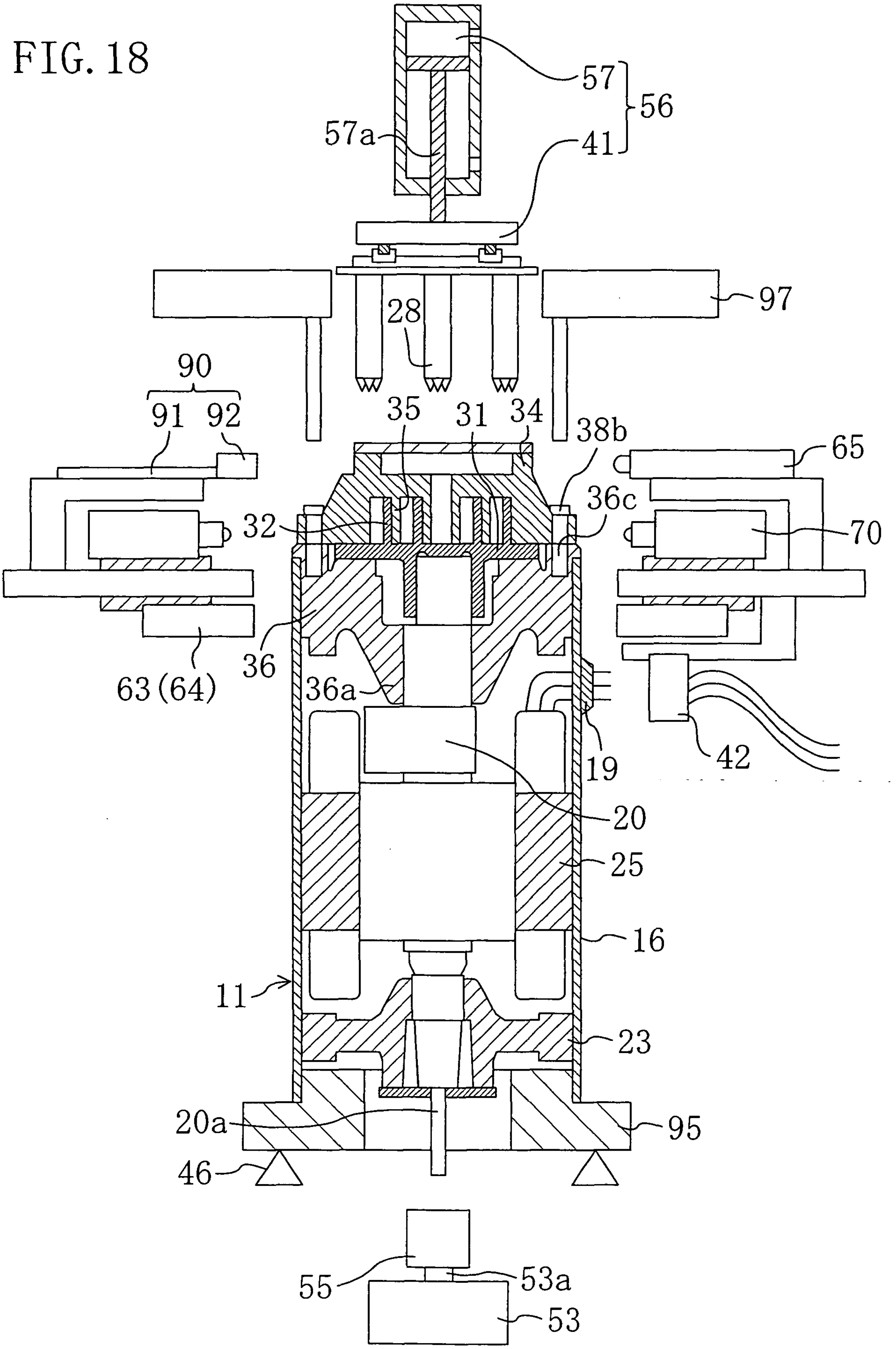

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FIG. 19

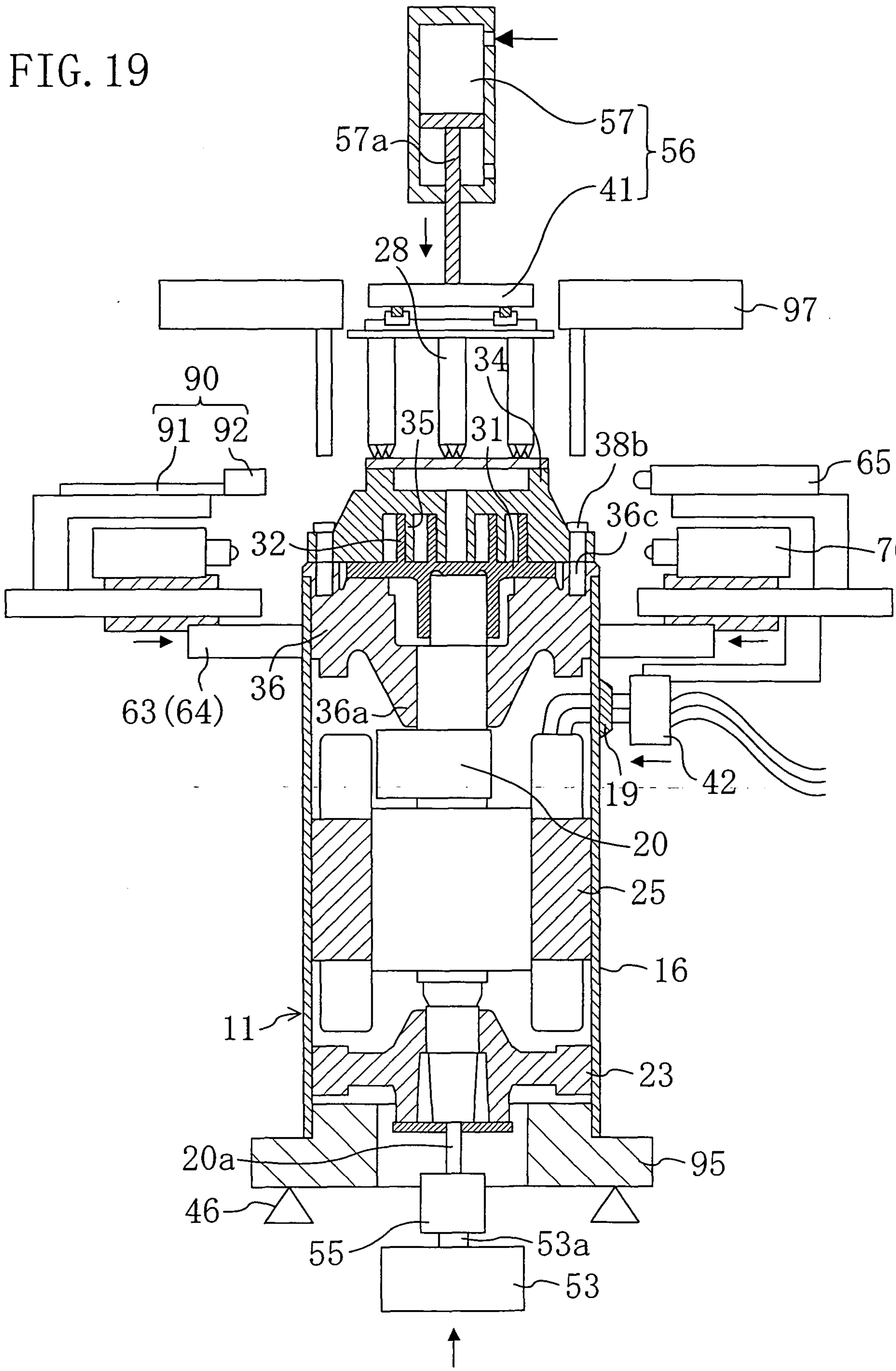
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FIG. 20

