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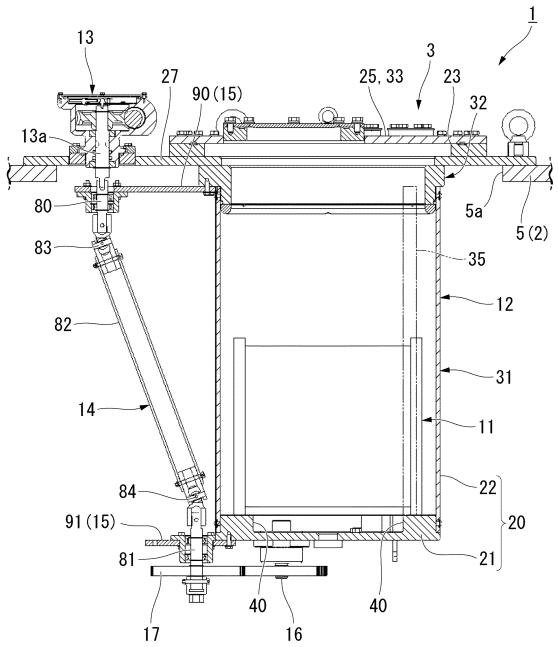
(54) ON-LOAD TAP CHANGER

(57) An on-load tap changer according to an embodiment comprises a changeover switch and a container. The changeover switch performs a winding tap changing operation. The container contains the changeover switch. The container has a bottom portion to which the changeover switch is secured.

FIG. 3



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Description

[Technical Field]

[0001] Embodiments of the present invention relate to an on-load tap changer.

[Background Art]

[0002] An on-load tap changer is a device that changes over a tap during an operation (during load) of a transformer. Generally, the on-load tap changer includes a tap selector and a changeover switch. The tap selector selects a tap to operate in a transformer tap winding. The changeover switch changes over a circuit to the selected tap. The changeover switch is contained in an insulating container together with an insulating oil or gas. The changeover switch is mainly driven by a releasing force of a spring. A large force acts on the changeover switch to instantly change over the circuit. Therefore, it is required to firmly install the changeover switch.

[Citation List]

[Patent Literature]

[0003]

[Patent Literature 1]
Japanese Patent No. 5707071
[Patent Literature 2]
Japanese Patent No. 6067220

[Summary of Invention]

[Technical Problem]

[0004] An object of the present invention is to provide an on-load tap changer in which a changeover switch can be firmly installed.

[Solution to Problem]

[0005] An on-load tap changer according to an embodiment includes a changeover switch and a container. The changeover switch performs a tap changeover operation in a winding. The container contains the changeover switch. The container has a bottom portion to which the changeover switch is fastened.

[Brief Description of Drawings]

[0006]

Fig. 1 is a schematic view of a transformer according to a first embodiment.
Fig. 2 is a perspective view showing a part of an on-load tap changer according to the first embodiment.
Fig. 3 is a sectional view showing a part of an on-load tap changer according to the first embodiment.
Fig. 4 is a perspective view schematically showing the inside of an oil tank main body of the first embodiment.
Fig. 5 is a sectional view along a line V-V of Fig. 4.
Fig. 6 is a perspective view showing a changeover switch according to the first embodiment.
Fig. 7 is a view illustrating installation work of the changeover switch according to the first embodiment.
Fig. 8 is a view showing a state in which a receiving seat and a support column are joined in the installation work of the changeover switch according to the first embodiment.
Fig. 9 is a view showing a state in which a receiving seat and a support column are joined in the installation work of the changeover switch according to the first embodiment.
Fig. 10 is a view showing a state in which a receiving seat and a support column are joined in the installation work of the changeover switch according to the first embodiment.
Fig. 11 is a sectional view showing a joint portion between a receiving seat and a support column according to a second embodiment.
Fig. 12 is a view showing a state in which the receiving seat and the support column are joined in installation work of a changeover switch according to the second embodiment.
Fig. 13 is a sectional view showing a part of an on-load tap changer according to a third embodiment.

[Description of Embodiments]

[0007] Hereinafter, an on-load tap changer of each of embodiments will be described with reference to the drawings.

(First embodiment)

[0008] Fig. 1 is a schematic view of a transformer according to a first embodiment.

[0009] As shown in Fig. 1, a transformer 1 includes a transformer main body (not shown), a tank 2 that contains the transformer main body together with an insulating oil, and an on-load tap changer 3 fixed to the tank 2. The transformer main body has an iron core and a winding mounted on the iron core. The tank 2 includes a top plate 5 extending in a horizontal direction. An opening portion 5a into which the on-load tap changer 3 is inserted from above is formed in the top plate 5. The on-load tap changer 3 closes the opening portion 5a of the top plate 5 in a state where a part of the on-load tap changer 3 is disposed in the tank 2. An electric operation mechanism (not shown) is disposed outside the tank 2 as a drive source that applies power to the on-load tap changer 3. The electric operation mechanism includes a motor. The

electric operation mechanism rotates a relay shaft (not shown) connected to the on-load tap changer 3 and transmits power to the on-load tap changer 3.

[0010] Fig. 2 is a perspective view showing a part of an on-load tap changer according to the first embodiment.

[0011] As shown in Figs. 1 and 2, the on-load tap changer 3 includes a tap selector 10, a changeover switch 11, and an oil tank 12. The tap selector 10 selects a tap in the winding of the transformer main body. The tap selector 10 is disposed in the tank 2. The changeover switch 11 instantly changes over a circuit to the selected tap as a tap changeover operation. The changeover switch 11 is disposed on the top plate 5 side with respect to the tap selector 10. The oil tank 12 contains the changeover switch 11 together with the insulating oil in the tank 2. The oil tank 12 blocks communication between the inside of the tank 2 and the inside of the oil tank 12. The oil tank 12 completely isolates the changeover switch 11 from the transformer main body. The oil tank 12 supports the tap selector 10 from above.

[0012] Fig. 3 is a sectional view showing a part of an on-load tap changer according to the first embodiment.

[0013] As shown in Figs. 1 and 3, the oil tank 12 includes an oil tank main body 20 (a container), an oil tank lid 25, and a flange 27.

[0014] The oil tank main body 20 includes a bottom wall portion 21 (a bottom portion) located at a lower end portion and a peripheral wall portion 22 extending upward from an outer peripheral portion of the bottom wall portion 21. The bottom wall portion 21 is disposed in the tank 2. The bottom wall portion 21 is disposed between the tap selector 10 and the changeover switch 11. The bottom wall portion 21 is formed in a circular shape when viewed from above. A transmission shaft 16 (a transmission portion) penetrates the bottom wall portion 21. The transmission shaft 16 extends in a vertical direction. The transmission shaft 16 is rotatably supported by the bottom wall portion 21. The transmission shaft 16 transmits power for operating the changeover switch 11 from the outside of the oil tank 12 to the inside of the oil tank 12 (details will be described later). The peripheral wall portion 22 is formed in a cylindrical shape as a whole. The peripheral wall portion 22 surrounds the changeover switch 11 from the outside in the horizontal direction. An oil tank opening portion 23 through which the changeover switch 11 can pass in the vertical direction is formed at an upper end portion of the oil tank main body 20. The oil tank opening portion 23 is open upward.

[0015] Fig. 4 is a perspective view schematically showing the inside of an oil tank main body of the first embodiment.

[0016] As shown in Fig. 4, a receiving seat 40 is disposed on the bottom wall portion 21 of the oil tank main body 20. The receiving seat 40 supports the changeover switch 11 from below. The receiving seat 40 protrudes upward from an upper surface of the bottom wall portion 21. The receiving seat 40 may be integrally formed with the bottom wall portion 21, or may be formed as a separate member from the bottom wall portion 21 and joined to the bottom wall portion 21. In a case where the receiving seat 40 is joined to the bottom wall portion 21, a joining method between the bottom wall portion 21 and the receiving seat 40 may be metallurgical joining such as welding in which a joint portion has continuity, or may be mechanical joining such as fastening in which the joint portion has no continuity. Three or more receiving seats 40 (three in the present embodiment) are disposed to surround a central axis P of the peripheral wall portion 22 when viewed from above. The receiving seats 40 are disposed at equal angular intervals in a circumferential direction around the central axis P. A recess 41 that is recessed downward is formed in an upper surface of the receiving seat 40.

[0017] Fig. 5 is a sectional view along a line V-V of Fig. 4.

