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

(11) EP 3 171 373 A1

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

(43) Date of publication:
24.05.2017 Bulletin 2017/21

(21) Application number: **15821798.4**

(22) Date of filing: **30.06.2015**

(51) Int Cl.:
H01F 29/04 *(2006.01)*

(86) International application number:
PCT/JP2015/068802

(87) International publication number:
WO 2016/009825 (21.01.2016 Gazette 2016/03)

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

(30) Priority: **15.07.2014 JP 2014145430**

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(54) ON-LOAD TAP CHANGING DEVICE

(57) An on-load tap changer which ensures the compatibility of an oil tank when an interchange from the in-oil arc switching scheme to the vacuum-valve scheme is made, improves a retrofit function, achieves a space saving by simplifying components, and facilitates a construction of an actuation mechanism is provided. A change-over switch 46 for the vacuum-valve scheme is placed in an oil tank 50 filled with an insulation oil 56. The change-over switch 46 is provided with a main contact contained in vacuum valves 2, 3, 5, 6, and current-carrying conductors 7, 8 to reduce a current flowing in the main contact, and parallel link mechanisms actuating the current-carrying conductors 7, 8 in a parallel manner. A stationary contact 47 capable of contacting with and separating from the current-carrying conductors 7, 8 is attached to the internal wall surface of the oil tank 50. The change-over switch 46 is freely attachable to and detachable from the oil tank 50 with the stationary contact 47 being attached to the oil tank 50.

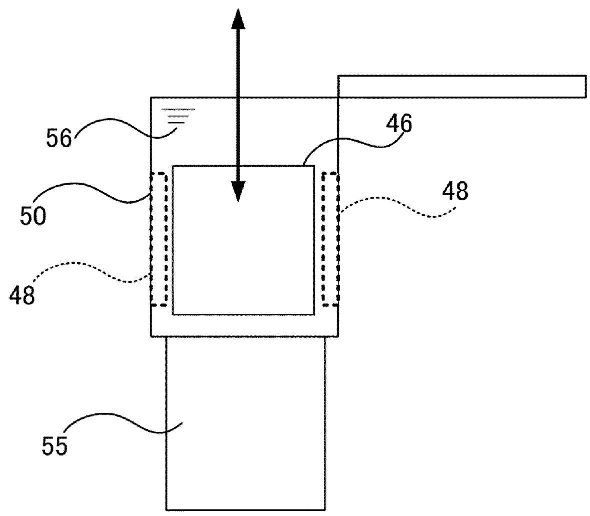

FIG. 1

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Description

TECHNICAL FIELD

[0001] Embodiments of the present disclosure relate to an on-load tap changer that includes a vacuum-valve scheme change-over switch.

BACKGROUND ART

[0002] In general, an on-load tap changer is installed in order to adjust the voltage of a power transmission line or a power distribution line. For example, an on-load tap changer 51 illustrated in FIG. 17 is provided with an on-load tap change unit 52 installed in a transformer main tank 60, and an electric actuation mechanism 53 installed outside the transformer main tank 60.

[0003] In those components, the electric actuation mechanism 53 is to actuate and control the on-load tap change unit 52. The on-load tap change unit 52 is a unit that switches the tap of winding with a load being applied to a transformer in accordance with a voltage fluctuation. The on-load tap change unit 52 is provided with an oil tank 50 filled with an insulation oil 56, and a change-over switch 54 is placed in the oil tank 50. Provided on the internal wall surface of the oil tank 50 are a stationary contact 47 and a stationary-side current-carrying contact 48. In addition, a tap selecting unit 55 is installed below the oil tank 50. The tap selecting unit 55 is connected to the winding of the transformer.

[0004] The change-over switch 54 collectively controls the three phases, and switches a carried current while maintaining the operation of the transformer. The change-over switch 54 cuts off and carries the carried current with the main contact in a breaker circuit being exposed to the insulation oil 56 in the oil tank 50. This scheme is called an in-oil arch switching scheme, and for example, a structure illustrated in FIGs. 18-20 is known.

[0005] As illustrated in FIG. 18, the change-over switch 54 is provided with movable contactors 36 at the M1 side, and movable contactors 38 at the M2 side. Each movable contactor 36, 38 is attached to a switch actuation link 37, and the switch actuation link 37 is coupled to a movable contactor actuation lever 43. Those movable contactors 36, 38 are each a so-called rotational arm type movable contact, and performs electrode opening-closing action relative to the stationary contact 47 (see FIG. 17) attached to the internal wall surface of the oil tank 50 with a phase difference.

[0006] In addition, the change-over switch 54 is provided with a current-carrying conductor 39 at the M1 side, and a current-carrying conductor 40 at the M2 side in order to reduce the current flowing in a breaker unit. Each current-carrying conductor 39, 40 is attached with a link 41 that supports the current-carrying conductor 39, 40, and the link 41 is coupled to an actuation lever 42. The actuation lever 42 actuates the current-carrying conductor 39, 40, in conjunction with the sequential action of the movable contactor 36, 38.

[0007] The structure of the stationary contact 47 and the stationary-side current-carrying contact 48 at the oil-tank-50 side will be explained with reference to FIG. 19. As illustrated in FIG. 19, the stationary contact 47 is provided with a stationary contactor 44 at the M1 side and a stationary contactor 54 at the M2 side. The stationary contactor 44 at the M1 side is disposed so as to face the movable contactor 36 (illustrated in FIG. 18) at the M1 side and to be in contact with and move apart from the movable contactor 36. The stationary contactor 45 at the M2 side is disposed so as to face the movable contactor 38 (illustrated in FIG. 18) at the M2 side and to be in contact with and move apart from the movable contactor 38.

[0008] In addition, as for the stationary-side current-carrying contact 48, provided on the internal wall surface of the oil tank 50 are neutral current-carrying contacts 30, 32, a tap current-carrying contact 31 at the M1 side, and a tap current-carrying contact 33 at the M2 side. According to the change-over switch 54, when the current-carrying conductors 39, 40 illustrated in FIG. 18 are actuated, the neutral current-carrying contact 30 and the tap current carrying contact 31 at the M1 side, the neutral current-carrying contact 32 and the tap current carrying contact 33 at the M1 side are alternatively short-circuit, and therefore switches a tap current-carrying.

[0009] In the above FIG. 19, the components attached to the internal wall surface of the oil tank 50 are illustrated, and now the external appearance of the oil tank 50 will be explained with reference to FIG. 20. As illustrated in FIG. 20, the oil tank 50 includes a cylindrical insulation cylinder 12, and an oil tank bottom 17 fixed to the lower part thereof. The change-over switch 54 (unillustrated in FIG. 20) is placed in the insulation cylinder 12. A tap head 10 is installed on the upper part of the oil tank 50, and a deceleration gear mechanism 11 to transmit rotation force to the change-over switch 54 is attached to the head.