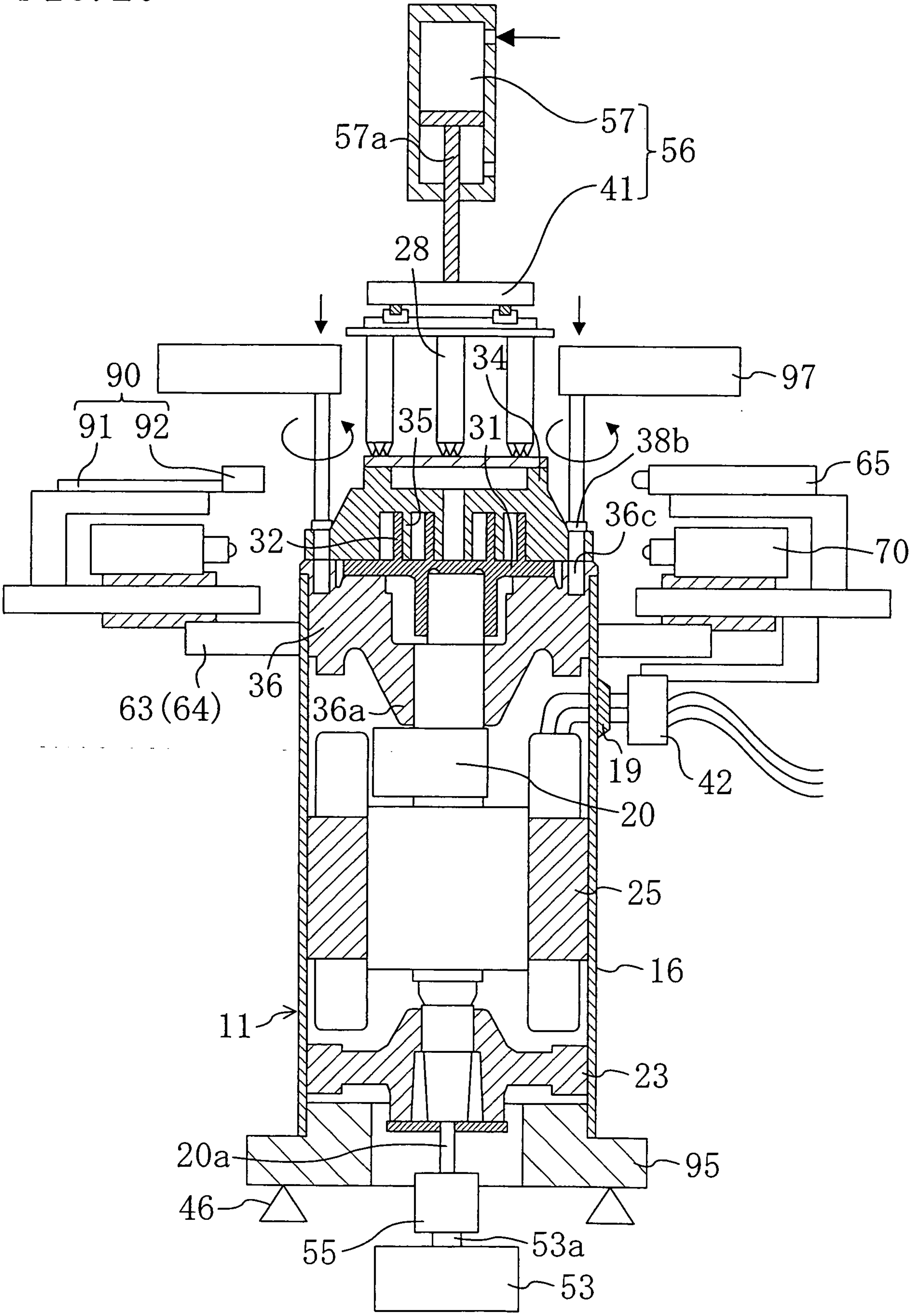
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FIG. 21