[0018] As shown in Fig. 5, the recess 41 includes a side surface 42 and a bottom surface 45. The side surface 42 extends downward from an upper end opening edge of the recess 41. The side surface 42 is formed in a circular shape in a cross section. The side surface 42 includes a tapered surface 43 facing the oil tank opening portion 23 side (upward) and a straight surface 44 extending uniformly in the vertical direction. The tapered surface 43 gradually reduces in diameter from the upper end opening edge of the recess 41 toward a downward side. The straight surface 44 extends downward from a lower end edge of the tapered surface 43 with a constant inner diameter. The bottom surface 45 extends inward in a radial direction (the horizontal direction) from a lower end edge of the straight surface 44. A female screw 46 extending downward is formed in the bottom surface 45. The female screw 46 is formed coaxially with the straight surface 44.

[0019] As shown in Fig. 3, a pipe 35 is disposed in the oil tank main body 20. The pipe 35 is fixedly disposed with respect to the oil tank main body 20. The pipe 35 extends in the vertical direction in the oil tank main body 20. A lower end portion of the pipe 35 is open near the bottom wall portion 21. The pipe 35 is used for sucking up the insulating oil in the oil tank main body 20.

[0020] As shown in Figs. 1 and 3, the oil tank lid 25 closes the oil tank opening portion 23. The oil tank lid 25 is disposed at an interval with respect to the changeover switch 11. The oil tank lid 25 is formed in a circular shape concentric with the oil tank main body 20 when viewed from above. The oil tank lid 25 is fastened to the upper end portion of the oil tank main body 20 from above. An outer peripheral portion of the oil tank lid 25 is in close contact with the upper end portion of the peripheral wall portion 22 of the oil tank main body 20 over the entire circumference.

[0021] The flange 27 projects from an upper portion of the oil tank main body 20 and extends from the vicinity of the oil tank main body 20 over the entire circumference thereof. The flange 27 extends in the horizontal direction.

The flange 27 is joined to the top plate 5 of the tank 2. The flange 27 is fastened to the top plate 5 from above. The flange 27 overlaps the entire inner peripheral edge of the opening portion 5a of the top plate 5 when viewed from above. The flange 27 is in close contact with the periphery of the opening portion 5a over the entire circumference in a state where the oil tank main body 20 is inserted into the opening portion 5a of the top plate 5 from above. The flange 27 closes a portion between the opening portion 5a of the top plate 5 and the oil tank main body 20. An outer peripheral edge of the flange 27 is formed to surround the entire tap selector 10 when viewed from above.

[0022] The oil tank 12 is mainly formed by combining an oil tank main portion 31, an oil tank head portion 32, and a head portion lid 33 as parts. The oil tank main portion 31 includes a portion extending from an intermediate portion to a lower end portion of the oil tank main body 20 in the vertical direction. The entire oil tank main portion 31 is disposed in the tank 2. The oil tank main portion 31 is formed in a cylindrical shape that is open upward. The oil tank head portion 32 includes an upper portion of the oil tank main body 20 and the flange 27. The oil tank head portion 32 is formed in a cylindrical shape as a whole. A lower end portion of the oil tank head portion 32 is closely inserted inside an upper end portion of the oil tank main portion 31. The flange 27 is disposed at an intermediate portion of the oil tank head portion 32 in the vertical direction. The head portion lid 33 is the oil tank lid 25. The head portion lid 33 closes an opening at the upper end portion of the oil tank head portion 32 from above.

[0023] Fig. 6 is a perspective view showing a changeover switch according to the first embodiment.

[0024] As shown in Fig. 6, the changeover switch 11 is fastened to the oil tank main body 20 with bolts 70 (male screws) disposed in the oil tank main body 20. The changeover switch 11 has an upper plate 50, a lower plate 51, a support column 52 (a guide), an energy saving mechanism 53, a changeover unit 54, and a current limiting resistor 55. The upper plate 50 and the lower plate 51 are formed in a disk shape concentric with a central axis O of the peripheral wall portion 22 of the oil tank main body 20 and are disposed to be in line in the vertical direction and parallel to each other. A cutout portion 56 is provided in an outer peripheral edge of each of the upper plate 50 and the lower plate 51. The cutout portions 56 are formed to overlap each other when viewed from above. The pipe 35 (see Fig. 3) is disposed in each cutout portion 56.

[0025] The support column 52 connects the upper plate 50 and the lower plate 51. The support column 52 as a leg of the changeover switch 11 is supported by the receiving seat 40. The support column 52 extends in the vertical direction. The support column 52 includes an upper end portion 60 (a first end portion) that faces the oil tank opening portion 23 side and a lower end portion 61 (a second end portion) that faces the receiving seat 40 side. The upper end portion 60 is formed at a position visible from above through the oil tank opening portion 23. The lower end portion 61 is inserted into the recess 41 of the receiving seat 40. The lower end portion 61 is formed to have a smaller diameter than the straight surface 44 (see Fig. 5) of the recess 41.

[0026] A hollow portion 62 extending over from the upper end portion 60 to the lower end portion 61 is formed in the support column 52. In the present embodiment, the support column 52 is formed in a cylindrical shape. The hollow portion 62 is open to the oil tank opening portion 23 side at the upper end portion 60. The hollow portion 62 is open to the receiving seat 40 side at the lower end portion 61.

[0027] A bolt 70 is inserted through the hollow portion 62. The support column 52 guides the bolt 70 inserted into the hollow portion 62 from above to the receiving seat 40. A tip end of the bolt 70 protrudes downward from a lower end opening of the support column 52 and is coupled to the female screw 46 (see Fig. 5) of the receiving seat 40. The head of the bolt 70 tightens the upper end portion 60 of the support column 52 downward. As a result, the changeover switch 11 is fastened to the bottom wall portion 21 of the oil tank main body 20.

[0028] The energy saving mechanism 53 is disposed between the lower plate 51 and the bottom wall portion 21 of the oil tank main body 20. The energy saving mechanism 53 is connected to the transmission shaft 16 (see Fig. 3). The energy saving mechanism 53 includes an energy saving spring 58. The energy saving mechanism 53 expands or compresses the energy saving spring 58 on the basis of rotation of the transmission shaft 16 along with a tap selection operation of the tap selector 10. The energy saving mechanism 53 releases the energy saving spring 58 in an energy saved state after the tap selection operation of the tap selector 10 is completed. The energy saving mechanism 53 instantly drives the changeover unit 54 with a restoring force (a releasing force) of the energy saving spring 58 at the time of releasing.

[0029] The changeover unit 54 is disposed between the upper plate 50 and the lower plate 51 and is supported by both. The changeover unit 54 includes a valve 59 which is a vacuum circuit breaker. The changeover unit 54 controls the opening and closing of the valve 59 by the releasing force of the energy saving spring 58.

[0030] The current limiting resistor 55 is disposed on a side opposite to the changeover unit 54 with the upper plate 50 interposed therebetween. The current limiting resistor 55 is fixed to the upper plate 50. The current limiting resistor 55 is temporarily energized prior to changing over the circuit.

[0031] As shown in Figs. 1 and 3, the on-load tap changer 3 includes a gear mechanism 13, a drive shaft 14, and a support portion 15.

[0032] The gear mechanism 13 is disposed in the flange 27. The gear mechanism 13 is disposed between the oil tank main body 20 and the inner peripheral edge of the opening portion 5a of the tank 2 when viewed from

above. The relay shaft that is rotated with the power of the electric operation mechanism is connected to the gear mechanism 13 from the outside of the tank 2. The gear mechanism 13 introduces the power of the electric operation mechanism from the outside of the tank 2 into the tank 2. The gear mechanism 13 includes a worm connected to the relay shaft, a worm wheel that meshes with the worm, and a shaft 13a that rotates integrally with the worm wheel. The gear mechanism 13 decelerates the rotation of the relay shaft by the worm and the worm wheel and transmits the rotation to the shaft 13a. The shaft 13a extends in the vertical direction. A lower end portion of the shaft 13a is located in the tank 2 and is connected to the drive shaft 14.

[0033] The drive shaft 14 is disposed in the tank 2. The drive shaft 14 transmits the power of the electric operation mechanism from the gear mechanism 13 to the tap selector 10 and the changeover switch 11. The drive shaft 14 is disposed outside the oil tank 12. The drive shaft 14 includes a shaft upper portion 80 connected to the lower end portion of the shaft 13a of the gear mechanism 13, a shaft lower portion 81 connected to the tap selector 10, and an intermediate portion 82 disposed between the shaft upper portion 80 and the shaft lower portion 81.