[0010] Attached to the outer circumference surface of the insulation cylinder 12 are, for each phase, a neutral connection terminal 14, a tap connection terminal 15 at the M1 side, and a tap connection terminal 16 at the M2 side, and further a neutral ring 13 that couples the neutral points of the three phases. The neutral connection terminal 14 is disposed below the neutral ring 13, and the tap connection terminals 15, 16 are disposed below the neutral connection terminal 14. The tap connection terminals 15, 16 are disposed side by side in the horizontal direction by a predetermined distance therebetween.

[0011] According to the in-oil arc switching scheme change-over switch 54 as explained above, the contact wears due to an arc generated in the insulation oil 56. In addition, carbon sludge produced together with the arc may contaminate the insulation oil 56 in the oil tank 50. Hence, as for the change-over switch 54 in the in-oil arc switching scheme, the maintenance and inspection work, and the filtering work of the insulation oil 56 are essential, resulting in an increase in costs.

[0012] Therefore, instead of the in-oil arc switching scheme, a vacuum-valve scheme change-over switch that employs a breaker unit that is a vacuum valve is getting attention. According to the vacuum-valve scheme, the main contact is sealed in the vacuum valve in a high vacuum state, and a current is broken by opening and closing the vacuum valve. Thus, excellent dielectric strength and arc-extinguishing performance are achieved.

[0013] In addition, no arc is generated in the oil tank 50, suppressing a worn-out of the main contact. Furthermore, since no insulation oil 56 in the oil tank 50 is contaminated, the filtering work for the insulation oil 56 is unnecessary, extending the cycle of the maintenance and inspection work. This improves the maintenance easiness, and reduces the work costs.

CITATION LIST

PATENT LITERATURES

[0014]

Patent Document 1: JP 2006-520535A
Patent Document 2: JP H11-504755A

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0015] Since change-over switches in the vacuum-valve scheme have the above advantages, an interchange from the in-oil arc switching scheme is desired, however the following disadvantages are pointed out. When the change-over switch 54 is interchanged from the in-oil arc switching scheme to the vacuum-valve scheme, among the components attached to the internal wall surface of the oil tank 50, the stationary contact 47 is placed in the vacuum valve, and since the stationary-side current-carrying contact 48 is attached to the internal wall surface of the oil tank 50, it is necessary to replace this contact with a contact proper for the vacuum-valve scheme.

[0016] According to the vacuum-valve scheme, a large number of vacuum valves are disposed, and the opening closing mechanisms thereof are necessary. The layout of the components disposed in the oil tank is largely different from that of the in-oil arc switching scheme. Hence, according to conventional technologies, when an interchange from the in-oil arc switching scheme to the vacuum-valve scheme is made, it is necessary to replace the whole oil tank 50 or to modify the oil tank 50 to meet the vacuum-valve scheme.

[0017] However, since the oil tank 50 is directly installed in the transformer main tank 60, it is difficult to detach the oil tank 50 from the transformer main tank 60. In addition, in general, the service life of the oil tank 50 is designed to be substantially consistent with that of the transformer main tank 60. Accordingly, there is a desire to interchange the change-over switch 54 from the in-oil arc switching scheme to the vacuum-valve scheme but use the oil tank 50 for a long time with the transformer main tank 60 without a replacement and a modification.

[0018] In recent years, there is a need to enhance so-called retrofit function, which is a function to maximize the performance at low costs by effectively utilizing the existing facilities as much as possible. Hence, in the field of on-load tap changers, although an interchange from the in-oil arc switching scheme to the vacuum-valve scheme is made, there is an anticipation to continuously utilize the oil tank 50 that has a long service life without a replacement or modifications.

[0019] In addition, according to vacuum-valve scheme change-over switches, a plurality of actuation mechanisms, such as a mechanism to open and close the vacuum valve, and a mechanism that actuates the current-carrying conductor in conjunction therewith, is provided. An example and typical actuation mechanism is a toggle ring having a complex structure. In the case of the vacuum-valve scheme, in particular, when a large number of vacuum valves are to be disposed, it is difficult to construct the actuation mechanism in the limited space that is the interior of the oil tank 50.

[0020] Embodiments of the present disclosure have been proposed to address the aforementioned technical problems, and an objective is to provide an on-load tap changer which ensures the compatibility of an oil tank when an interchange from the in-oil arc switching scheme to the vacuum-valve scheme is made, enhancing a retrofit function, achieving a space saving by simplifying components, and facilitating a construction of an actuation mechanism.

SOLUTION TO PROBLEM

[0021] In order to achieve the above objective, according to an embodiment of the present disclosure, an on-load tap changer includes an oil tank filled with an insulation oil, and a vacuum-valve scheme change-over switch placed in the oil tank, the change-over switch includes a main contact contained a vacuum valve, and a current-carrying conductor reducing a current flowing in the main contact. This on-load tap changer includes the following features.

[0022]

(a) A current-carrying cam rotatable around a center axis of the change-over switch;
(B) A parallel link mechanism receiving rotation force from the current-carrying cam, and actuating the current-carrying conductor in a parallel manner and in a radial direction of the change switch; and
(C) A stationary-side current-carrying contact attached to an internal wall surface of the oil tank, and

capable of contacting with and separating from the current-carrying contact.

(D) The change-over switch is freely attachable to and detachable from the oil tank with the stationary-side current-carrying contact being attached to the oil tank.

BRIEF DESCRIPTION OF DRAWINGS

[0023]

FIG. 1 is a structural diagram according to a first embodiment;
FIG. 2 is a perspective view illustrating an entire change-over switch according to the first embodiment;
FIG. 3 is a perspective view illustrating a breaker unit of the change-over switch in the first embodiment;
FIG. 4 is a perspective view illustrating a parallel link mechanism in the first embodiment;
FIG. 5 is a perspective view illustrating the parallel link mechanism in the first embodiment;
FIG. 6 is a perspective view illustrating the parallel link mechanism in the first embodiment;
FIG. 7 is a side view illustrating the parallel link mechanism in the first embodiment;
FIG. 8 is a plan view illustrating the parallel link mechanism in the first embodiment;
FIGs. 9A-9C are each a plan view for explaining an action of the parallel link mechanism in the first embodiment;
FIG. 10 is a perspective view for explaining the action of the parallel link mechanism in the first embodiment;
FIG. 11 is a perspective view for explaining the action of the parallel link mechanism in the first embodiment;
FIG. 12 is a perspective view for explaining the action of the parallel link mechanism in the first embodiment;
FIG. 13 is a perspective view for explaining the action of the parallel link mechanism in the first embodiment;
FIG. 14 is a perspective view for explaining the action of the parallel link mechanism in the first embodiment;
FIGs. 15A-15C are each a breaker circuit diagram of the change-over switch in the first embodiment;
FIG. 16 is a change sequence of the breaker unit of the change-over switch in the first embodiment;
FIG. 17 is a structural diagram illustrating a general on-load tap changer;
FIG. 18 is a major part perspective view of a change-over switch in an in-oil arc switching scheme;
FIG. 19 is a major part plan view of the change-over switch in the in-oil arc switching scheme; and
FIG. 20 is a perspective view illustrating an external appearance of an oil tank that houses therein the change-over switch in the in-oil arc switching scheme.