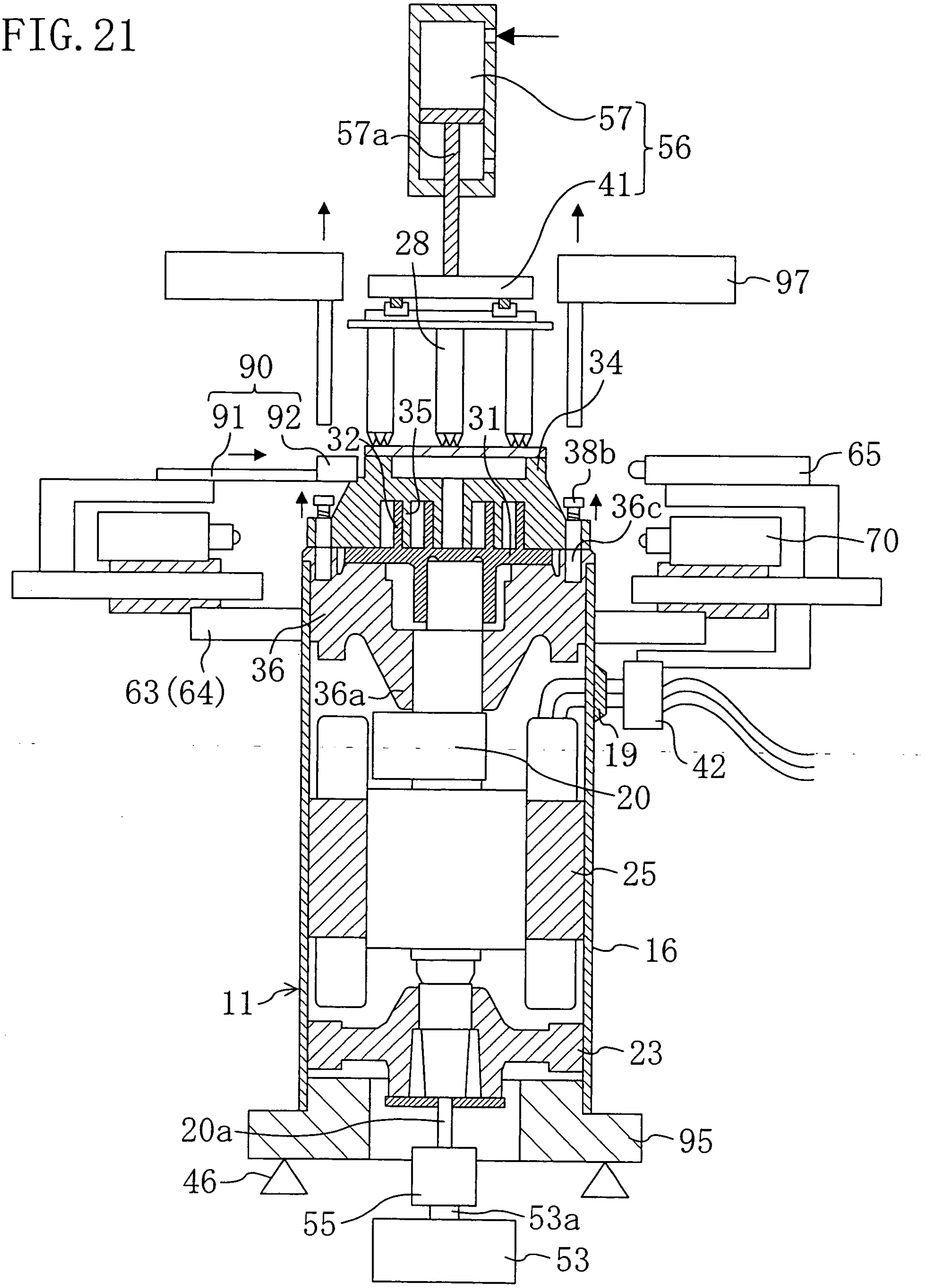
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FIG. 22

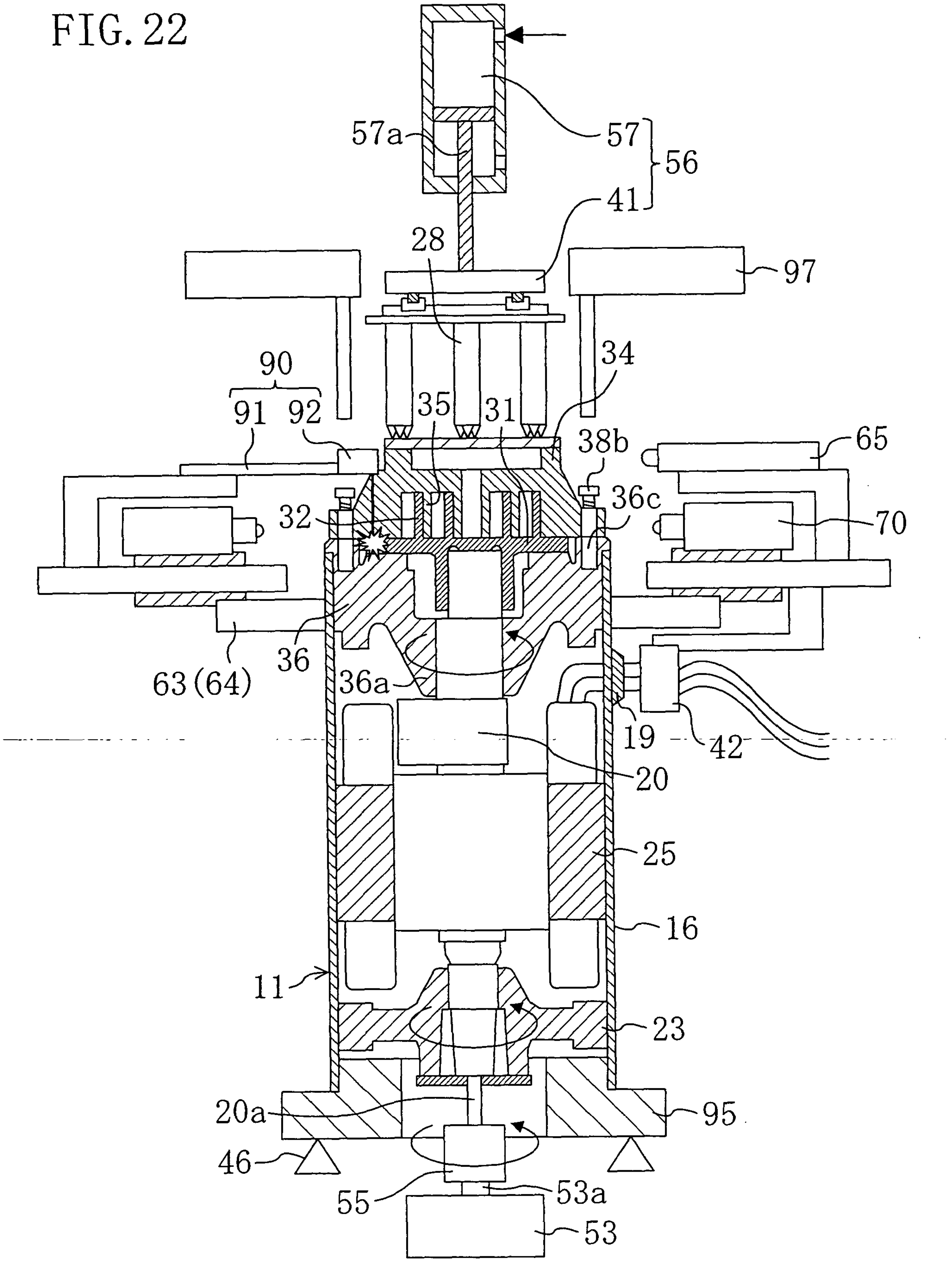
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FIG. 23