[0034] As shown in Fig. 3, the shaft upper portion 80 extends in the vertical direction and is disposed coaxially with the shaft 13a of the gear mechanism 13. The shaft upper portion 80 rotates integrally with the shaft 13a. The shaft lower portion 81 extends in the vertical direction. A gear 17 that transmits the rotation to the changeover switch 11 is fixed to the shaft lower portion 81. The gear 17 meshes with a gear fixed to the transmission shaft 16. As a result, the rotation of the shaft lower portion 81 is transmitted from the outside of the oil tank 12 into the oil tank 12 through the transmission shaft 16. The shaft lower portion 81 is disposed closer to the oil tank main body 20 than the shaft upper portion 80. The intermediate portion 82 is connected to the shaft upper portion 80 and the shaft lower portion 81. The intermediate portion 82 is connected to the lower end portion of the shaft upper portion 80 via a first universal joint 83 and is connected to the upper end portion of the shaft lower portion 81 via a second universal joint 84. As a result, the shaft lower portion 81 rotates integrally with the shaft upper portion 80. The intermediate portion 82 extends in a direction inclined with respect to the vertical direction. Specifically, the intermediate portion 82 gradually approaches the oil tank main body 20 from the first universal joint 83 toward the second universal joint 84.

[0035] The support portion 15 is disposed in the tank 2. The support portion 15 rotatably supports the drive shaft 14. The support portion 15 includes an upper support portion 90 that supports the shaft upper portion 80 of the drive shaft 14 and a lower support portion 91 that supports the shaft lower portion 81 of the drive shaft 14. The upper support portion 90 is fixed to the oil tank main body 20. Specifically, the upper support portion 90 is fixed to the lower end portion of the oil tank head portion 32. The upper support portion 90 holds a rolling bearing mounted on the shaft upper portion 80 of the drive shaft 14. The upper support portion 90 rotatably supports the shaft upper portion 80 of the drive shaft 14. The lower support portion 91 is fixed to the oil tank main body 20 and the tap selector 10 (see also Fig. 1). Specifically, the lower support portion 91 is fixed to a lower portion of the oil tank main portion 31 and an upper portion of the tap selector 10. The lower support portion 91 holds a rolling bearing mounted on the shaft lower portion 81 of the drive shaft 14. The lower support portion 91 rotatably supports the shaft lower portion 81 of the drive shaft 14.

[0036] An installation procedure of the changeover switch 11 of the present embodiment will be described with reference to Figs. 7 to 10. Fig. 7 is a view illustrating installation work of the changeover switch according to the first embodiment. Figs. 8 to 10 are views showing states in which a receiving seat and a support column are joined in the installation work of the changeover switch according to the first embodiment.

[0037] As shown in Fig. 7, the changeover switch 11 is inserted into the oil tank main body 20 from the oil tank opening portion 23 of the oil tank main body 20 in a state where the changeover switch 11 is suspended by a crane or the like. The changeover switch 11 is inserted into the oil tank main body 20 in a state where the pipe 35 enters the cutout portion 56 of each of the upper plate 50 and the lower plate 51 (both see Fig. 6). As a result, the changeover switch 11 is approximately positioned with respect to the oil tank main body 20.

[0038] As shown in Fig. 8, when the changeover switch 11 is lowered toward the bottom wall portion 21 of the oil tank main body 20, the lower end portion 61 of the support column 52 enters the recess 41 of the receiving seat 40. At this time, if the changeover switch 11 is deviated from an installation position with respect to the oil tank main body 20 when viewed from above, the lower end portion 61 of the support column 52 comes into contact with the tapered surface 43 of the recess 41 of the receiving seat 40.

[0039] As shown in Fig. 9, when the changeover switch 11 is further lowered, the lower end portion 61 of the support column 52 is displaced toward a center side of the recess 41 along the inclination of the tapered surface 43. Finally, the lower end portion 61 of the support column 52 enters the inside of the straight surface 44 of the recess 41 and comes into contact with the bottom surface 45. As a result, the lower end portion 61 is supported from below by the receiving seat 40, and the movement in the horizontal direction is restricted by the side surface 42 of the recess 41.

[0040] Subsequently, as shown in Fig. 10, the bolt 70 is inserted into the hollow portion 62 of each support column 52 from above. The tip end of the bolt 70 protrudes downward from the lower end portion 61 of the support column 52 and is inserted into a screw hole of the female screw 46. When the bolt 70 is rotated, the tip end of the bolt 70 is screwed into the female screw 46, and the

changeover switch 11 is fastened to the bottom wall portion 21 of the oil tank main body 20. As a result, the installation of the changeover switch 11 is completed. After that, the oil tank lid 25 is attached to the oil tank main body 20 to close the oil tank opening portion 23.

[0041] As described above, the on-load tap changer 3 of the present embodiment includes the oil tank main body 20 having the bottom wall portion 21 to which the changeover switch 11 is fastened. According to this configuration, the releasing force of the energy saving spring which is generated when the changeover switch 11 is operated can be directly dispersed to the bottom wall portion 21. Therefore, the changeover switch 11 can be firmly installed in the oil tank main body 20.

[0042] Here, as a configuration of the related art, there is an attachment structure in which a changeover switch is suspended from above. In the configuration of the related art, in order to insulate the changeover switch from a charging section, it is necessary to leave an insulating distance between the changeover switch and the charging section. Therefore, the changeover switch may be suspended by a long insulation support column. In this case, since a large moment acts on the insulation support column when the changeover switch is operated, the attachment structure of the changeover switch is complicated in order to firmly install the changeover switch.

[0043] Therefore, according to the present embodiment, since the insulation support column as in the configuration of the related art is not required, the structure of the on-load tap changer 3 can be simplified. Further, with the simplification of the structure, the maintenance interval of the on-load tap changer 3 can be extended, and the maintenance cost can be reduced.

[0044] In particular, in the present embodiment, the transmission shaft 16 that transmits the power for operating the changeover switch 11 from the outside of the oil tank main body 20 into the oil tank main body 20 is disposed in the bottom wall portion 21. Therefore, the changeover switch 11 can be fastened on the drive portion (the transmission shaft 16) side with respect to the changeover switch 11. Therefore, the changeover switch 11 can be installed more firmly as compared with the configuration in which the changeover switch is fixed on a side opposite to the drive portion.

[0045] Further, in the present embodiment, the bottom wall portion 21 supports the support column 52 from below. Therefore, when the changeover switch 11 is operated, even if a force in a direction in which the changeover switch 11 separates from the bottom wall portion 21 acts on the joint portion between the changeover switch 11 and the bottom wall portion 21, the force can be offset with a gravity of the changeover switch 11. Therefore, the changeover switch 11 can be firmly installed.

[0046] The on-load tap changer 3 includes the receiving seat 40 that supports the changeover switch 11 and the bolt 70 that is coupled to the receiving seat 40. The changeover switch 11 has the support column 52 that guides the bolt 70 to the receiving seat 40. Therefore, when the bolt 70 is attached from a side opposite to the bottom wall portion 21 (that is, above) with the changeover switch 11 interposed therebetween, the bolt 70 can be easily coupled to the receiving seat 40. Therefore, maintenance that requires fastening of the changeover switch 11 can be easily performed. Further, since the bolt 70 can be easily coupled to the receiving seat 40, the risk of dropping the bolt 70, a tool, or the like into the oil tank 12 can be reduced. As a result, the maintenance that requires fastening of the changeover switch 11 can be easily performed. Further, work man-hours and work time of the maintenance can be reduced, and the maintenance cost can be reduced.

[0047] The hollow portion 62 which extends over from the upper end portion 60 to the lower end portion 61 and through which the bolt 70 is inserted is formed in the support column 52. Therefore, the bolt 70 can be guided to the receiving seat 40 simply by inserting the bolt 70 into the hollow portion 62 from the upper end portion 60 of the support column 52. Therefore, when the bolt 70 is attached from the oil tank opening portion 23, the bolt 70 can be easily coupled to the receiving seat 40.

[0048] The recess 41 into which the support column 52 is inserted is formed in the receiving seat 40. The female screw 46 that is coupled to the bolt 70 is formed in the bottom surface 45 of the recess 41. The tapered surface 43 that faces the oil tank opening portion 23 side is formed on the side surface 42 of the recess 41. According to this configuration, when the support column 52 is inserted into the recess 41, even if the position of the support column 52 in the horizontal direction is deviated from a specified attachment position, the support column 52 comes into contact with the tapered surface 43 of the recess 41, and thus the support column 52 can be guided to the specified attachment position in the horizontal direction along the inclination of the tapered surface 43. The specified attachment position is a position where the bolt 70 can be coupled to the female screw 46. Therefore, the opening on the oil tank opening portion 23 side in the recess 41 can be formed sufficiently larger than an outer shape of the lower end portion 61 of the support column 52, and the work of disposing the support column 52 at the specified attachment position can be easily performed.

(Second embodiment)

[0049] Fig. 11 is a sectional view showing a joint portion between a receiving seat and a support column according to a second embodiment.

[0050] In the first embodiment shown in Fig. 5, the female screw 46 is formed in the bottom surface 45 of the recess 41 of the receiving seat 40. On the other hand, the second embodiment shown in Fig. 11 is different from the first embodiment in that a male screw 47 protrudes from the bottom surface 45 of the recess 41 of the receiving seat 40A. The configuration other than those which will be described below is the same as that of the

first embodiment.