DESCRIPTION OF EMBODIMENTS

(First Embodiment)

(Structure)

[0024] A first embodiment will be explained in detail with reference to FIGs. 1-16. According to the first embodiment, an improvement is made to the change-over switch of an on-load tap changer, and the same component as that of the conventional on-load tap changer illustrated in FIG. 17 will be denoted by the same reference numeral, and the explanation thereof will be omitted.

(Feature of Change-Over Switch)

[0025] As illustrated in FIG. 1, a change-over switch 46 according to the first embodiment employs the vacuum-valve scheme, and a stationary-side current-carrying contact 48 is attached to the internal wall surface of an oil tank 50. The oil tank 50 and the stationary-side current-carrying contact 48 employ the same structures as those of the conventional in-oil arc switching scheme illustrated in FIG. 19, 20. That is, the stationary-side current-carrying contact 48 includes neutral current-carrying contacts 30, 32, a tap current-carrying contact 31 at the M1 side, and a tap current-carrying contact 33 at the M2 side, as illustrated in FIG. 19 .

[0026] In the first embodiment, a feature such that the change-over switch 46 is freely attachable to and detachable from the oil tank 50 while the stationary-side current-carrying contact 48 being attached to the oil tank 50 is employed. Hence, when the change-over switch 46 is to be detached from the oil tank 50, or when the change-over switch 46 is to be attached to the oil tank 50, no component is provided at the location that disturbs the attachment and detachment work of the change-over switch 46 at both the oil-tank-50 side and the change-over-switch-46 side.

(Entire Change-Over Switch)

[0027] As illustrated in FIG. 2, a ground shield 18 is installed on the upper part of the change-over switch 46, and an accumulating mechanism 19 is attached just below. A breaker unit 49 is built in the lower part of the accumulating mechanism 19. Provided on the outer circumference of the breaker unit 49 are a slide neutral contact 20, a slide M1 contact 21, and a slide M2 contact 22.

[0028] The slide neutral contact 20, the slide M1 contact 21, and the slide M2 contact 22 are abutting to a neutral connection terminal 14, tap connection terminals 15, 16 (located outside the oil tank 50) explained in reference to FIG. 20, and are contacts that draw a current into the change-over switch 46. In addition, a current limiting resistor 23 and a varistor 24 are provided at the lower part of each contact 20-22. The varistor 24 is to protect a part between current-breaking electrodes of the change-over switch 54 when an abnormal surge voltage is applied between taps.

(Breaker Unit of Change-Over Switch)

[0029] The breaker unit 49 of the change-over switch 46 will be explained with reference to FIG. 3. In FIG. 3, with the left side and the right being defined as the M1 side and the M2 side, respectively, vacuum valves that are an M1-side main valve 2, an M2-side main valve 3, an M1-side resistance valve 5, and an M2-side resistance valve 6 are provided. All of the vacuum valves are formed of cylindrical components, and are installed in such way that the lengthwise direction of the cylindrical component is in parallel with the axial-line direction of the breaker unit 49.

[0030] The breaker unit 49 is provided with three phases that are the U-phase, the V-phase, and the W-phase, and the four vacuum valves per each phase, that is, a total of 12 vacuum valves in the three phases are attached to breaker holders 4. The breaker holder 4 is provided at the middle part of the breaker unit 49, and is provided for each phase respectively. An opening-closing mechanism for the vacuum valves including the four vacuum valves, and a parallel link mechanism that actuates current-carrying conductors 7, 8 in a parallel manner are attached to the breaker holder 4.

[0031] In addition, the current-carrying conductor 7 at the M1 side and the current-carrying conductor 8 at the M2 side are provided adjacent to the M1-side resistance valve 5, and the M2-side resistance valve 6, respectively. The current-carrying conductors 7, 8 close electrodes to carry the current after the tap change, thereby suppressing a deterioration of the current-breaking performance in the breaker unit 49 to enhance the durability performance, and contributing to the downsizing and the simplification of the change-over switch 46. In addition, a resistance switch holder 9 is provided below the resistance valves 5, 6. The resistance switch holder 9 is built with a switch mechanism (unillustrated) that ensures the insulation of the non-current-carrying tap.

[0032] A change crank 1 is provided at the upper part of the breaker unit 49. The change crank 1 is coupled to the opening-closing mechanism for the vacuum valve, the parallel link mechanism that actuates the current-carrying conductor 7, 8 in the parallel manner, and the switch mechanism that ensures the insulation of the non-current-carrying tap. Those mechanisms are actuated by the rotation of the change crank 1.

(Parallel Link Mechanism)

[0033] Next, an explanation will be given of the parallel link mechanism that actuates the current-carrying conductor 7, 8 in the parallel manner. The parallel link mechanism is a current-carrying contact mechanism that actuates the current-carrying conductor 7, 8, moves in and out the current-carrying conductor 7, 8 in the radial direction of the change-over switch 46 upon receiving rotation forces from current-carrying cams 26, 29, causes M1, M2 taps in the stationary-side current-carrying contact 48 to be alternately short-circuited, thereby switching the current-carrying.

[0034] The current-carrying cam 26 is a component that actuates the parallel link mechanism, and is a cam component in a disk shape provided to be freely rotatable around the center axis of the change-over switch 46. As illustrated in FIGs. 3, 4, the current-carrying cam 26 is disposed to engage with the respective upper parts of the current-carrying conductors 7, 8. In addition, as illustrated in FIG. 4, the current-carrying cam 29 is disposed to engage with the respective lower parts of the current-carrying conductors 7, 8.

[0035] The structure of the parallel link mechanism will be explained in further detail. As illustrated in FIG. 4, the parallel link mechanism is provided with a pair of current-carrying links 27, and one end of the current-carrying links 27 rotatably support the current-carrying conductors 7, 8 via coupling shafts 7b, 8b. A current-carrying link support pin 28 is attached to the other end of the current-carrying link 27. The current-carrying link support pin 28 is a component elongated in the axial-line direction of the breaker unit 49. The end of the current-carrying link support pin 28 is rotatably supported by a current-carrying link support hole 25 (shown in FIG. 5) formed in the breaker holder 4.

[0036] As already explained above, provided at the oil-tank-50 side are the stationary-side current-carrying contact 48 that includes the neutral current-carrying contacts 30, 32, and the tap current-carrying contacts 31, 33 at the M1 side and M2 side respectively. Those current-carrying contacts 30-33 will be explained with reference to FIGs. 6-8. As illustrated in FIGs. 6, 7, the tap current-carrying contact 31 at the M1 side is disposed under the neutral current-carrying contact 30, and the tap current-carrying contact 33 at the M2 side is disposed under the neutral current-carrying contact 32.

[0037] As illustrated in FIGs. 7, 8, actuation rollers 7a, 8a are provided to respective upper end and lower end of the current-carrying conductors 7, 8 in free rotatable manner, and the upper current-carrying cam 26 and the lower current-carrying cam 29 are installed to sandwich the actuation rollers 7a, 8a from above and below. Cam grooves 26a, 29a are formed in the current-carrying cams 26, 29, respectively, and are engaged with the actuation rollers 7a, 8a.