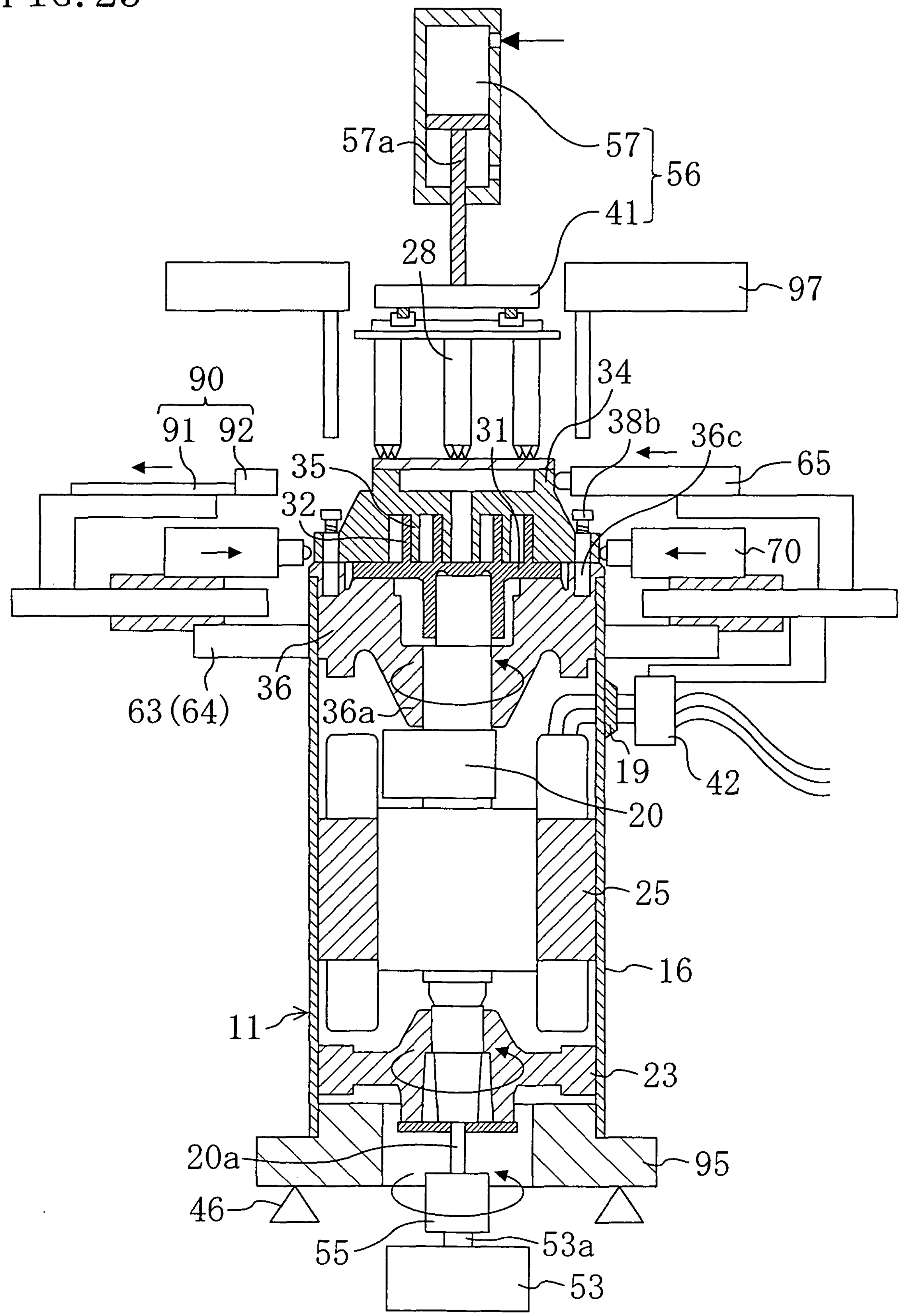
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FIG. 24