[0051] As shown in Fig. 11, the oil tank main body 20 includes a receiving seat 40A instead of the receiving seat 40 of the first embodiment. The male screw 47 protruding to the oil tank opening portion 23 side is disposed in the receiving seat 40A. The male screw 47 protrudes upward from a center of the bottom surface 45 of the recess 41 of the receiving seat 40A. A tip end of the male screw 47 is located closer to the bottom surface 45 than to the tapered surface 43. That is, the entire male screw 47 is located inside the straight surface 44.

[0052] The changeover switch 11 includes a support column 52A (a shaft portion) instead of the support column 52 of the first embodiment. The support column 52A is rotatably disposed with respect to the upper plate 50 and the lower plate 51 (both see Fig. 6). A female screw 63 that is coupled to the male screw 47 is formed on an inner peripheral surface of a lower portion of the support column 52A.

[0053] In the installation procedure of the changeover switch 11 of the present embodiment, a point different from that of the first embodiment will be described. Fig. 12 is a view showing a state in which the receiving seat and the support column are joined in installation work of a changeover switch according to the second embodiment.

[0054] As shown in Fig. 12, the changeover switch 11 is lowered toward the bottom wall portion 21 of the oil tank main body 20, and the lower end portion 61 of the support column 52A is inserted into the recess 41 of the receiving seat 40A. When the lower end portion 61 of the support column 52A reaches the inside of the straight surface 44 of the recess 41, the lower end portion 61 of the support column 52A comes into contact with the male screw 47. Since the lower end portion 61 of the support column 52A is approximately positioned at the center of the recess 41 when viewed from above, when the support column 52A is rotated, the support column 52A is lowered while the female screw 63 is coupled to the male screw 47. Finally, the lower end portion 61 of the support column 52A comes into contact with the bottom surface 45 of the recess 41. As a result, the changeover switch 11 is fastened to the bottom wall portion 21 of the oil tank main body 20, and the installation of the changeover switch 11 is completed.

[0055] As described above, the male screw 47 protruding to a side of the oil tank opening portion 23 is disposed in the receiving seat 40A. The changeover switch 11 has the support column 52A on which the female screw 63 that is coupled to the male screw 47 is formed. Therefore, the changeover switch 11 can be fastened to the receiving seat 40A. Therefore, the same effect as that of the first embodiment is obtained.

[0056] Further, the male screw 47 protrudes from the bottom surface 45 of the recess 41. The tapered surface 43 that faces the oil tank opening portion 23 side is formed on the side surface 42 of the recess 41. According to this configuration, when the support column 52A is inserted into the recess 41, even if the position of the support column 52A in the horizontal direction is deviated from a specified attachment position, the support column 52A comes into contact with the tapered surface 43 of the recess 41, and thus the support column 52A can be guided to the specified attachment position in the horizontal direction along the inclination of the tapered surface 43. The specified attachment position is a position where the female screw 63 of the support column 52A can be coupled to the male screw 47. Therefore, the opening on the oil tank opening portion 23 side in the recess 41 can be formed sufficiently larger than an outer shape of the lower end portion 61 of the support column 52A, and the work of disposing the support column 52A at the specified position can be easily performed.

(Third embodiment)

[0057] Fig. 13 is a sectional view showing a part of an on-load tap changer according to a third embodiment.

[0058] The third embodiment shown in Fig. 13 differs from the first embodiment in that the on-load tap changer 3 includes a state monitoring device 6 for monitoring a state in the oil tank 12. The configuration other than those which will be described below is the same as that of the first embodiment.

[0059] As shown in Fig. 13, the state monitoring device 6 includes a sensor 7. The sensor 7 is disposed in the oil tank 12. The sensor 7 is disposed between the changeover switch 11 and the oil tank lid 25. A disposition space for the sensor 7 is a space formed by installing the changeover switch 11 without suspending it in the oil tank 12. The sensor 7 monitors the state inside the oil tank 12. For example, the sensor 7 includes an optical sensor, an acoustic sensor, and the like. The optical sensor detects arc generation of the changeover switch 11. The acoustic sensor detects an operating sound of the changeover switch 11, an impact associated with the arc generation of the changeover switch 11, and the like. The state monitoring device 6 converts a monitoring result (a detection signal of the sensor 7) obtained by the sensor 7 into an electric signal. The state monitoring device 6 transmits the electric signal to the outside of the transformer 1 through a communication cable, wireless transmission, or the like.

[0060] According to the present embodiment described above, in addition to the same effect as that of the first embodiment, the following effect is obtained.

[0061] According to the on-load tap changer 3 of the present embodiment, information such as whether or not the changeover switch 11 is normal and the deterioration status of the changeover switch 11 can be collected at any time even during the operation of the transformer 1. As a result, it possible to make a rational maintenance plan according to the usage status of the changeover switch 11. Therefore, the burden of maintenance and management of a user can be reduced.

[0062] The disposition of the receiving seats is not lim-

ited to the disposition in each of the above embodiments. For example, the plurality of receiving seats may be disposed such that a polygon having the plurality of receiving seats as vertices overlaps a center of a gravity of the changeover switch 11 when viewed from above.

[0063] Further, if the tapered surface is formed in the recess of each of at least two receiving seats among the plurality of receiving seats, the above-mentioned effect can be obtained.

[0064] The shape of the recess of the receiving seat is not limited to the shape in each of the above embodiments. For example, a surface extending upward from an upper end edge of the tapered surface with a constant inner diameter may be formed between the tapered surface and the upper end opening edge of the recess. Further, a cross-sectional shape of the side surface of the recess may be, for example, an oval shape or a polygonal shape. Further, the side surface of the recess does not have to be provided with the straight surface. That is, the bottom surface may extend from the lower end edge of the tapered surface.

[0065] Further, in each of the above embodiments, the support column 52 is formed in a cylindrical shape, but the present invention is not limited to this. For example, the support column may be formed in a square cylinder shape.

[0066] Further, in the above embodiment, the transformer is an oil-filled insulation transformer, but the transformer may be a gas insulation transformer.

[0067] According to at least one embodiment described above, since the embodiment includes the oil tank main body in which the changeover switch is contained and which has the bottom wall portion to which the changeover switch is fastened, the force generated when operating the changeover switch can be directly dispersed on the bottom wall portion. Therefore, the changeover switch can be firmly installed in the oil tank main body.

[0068] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

Claims

1. An on-load tap changer comprising:

a changeover switch that performs a tap changeover operation in a winding; and
a container that contains the changeover switch and has a bottom portion to which the changeover switch is fastened.

2. The on-load tap changer according to claim 1, wherein a transmission portion that transmits power for operating the changeover switch from the outside of the container to the inside of the container is disposed at the bottom portion of the container.

3. The on-load tap changer according to claim 1 or 2, further comprising:

a receiving seat that is disposed on the bottom portion of the container and supports the changeover switch; and
a male screw that is coupled to the receiving seat and fastens the changeover switch to the container,
wherein the changeover switch has a guide that guides the male screw to the receiving seat.

4. The on-load tap changer according to claim 3,

wherein an opening portion through which the changeover switch can pass is formed in the container on a side opposite to the bottom portion with the changeover switch interposed therebetween,
wherein the guide has
a first end portion that faces the opening portion side, and
a second end portion that faces the receiving seat side, and
wherein a hollow portion which extends over from the first end portion to the second end portion and through which the male screw is inserted is formed in the guide.

5. The on-load tap changer according to claim 4,

wherein a recess into which the guide is inserted is formed in the receiving seat,
wherein a female screw that is coupled to the male screw is formed in a bottom surface of the recess, and
wherein a tapered surface that faces the opening portion side is formed on a side surface of the recess.

6. The on-load tap changer according to claim 1 or 2, further comprising:

a receiving seat that is disposed at the bottom portion of the container and supports the changeover switch,
wherein an opening portion through which the changeover switch can pass is formed in the container on a side opposite to the bottom por-

tion with the changeover switch interposed therebetween,
wherein a male screw protruding to the opening portion side is disposed in the receiving seat, and
wherein the changeover switch has a shaft portion on which a female screw that is coupled to the male screw is formed.

7. The on-load tap changer according to claim 6,

wherein a recess into which the shaft portion is inserted is formed in the receiving seat,
wherein the male screw protrudes from a bottom surface of the recess, and
wherein a tapered surface that faces the opening portion side is formed on a side surface of the recess.

8. The on-load tap changer according to any one of claims 1 to 7, further comprising:
a state monitoring device that has a sensor disposed inside the container, monitors a state inside the container with the sensor, and transmits a monitoring result to the outside of a transformer.