[0038] Hence, when the current-carrying cam 26, 29 rotate, the cam grooves 26a, 29a respectively move the actuation rollers 7a, 8a, and thus the current-carrying conductors 7, 8 are actuated. The actuated current-carrying conductors 7, 8 move in and out in the radial direction of the change-over switch 46, and therefore being in contact with or retracted from the current-carrying contacts 30-33 fastened at the oil-tank-50 side, thereby switching the tap carrying the current between the M1 and the M2.

[0039] The parallel link mechanisms in this embodiment are disposed at both ends of a divided region per a phase. That is, as illustrated in FIG. 8, the three phases (U-phase, V-phase, and W-phase) are similarly provided at a dividing angle of 120 degrees, and the parallel link mechanisms are supported by the respective current-carrying link support holes 25 (see FIG. 5) formed in the breaker holders 4 at both ends of the respective divided regions for the three phases, and are disposed in a mirror-image manner. In addition, as illustrated in FIG. 8, the resistance valves 5, 6 at the M1 and M2 sides are disposed between the link mechanisms.

(Action of Parallel Link Mechanism)

[0040] An explanation will be given of an action of the parallel link mechanism, that is, the current-carrying contact mechanism of the change-over switch in the first embodiment with reference to FIGs. 9A-9C and FIGs. 10-14. In FIG. 9A, the M1 side closes to form a current-carrying electrode closing unit 34 at the M1 side, while at the same time, the M2 side opens to form a current-carrying electrode opening unit 35 at the M2 side. This state corresponds to FIG. 10. In FIG. 10, the current-carrying conductor 7 at the M1 side becomes a current-carrying ON state while the current-carrying conductor 8 at the M2 side becomes a current-carrying OFF state, and it will be at the current-carrying position of M1.

[0041] In this state, when the current-carrying cams 26, 29 rotate in the counterclockwise direction, as illustrated in FIG. 9B, both M1 and M2 become the electrode opening state. That is, the current-carrying electrode closing unit 34 at the M1 side now becomes a current-carrying electrode opening unit 36, and the current-carrying electrode opening unit 35 at the M2 side remains unchanged. This state corresponds to FIGs. 11-13. That is, a switching action that causes the current-carrying conductor 7 at the M1 side to be retracted is performed, and in FIGs. 11, 12, both M1 and M2 sides are in the current-carrying OFF state. In addition, when the state transitions to the stage illustrated in FIG. 13, the current-carrying conductor 8 at the M2 side starts moving so as to move outwardly from the center direction relative to the radial direction of the change-over switch 46.

[0042] When the current-carrying cams 26, 29 further keep rotating in the counterclockwise direction, as illustrated in FIG. 9C, the M1 side becomes the electrode opening state, and the M2 side becomes the electrode closing state, and the current-carrying electrode opening unit 36 at the M1 side remains unchanged while the M2 side now becomes a current-carrying electrode closing unit 37, and the tap switching action completes. This state corresponds to FIG. 14. In FIG. 14, the current-carrying conductor 7 at the M1 side becomes the current-carrying OFF state while the current-carrying conductor 8 at the M2 side becomes the current-carrying ON state, and it will be at the current-carrying position of M2.

[0043] FIGs. 15A-15C each illustrate a circuit diagram of the breaker unit 49 in this embodiment. FIGs. 9A-9C correspond to FIGs. 15A-15C, respectively. In FIGs. 15A-15C, the M1 side of the parallel link mechanism that is the contact current-carrying mechanism is indicated as B_{so}, while the M2 side is indicated as B_{se}. Reference signs 34-37 in FIGs. 15A-15C are the same as those of FIGs. 9A-9C, and 34, 35, 36, and 37 indicate the current-carrying electrode closing unit at the M1 side, the current-carrying electrode opening unit the M2 side, the current-carrying electrode opening unit at the M1 side, and the current-carrying electrode closing unit at the M2 side, respectively.

[0044] In addition, FIG. 16 illustrates an exemplary switching sequence of the breaker unit 49 in this embodiment. In this embodiment, the switching angle range is set to 0-75 degrees, the M1 side closes the electrode at 0-10 degrees, and opens the electrode at 10-75 degrees. In addition, the M2 side is set to open the electrode at 0-65 degrees, and to close the electrode at 65-75 degrees. Reference signs 34, 35 in FIG. 16 are the same as those of FIGs. 9A-9C, and 34, 35 indicate the current-carrying electrode closing unit at the M1 side, and the current-carrying electrode opening unit at the M2 side, respectively.

(Action and Effect)

[0045] The first embodiment as explained above achieves the following actions and effects.

(1) According to the first embodiment, the change-over switch 46 is attachable to and detachable from the oil tank 50 with the stationary-side current-carrying contact 48 being attached to the oil tank 50. The structure of the oil tank 50 and that of the stationary-side current-carrying contact 48 attached thereto employ the same structures as those of the conventional in-oil arc switching scheme illustrated in FIG. 19.
Hence, even when the change -over switch 46 is interchanged from the in-oil arc switching scheme to the vacuum-valve scheme, the compatibility of the oil tank 50 that contains the change-over switch 46 is is ensured, and thus a replacement and modifications of the oil tank 50 are unnecessary at all. This enables a continuous use of the oil tank 50 without a replacement or modifications. Hence, the oil tank 50 that has the substantially same service life as that of the transformer main tank 60 can still be used for a long time, improving the retrofit function.

(2) The parallel link mechanism that actuates the current-carrying conductor 7, 8 in the parallel manner is formed by simple components such as the current-carrying link 27 and the current-carrying link support pin 28. In addition, the current-carrying cams 26, 29

that apply actuation forces to the parallel link mechanism are components in a disk shape that rotate around the center axis of the change-over switch 46. Hence, the change-over switch 46 does not need to increase the dimension in the radial direction, suppressing an increase in dimension of the mechanism.

Accordingly, the current-carrying contact mechanism can be provided while achieving a space saving in the first embodiment. In the first embodiment, since the 12 vacuum valves are disposed, the available space in the oil tank 50 is not large, but by employing the parallel link mechanism that has an excellent space saving performance, a construction of the mechanism is facilitated, ensuring the achievement of the vacuum-valve scheme.

(3) Since the current-carrying cams 26, 29 are engaged with the upper part and the lower part of the current-carrying conductors 7, 8 respectively, the current-carrying cams 26, 29 are capable of uniformly receiving contact pressures by the current-carrying conductors 7, 8 from above and below. Hence, the current-carrying conductors 7, 8 are capable of obtaining sufficient contact forces to the current-carrying contacts 30-33, enabling the parallel link mechanism to obtain a high reliability as the current-carrying contact mechanism.