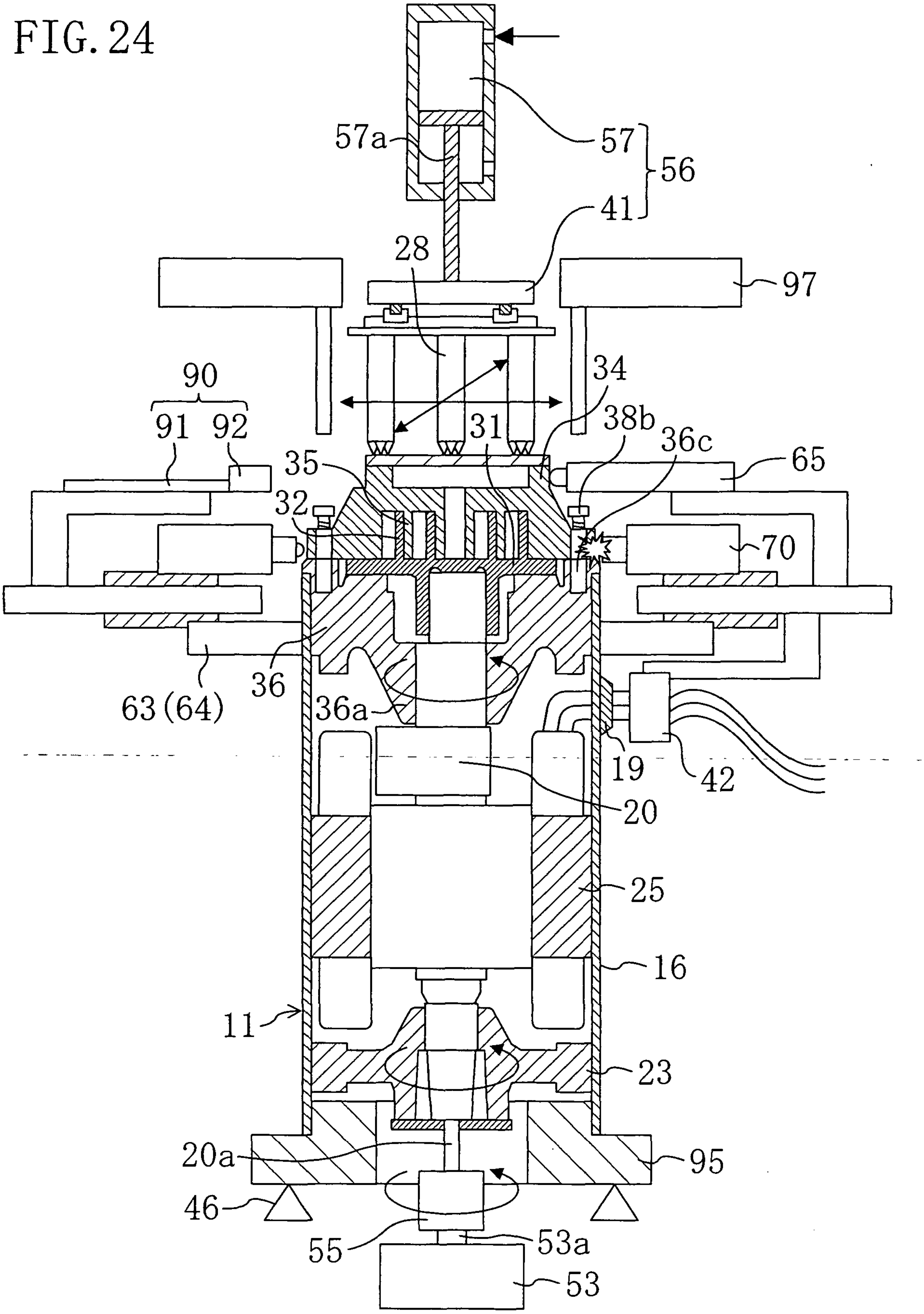
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FIG. 25