FIG. 1

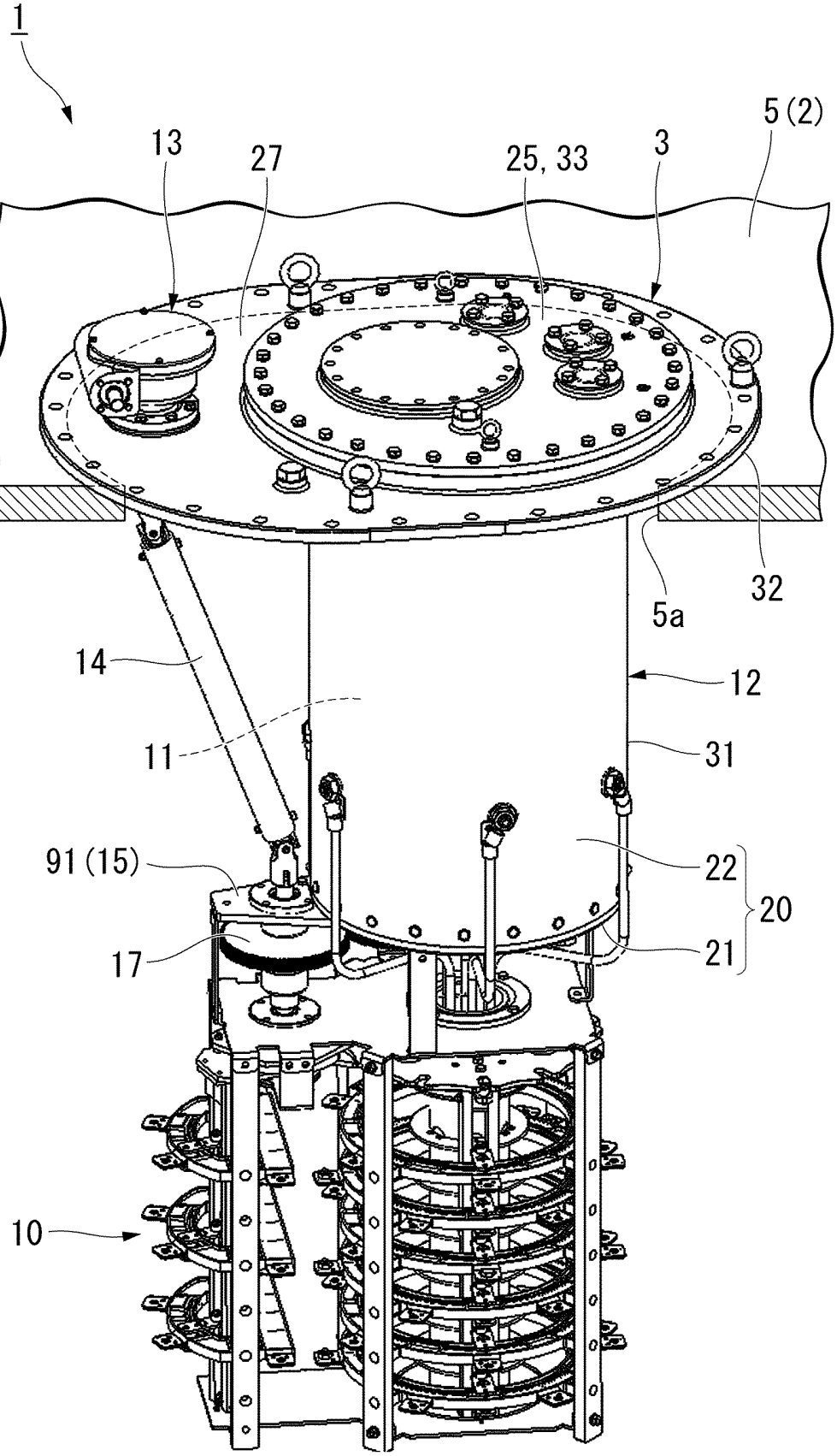

FIG. 2

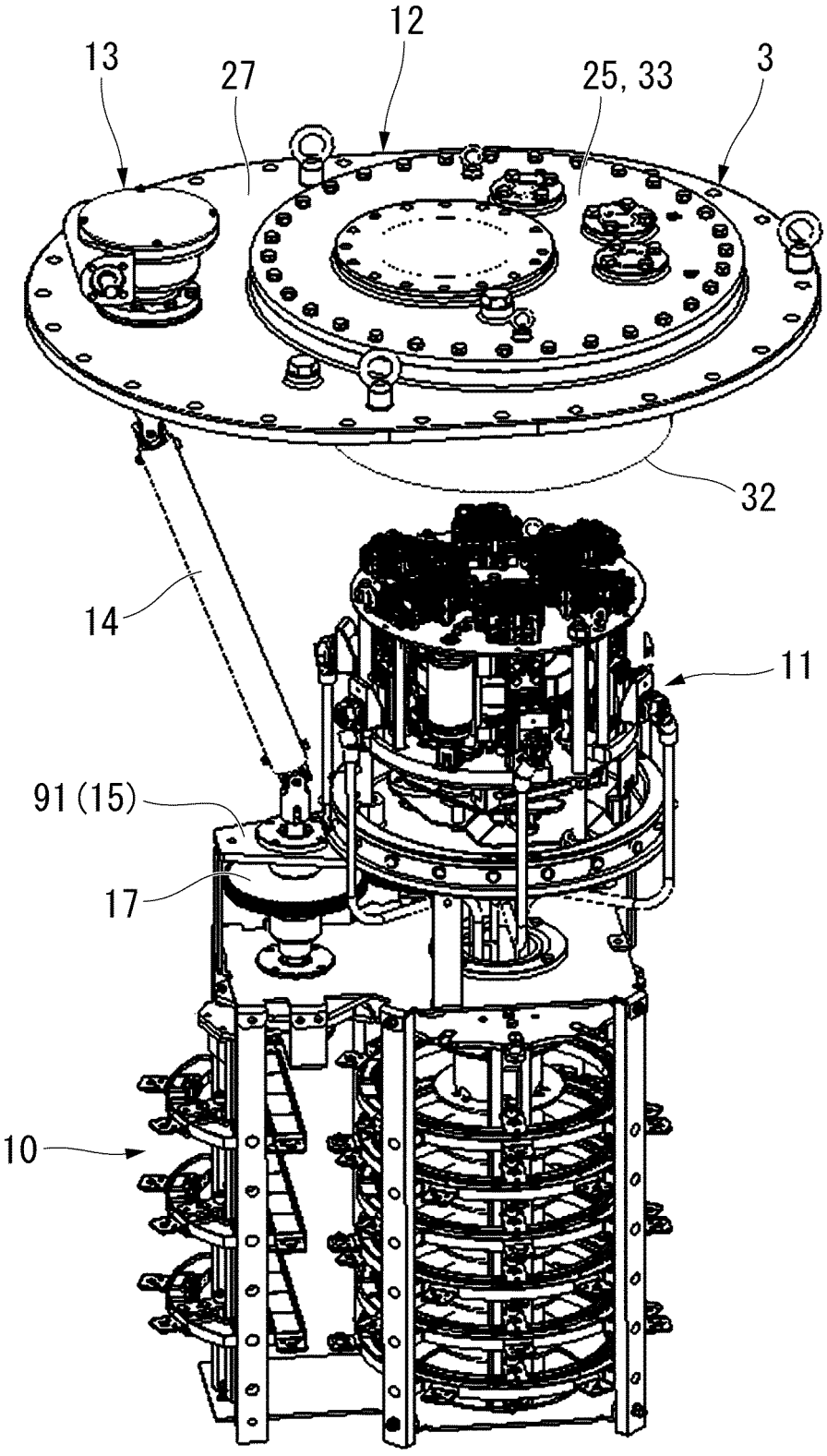

FIG. 3

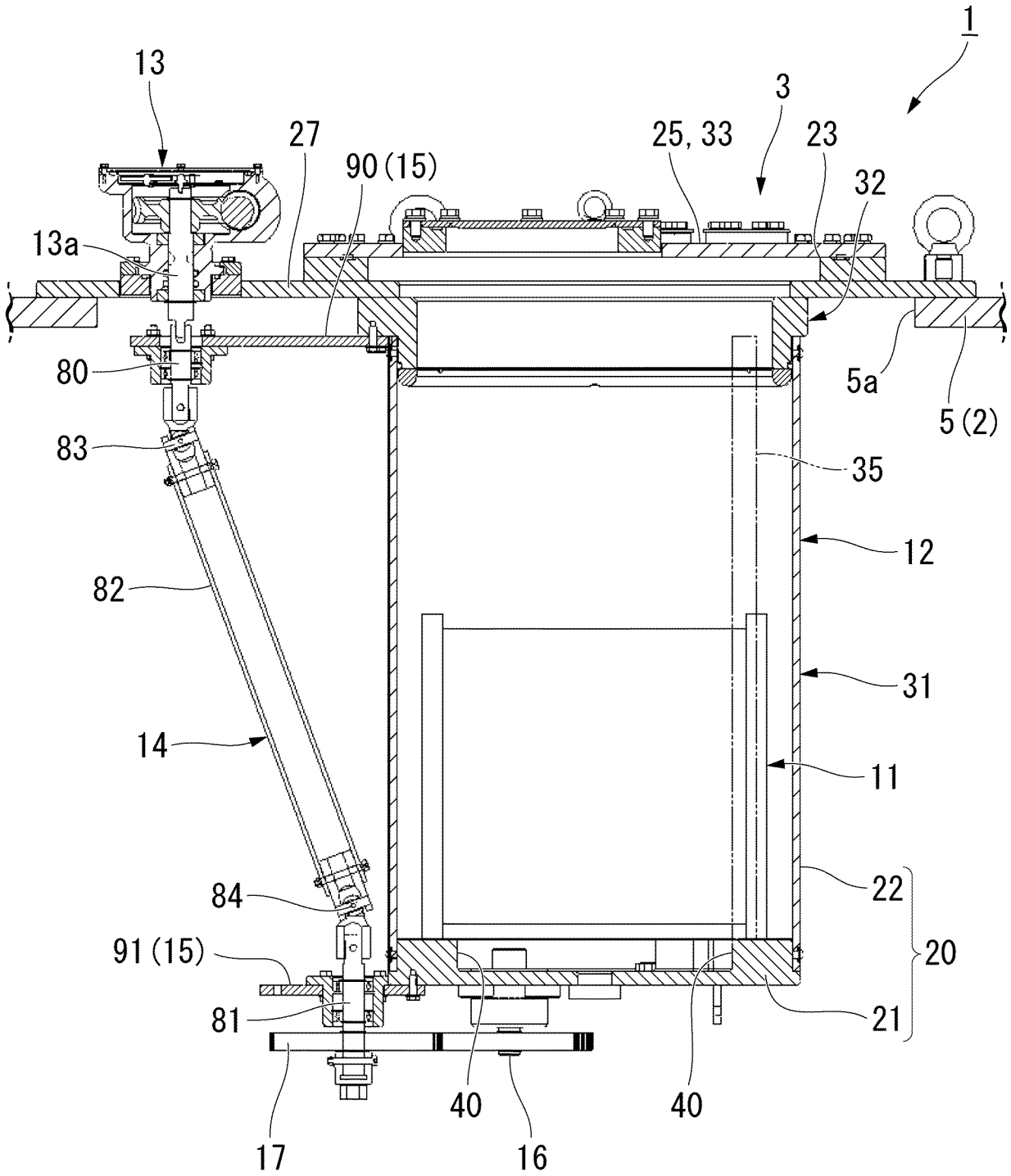