(4) According to the first embodiment, the parallel link mechanisms that are each the current-carrying contact mechanism are disposed at both ends of the divided region per a phase. Hence, a plurality of vacuum valves can be disposed between the parallel link mechanisms per a phase. Consequently, the space saving performance is further improved, contributing a further downsizing of the change-over switch 46.

(5) The breaker holder 4 each provided per a phase is attached with the opening-closing mechanism for the vacuum valve, and the current-carrying contact mechanism, that is, the parallel link mechanism. Hence, the actuation timing of the vacuum valve and the actuation timing of the current-carrying contact are ensured per a phase by the manufacturing accuracy of the breaker holder 4 that is a single component. Hence, the actuation timing does not depend on the assembling accuracy of the opening-closing mechanism for the vacuum valve and the parallel link mechanism that is the current-carrying contact mechanism, and thus the actuation timing of the vacuum valve and the current-carrying contact are highly precisely synchronized with each other.

(Other Embodiments)

[0046] The above embodiment is merely presented as an example in this specification, and is not intended to limit the scope of the present disclosure. That is, the present disclosure can be carried out in other various forms, and various omissions, replacements, and modifications can be made thereto without departing from the scope of the present disclosure. Such embodiments and modified forms thereof are within the scope of the present disclosure, and also within the scope of the invention as recited in the appended claims and the equivalent range thereto.

[0047] For example, as for the change-over switch with the exception of the stationary-side current-carrying contact, the oil tank may be provided with an opening that enables the entire change-over switch to be taken out, and a lid to close this opening may be provided in a manner slidable in the horizontal direction. According to such embodiment, even if the deceleration gear mechanism, etc., is provided near the opening, by sliding and opening the lid so as not to collide such mechanism, a take-out work of the change-over switch from the oil tank is made efficient.

REFERENCE SIGNS LIST

[0048]

1	Change crank
2	M1-side main valve
3	m2-side main valve
4	Breaker holder
5	M1-side resistance valve
6	M2-side resistance valve
7	M1-side current-carrying conductor
8	M2-side current-carrying conductor
9	Resistance switch holder
14	Neutral contact terminal
15,	16 Tap connection terminal
18	Ground shield
19	Accumulating mechanism
20	Slide neutral contact
21	Slide M1 contact
22	Slide M2 contact
23	Current Limiting resistor
24	Varistor
25	Current-carrying link support hole
26, 29	Current-carrying cam
27	Current-carrying link
28	Current-carrying link support pin
30,	32 Neutral current-carrying contact
31	M1-side tap current-carrying contact
33	M2-side tap current-carrying contact
34	M1-side current-carrying electrode closing unit
35	m2-side current-carrying electrode opening unit
36	M1-side current-carrying electrode opening unit
37	M2-side current-carrying electrode closing unit
46	Change-Over switch
47	Stationary electrode
48	Stationary-side current-carrying contact
49	Breaker unit

50	Oil tank
51	On-load tap changer
52	On-load tap switching unit
53	Electric actuation mechanism
54	Change-Over switch
55	Tap selecting unit
56	Insulation oil
60	Transformer main tank

Claims

1. An on-load tap changer comprising an oil tank filled with an insulation oil, and a vacuum-valve scheme change-over switch placed in the oil tank, the change-over switch comprising a main contact contained in a vacuum valve, and a current-carrying conductor reducing a current flowing in the main contact, the on-load tap changer further comprising:

a current-carrying cam rotatable around a center axis of the change-over switch;
a parallel link mechanism receiving rotation force from the current-carrying cam, and actuating the current-carrying conductor in a parallel manner and in a radial direction of the change-over switch; and
a stationary-side current-carrying contact attached to an internal wall surface of the oil tank, and capable of contacting with and separating from the current-carrying contact,
wherein the change-over switch is freely attachable to and detachable from the oil tank with the stationary-side current-carrying contact being attached to the oil tank.

2. The on-load tap changer according to claim 1, wherein the oil tank and the stationary-side current-carrying contact are same types as an oil tank and a stationary-side current-carrying contact applied for a change-over switch in an in-oil arc switching scheme in which a breaker is exposed to the insulation oil in the oil tank.

3. The on-load tap changer according to claim 1 or 2, wherein a plurality of the current-carrying cams is disposed to engage with an upper part of the current-carrying conductor and a lower part of the current-carrying conductor, respectively.

4. The on-load tap changer according to any one of claims 1-3, wherein a plurality of the parallel link mechanisms is disposed at both ends of a divided region in the change-over switch per a phase.

5. The on-load tap changer according to any one of claims 1-4, wherein:

a breaker holder is provided per a phase in the change-over switch; and
an opening-closing mechanism for the vacuum valve and the parallel link mechanism are attached to the breaker holder.