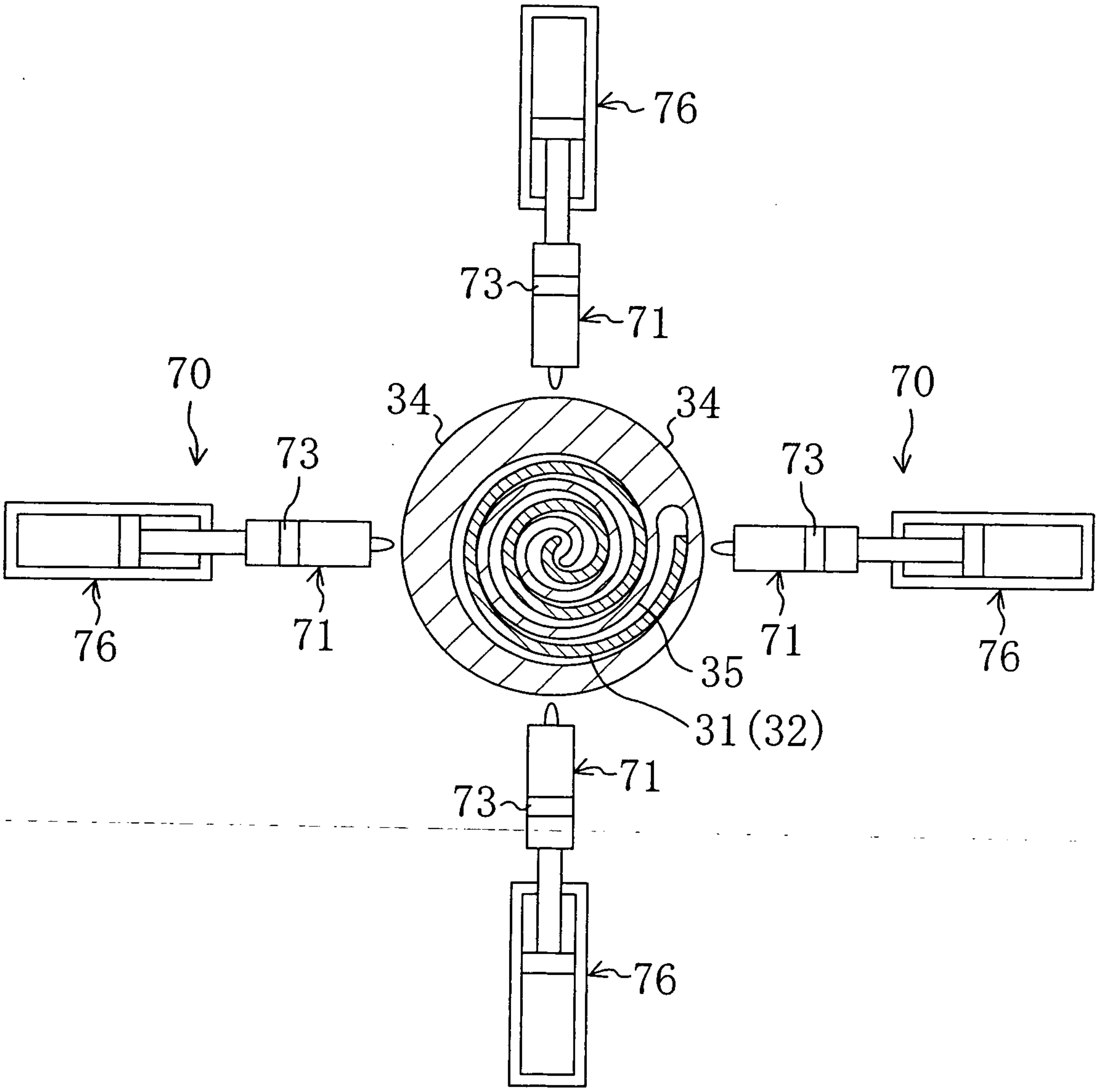

FIG. 26

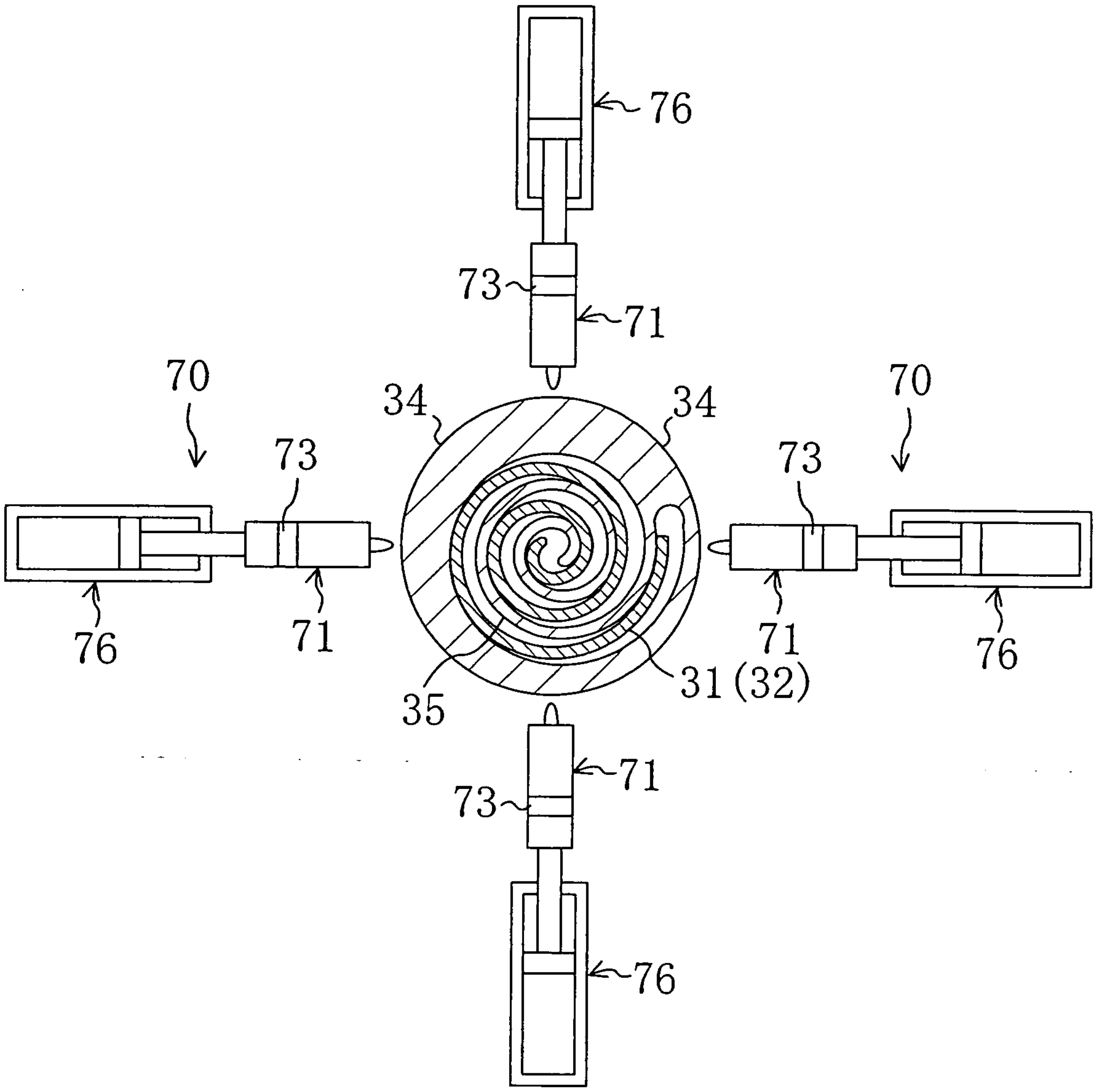

FIG. 27

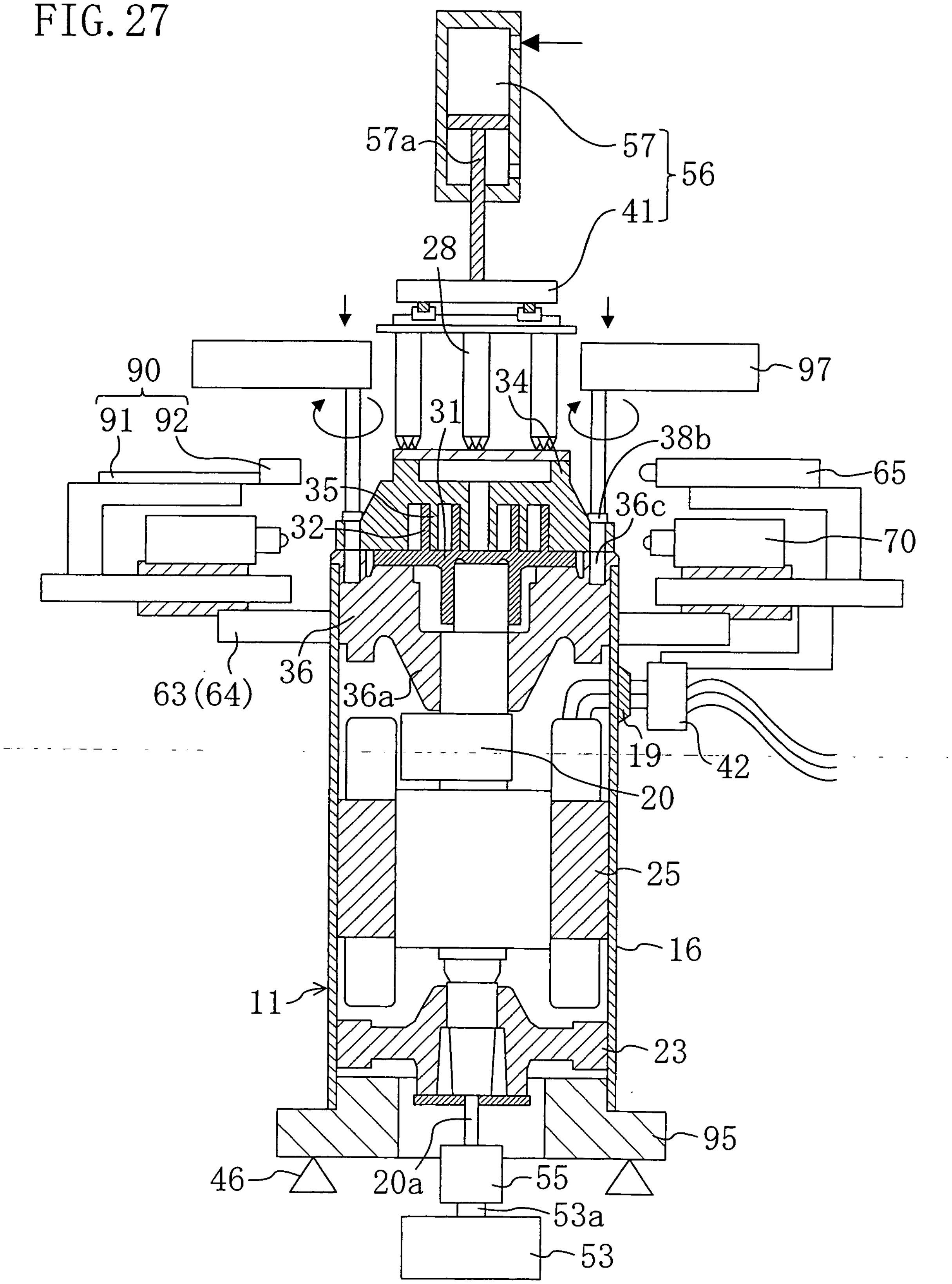
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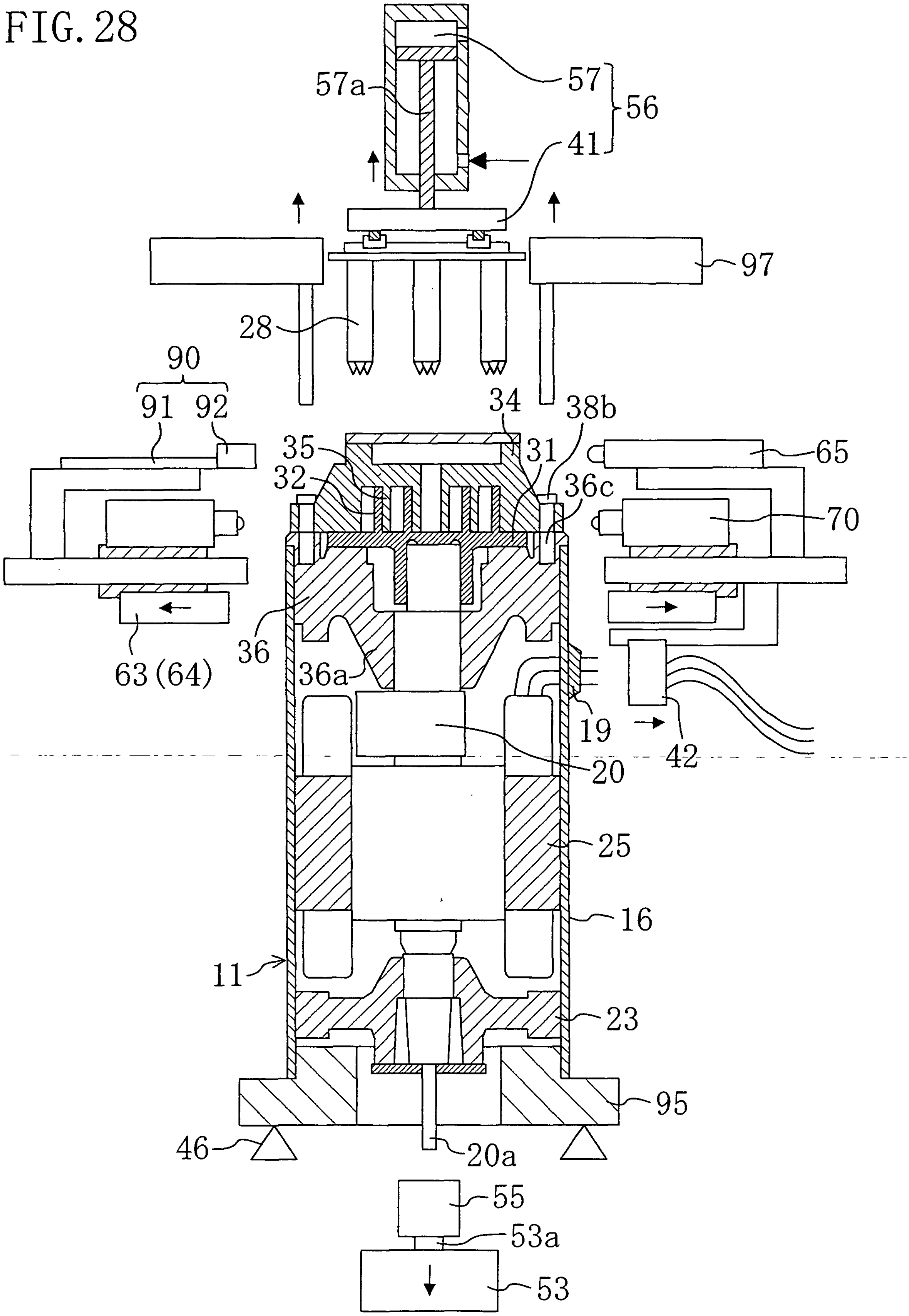
FIG. 28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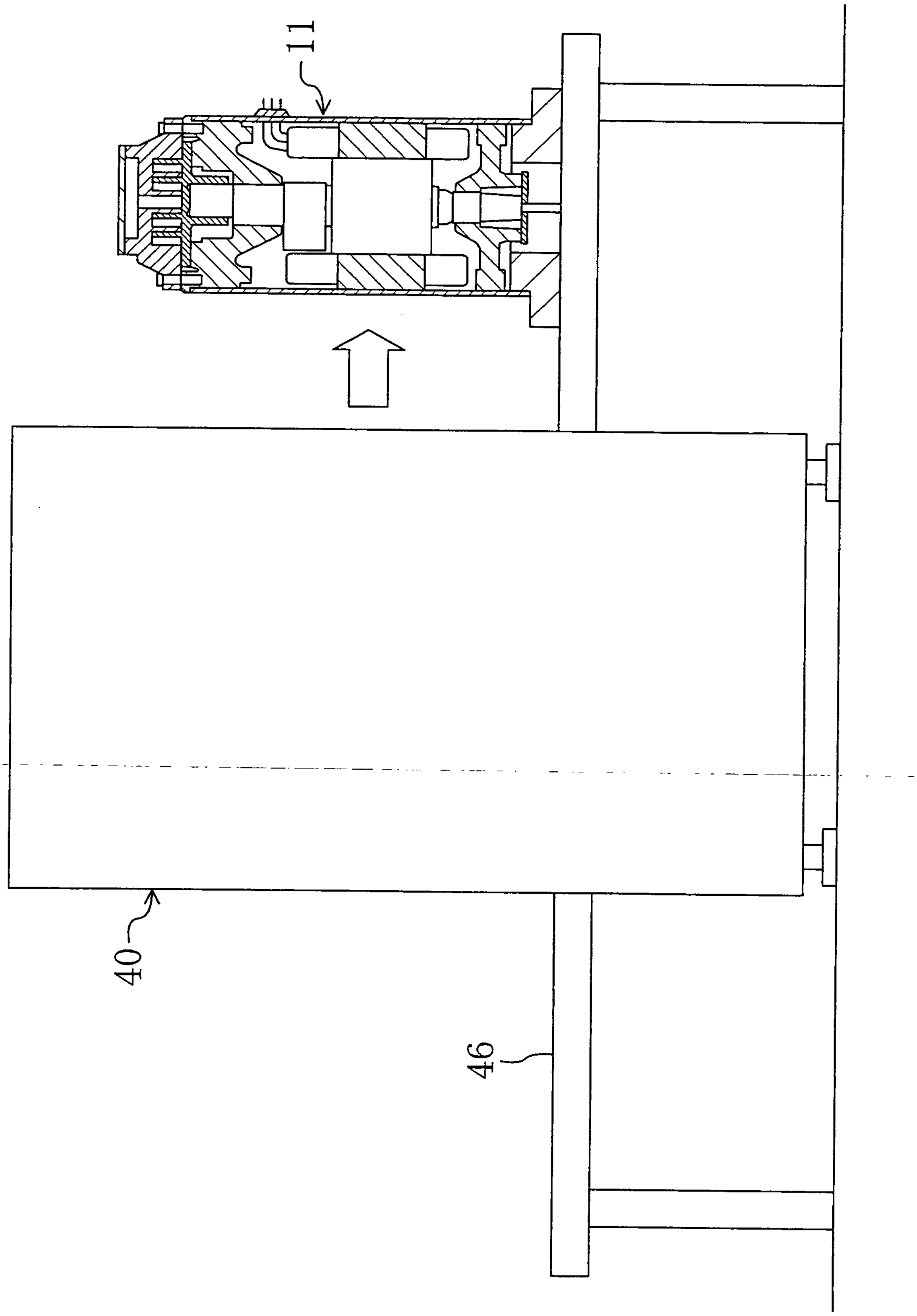

FIG. 29

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/074745

A. CLASSIFICATION OF SUBJECT MATTER
F04C18/02(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)
F04C18/02

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	1996-2008
Kokai Jitsuyo Shinan Koho	1971-2008	Toroku Jitsuyo Shinan Koho	1994-2008

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.
X Y	JP 2006-207529 A (Daikin Industries, Ltd.), 10 August, 2006 (10.08.06), Par. Nos. [0057] to [0067] & WO 2006/080230 A1	1-4 5,6
Y	JP 63-295886 A (Toshiba Corp.), 02 December, 1988 (02.12.88), Page 6, upper left column, lines 10 to 20 (Family: none)	5,6
A	JP 2003-184761 A (Fujitsu General Ltd.), 03 July, 2003 (03.07.03), Par. Nos. [0097] to [0108] (Family: none)	1-6

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

* Special categories of cited documents:
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- "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
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Name and mailing address of the ISA/	Authorized officer
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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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