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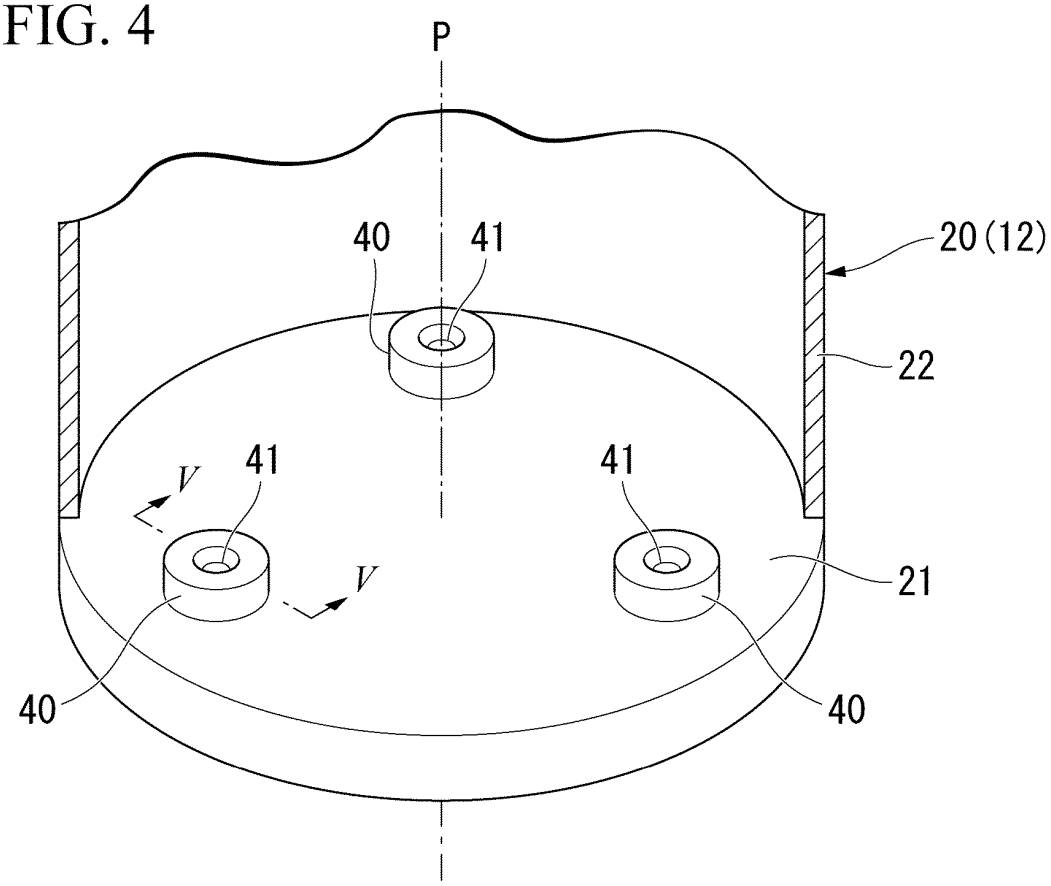
FIG. 4



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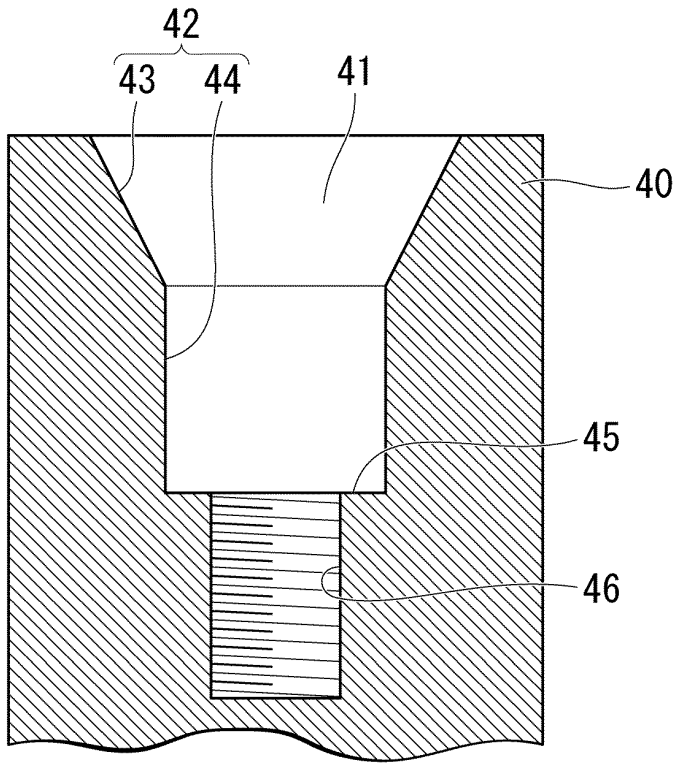