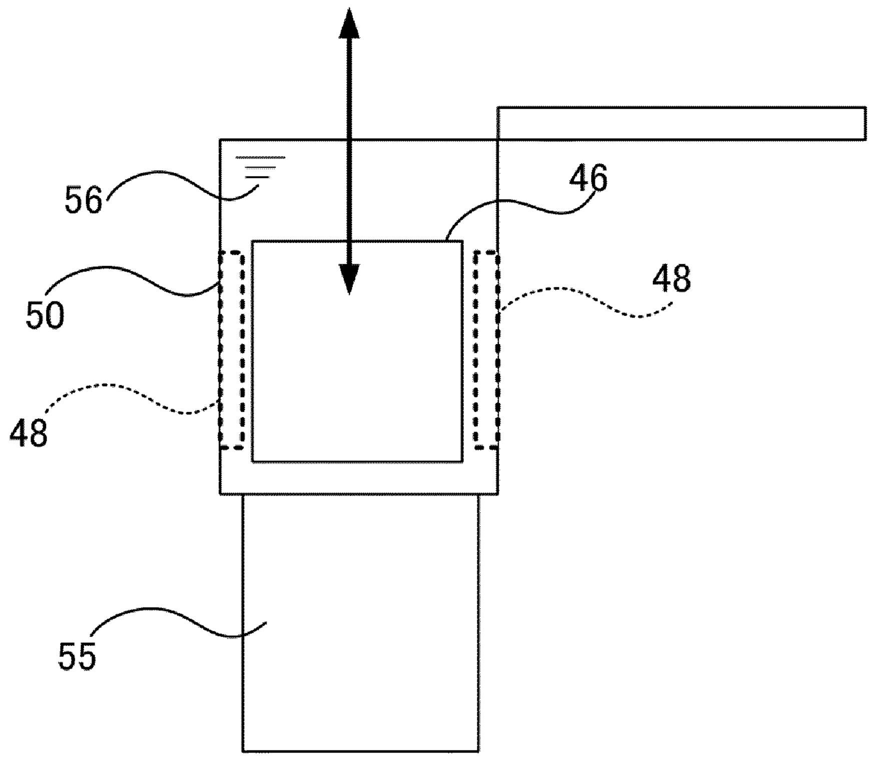

FIG. 1

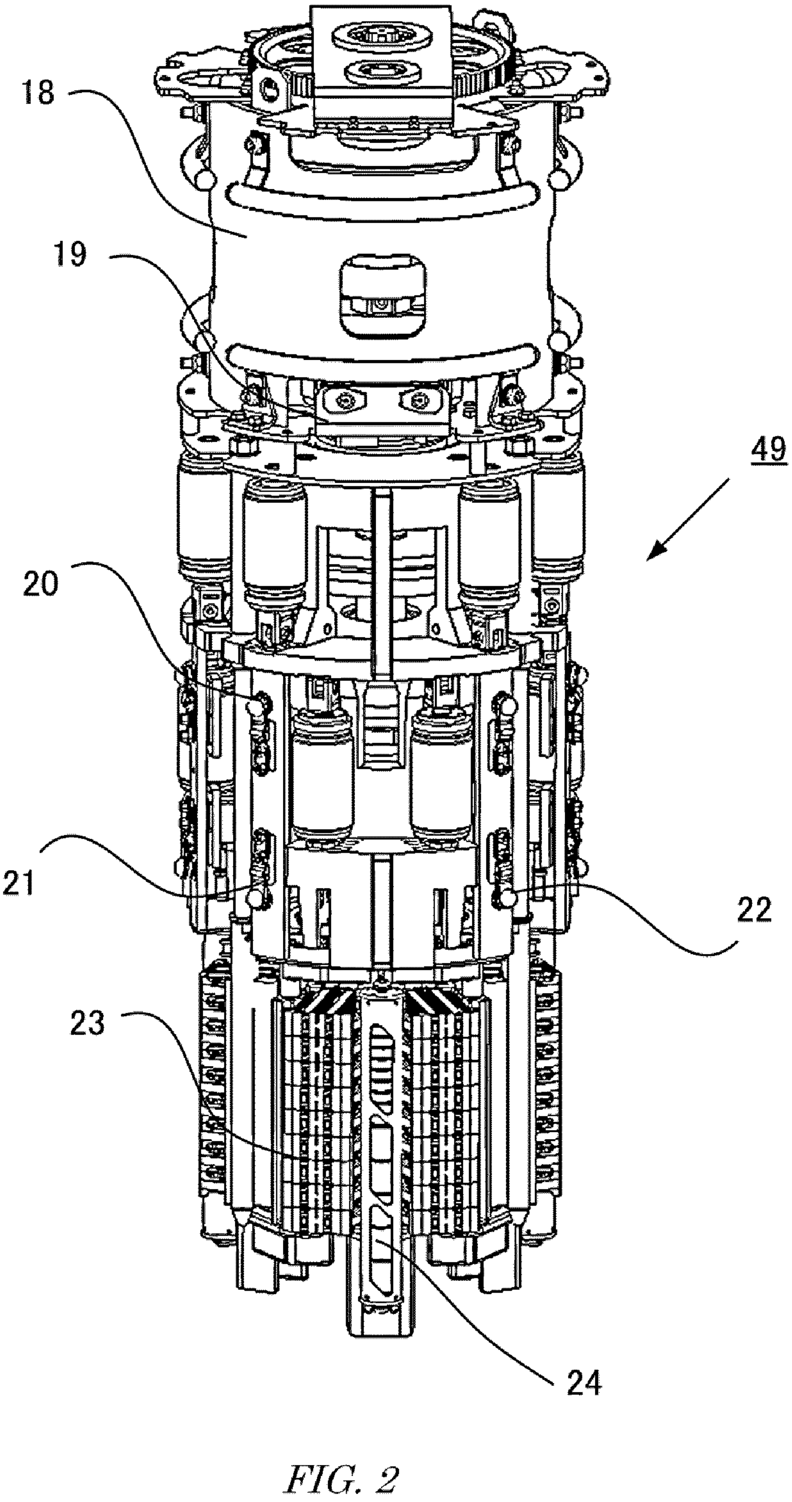

FIG. 2

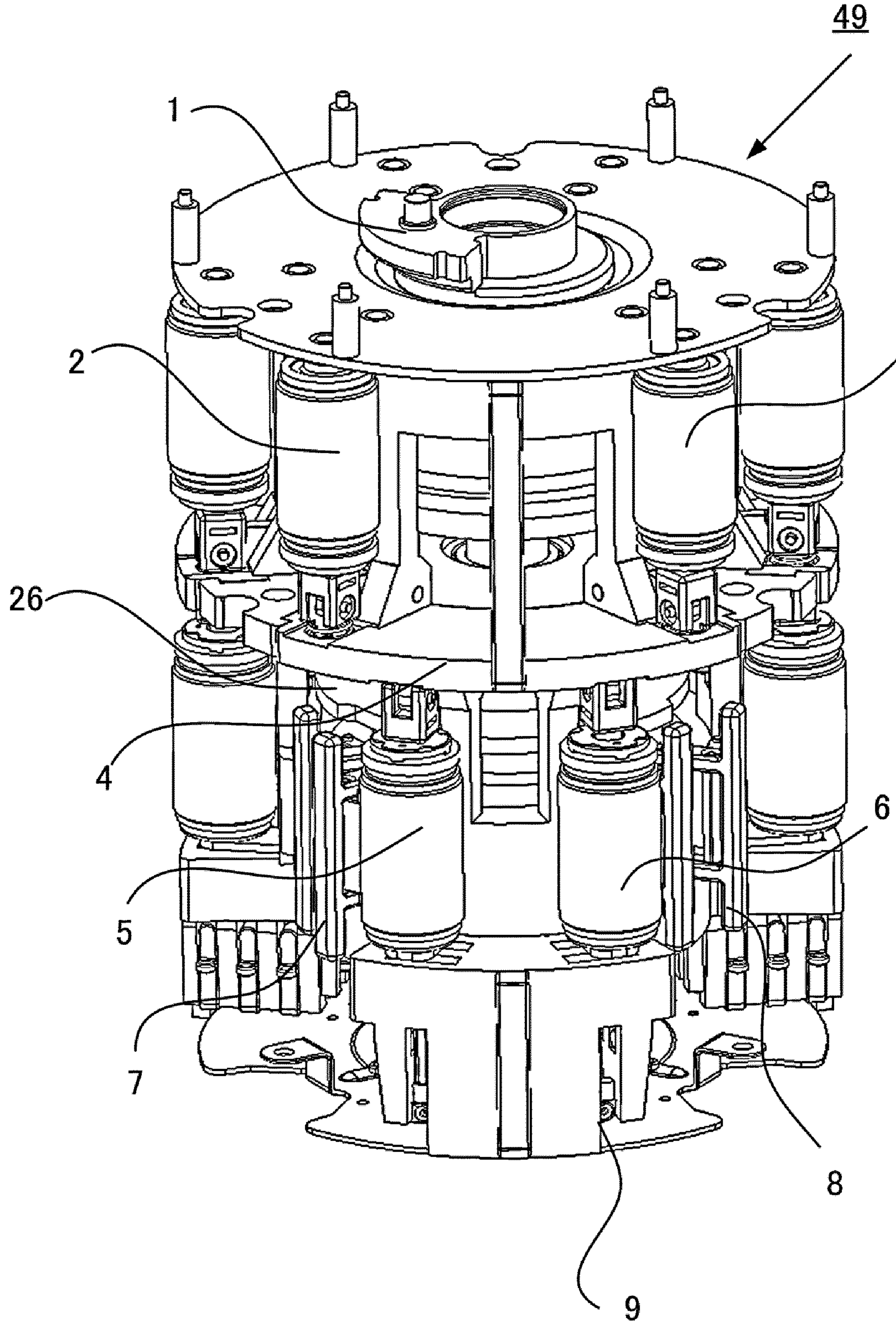

FIG. 3

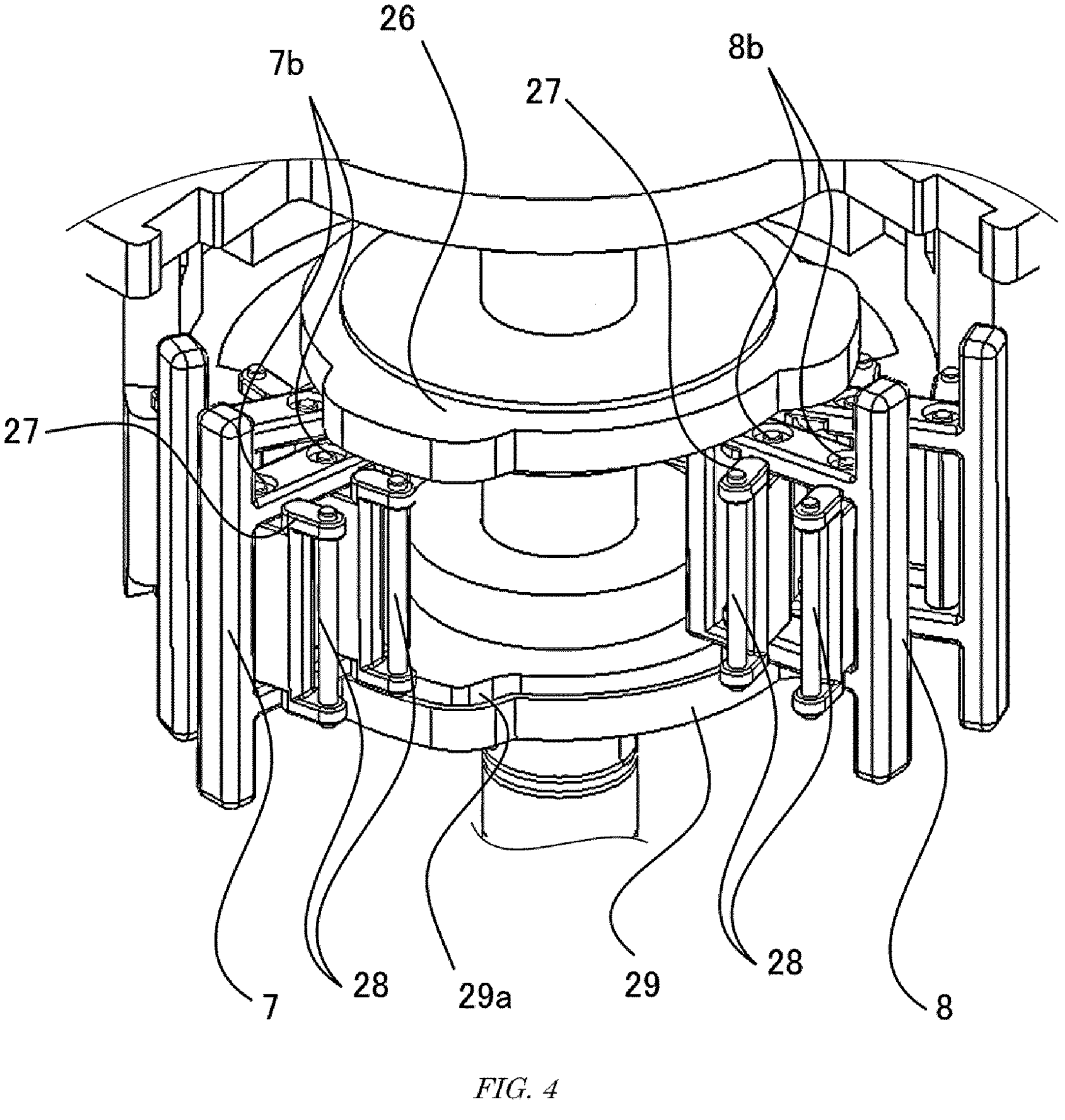

FIG. 4

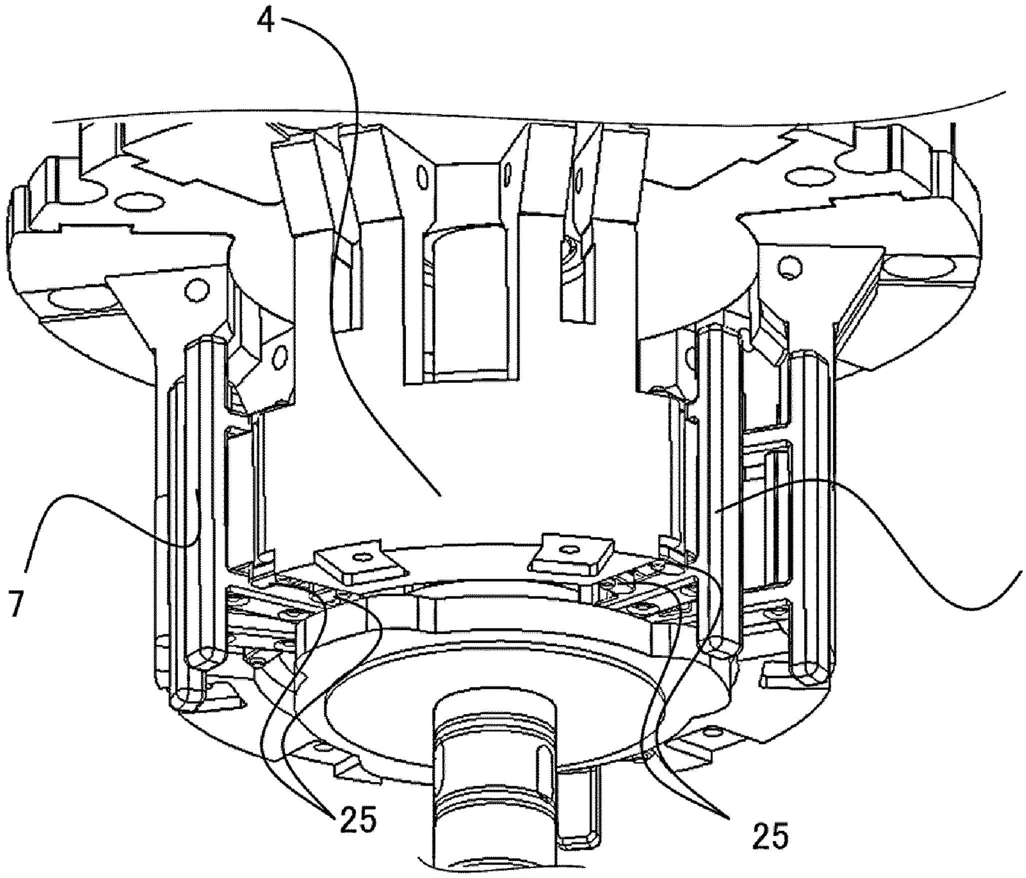