FIG. 6

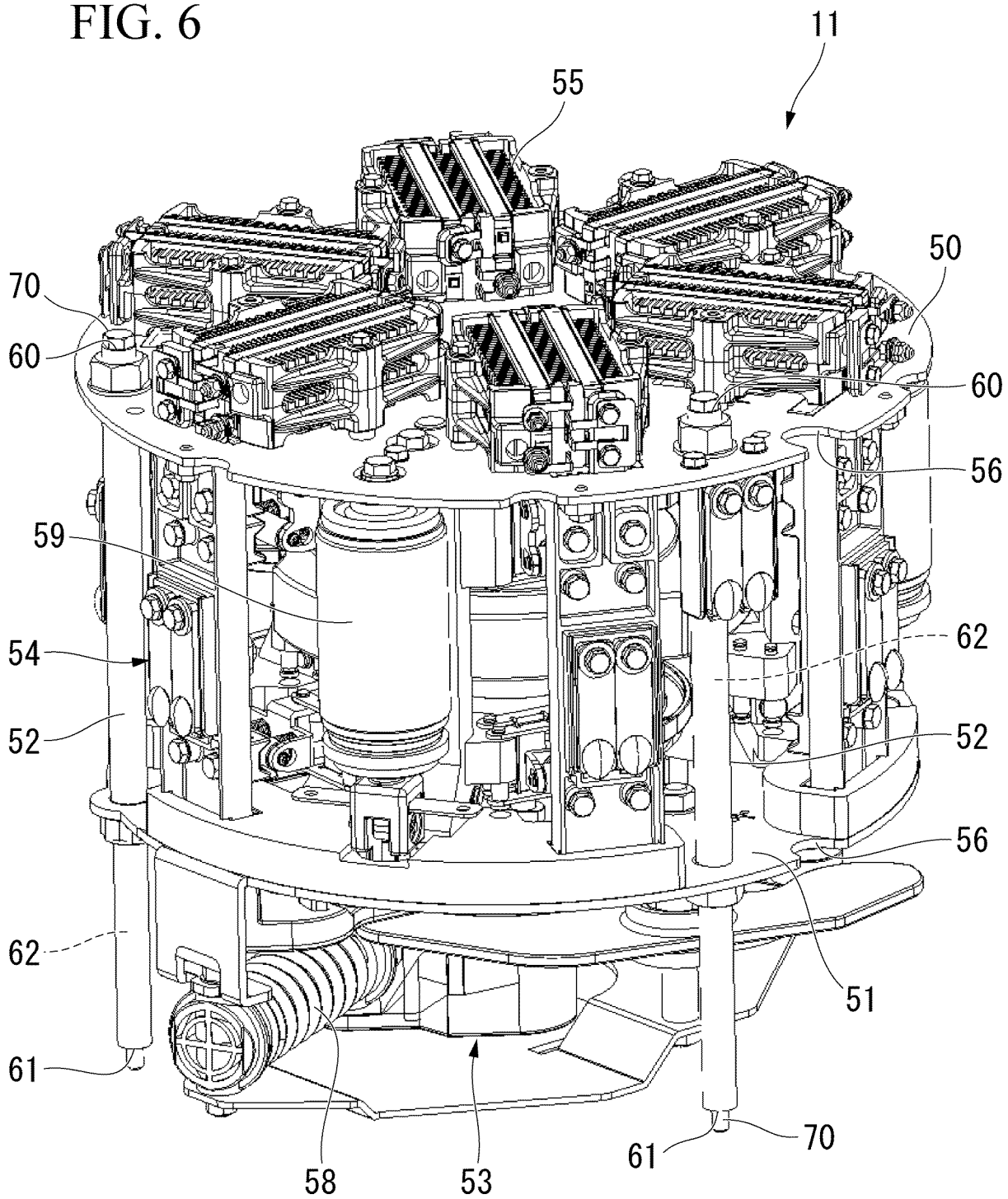

FIG. 7

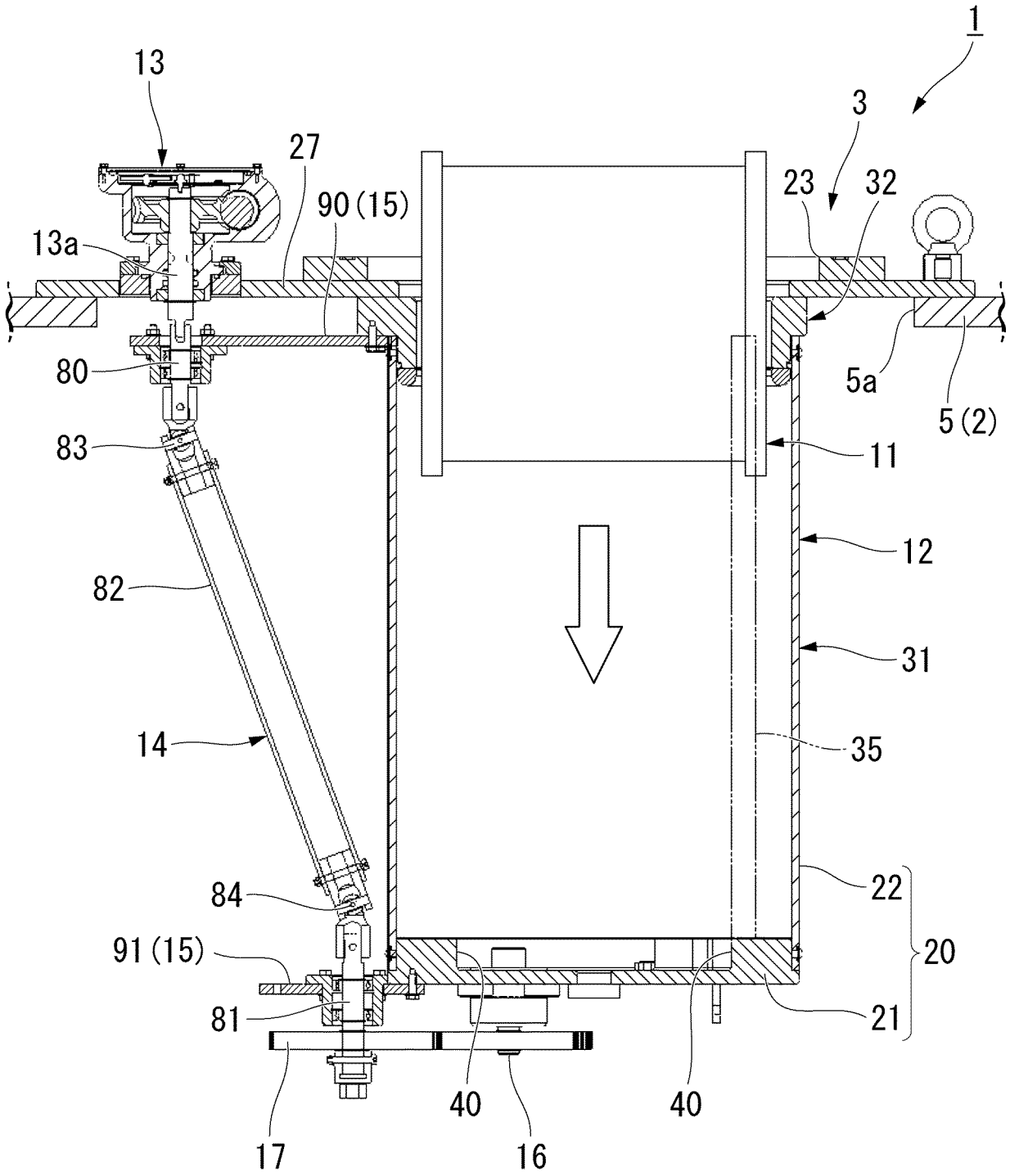
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FIG. 8

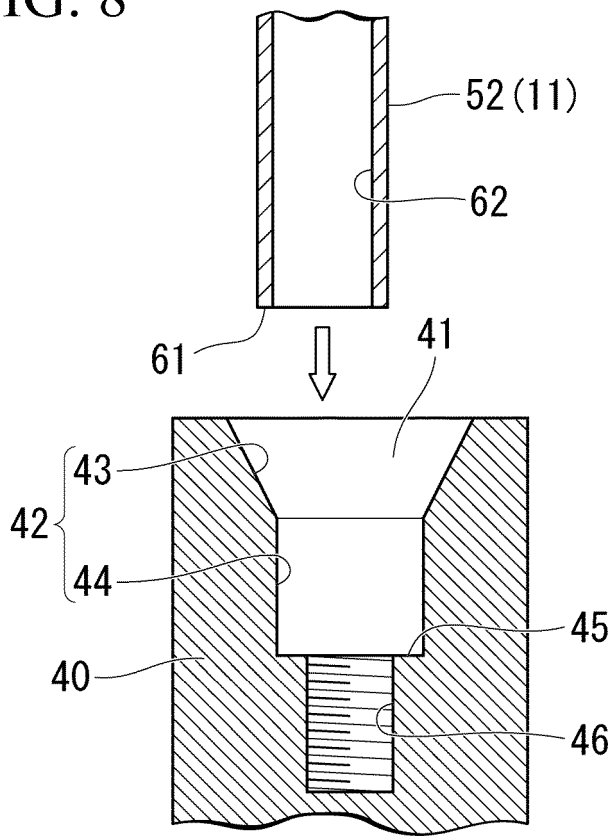


FIG. 9

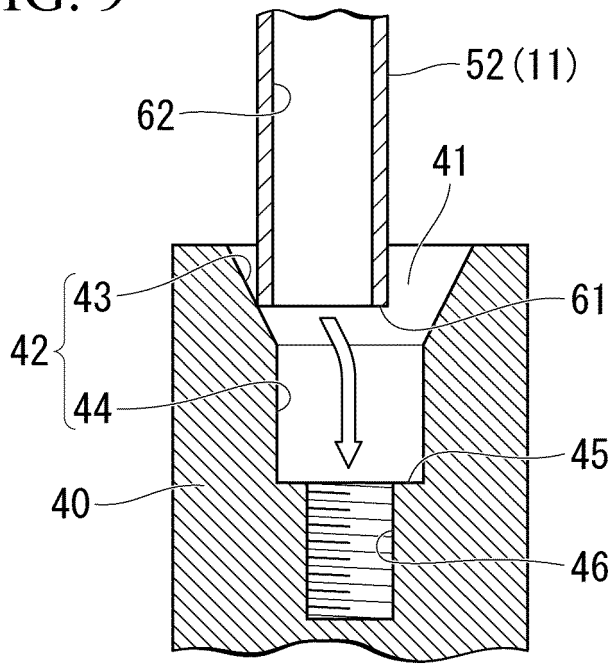


FIG. 10

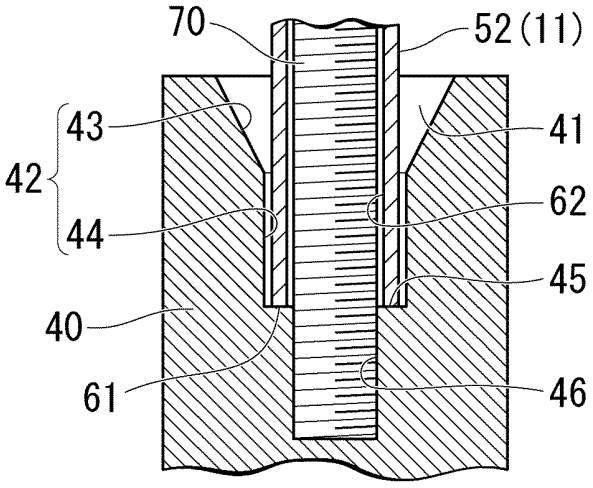


FIG. 11

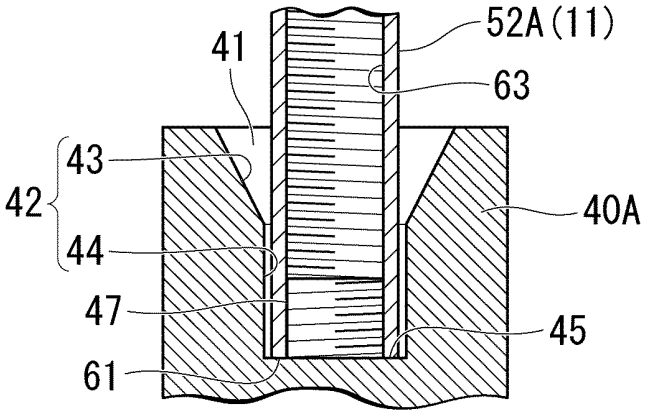


FIG. 12

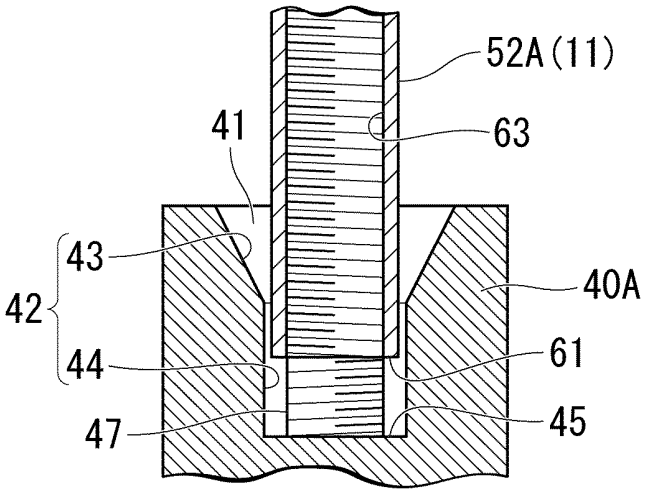
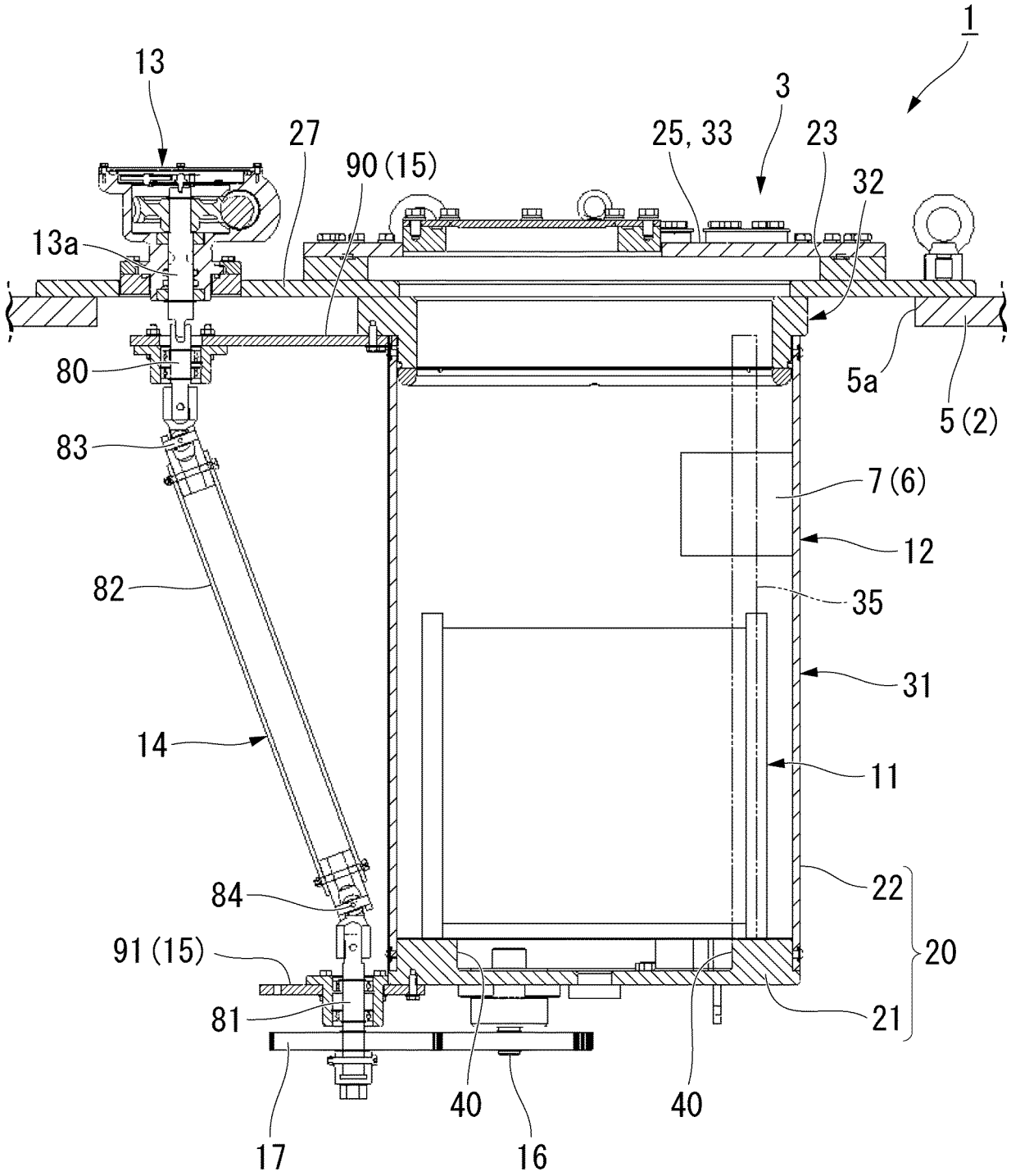


FIG. 13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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/046127

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. H01F29/02(2006.01)i, H01F29/04(2006.01)i
FI: H01F29/04 502A, H01F29/04 502M, H01F29/02 E

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)
Int. Cl. H01F29/02, H01F29/04

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

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 2015-192054 A (DAIHEN CORP.) 02 November 2015, paragraphs [0002], [0003], [0036]-[0038], fig. 1, 5, paragraphs [0002], [0003], [0036]-[0038], fig. 1, 5	1-2 8
Y	JP 2007-288072 A (TOSHIBA CORP.) 01 November 2007, paragraphs [0010]-[0045], fig. 1-8	8
A	JP 2008-91393 A (TOSHIBA CORP.) 17 April 2008, entire text, all drawings	1-8

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06.01.2020	21.01.2020

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2019/046127

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 2015-192054 A	02.11.2015	(Family: none)	
JP 2007-288072 A	01.11.2007	(Family: none)	
JP 2008-91393 A	17.04.2008	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 5707071 B **[0003]**
- JP 6067220 B **[0003]**