FIG. 5

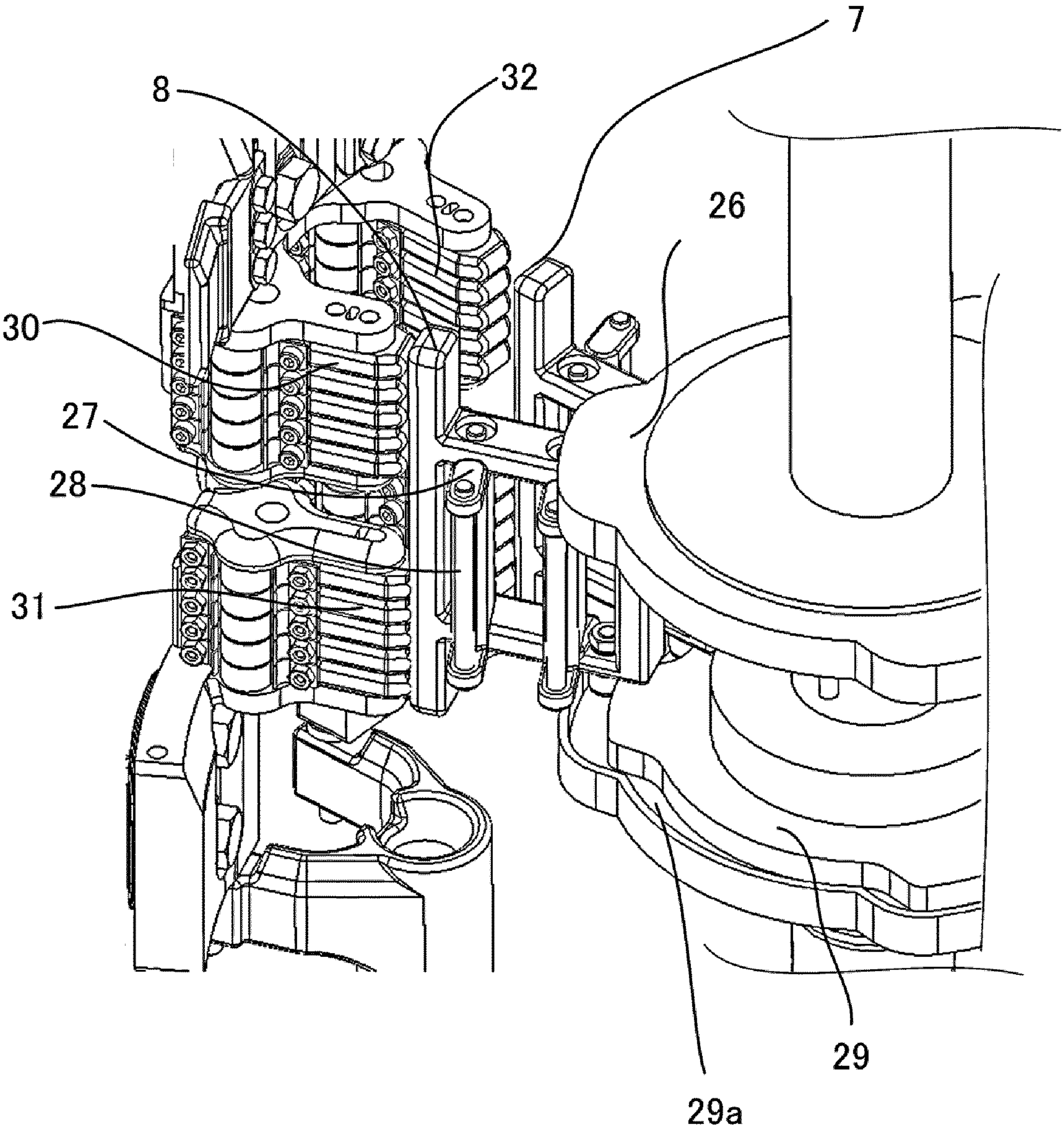

FIG. 6

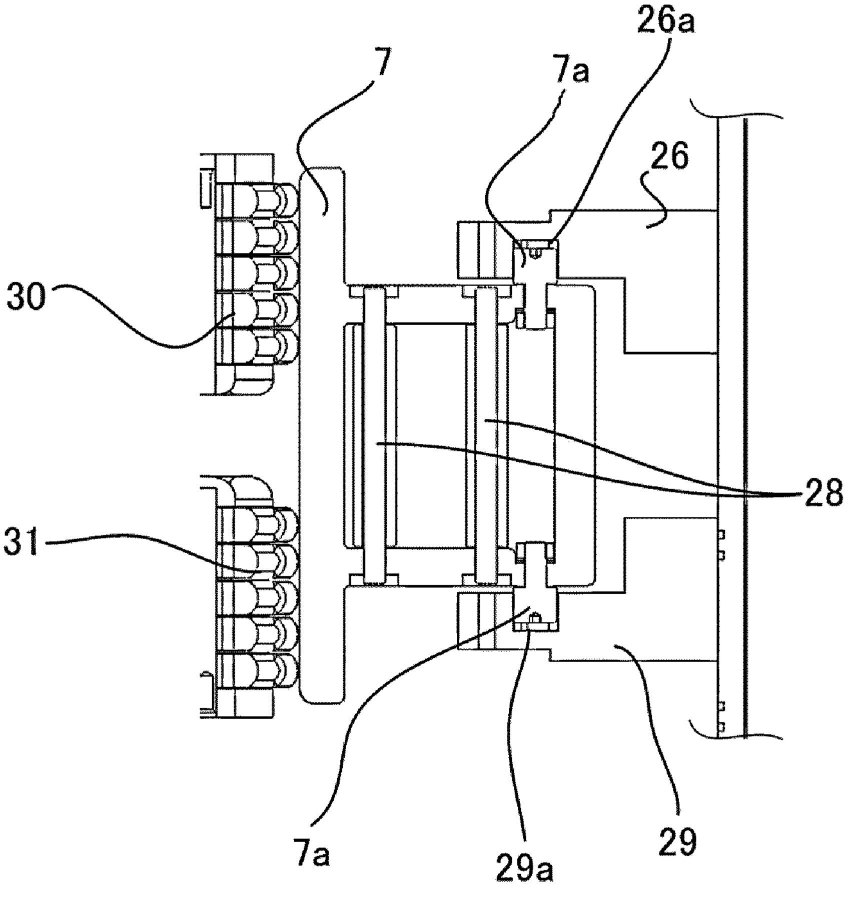

FIG. 7

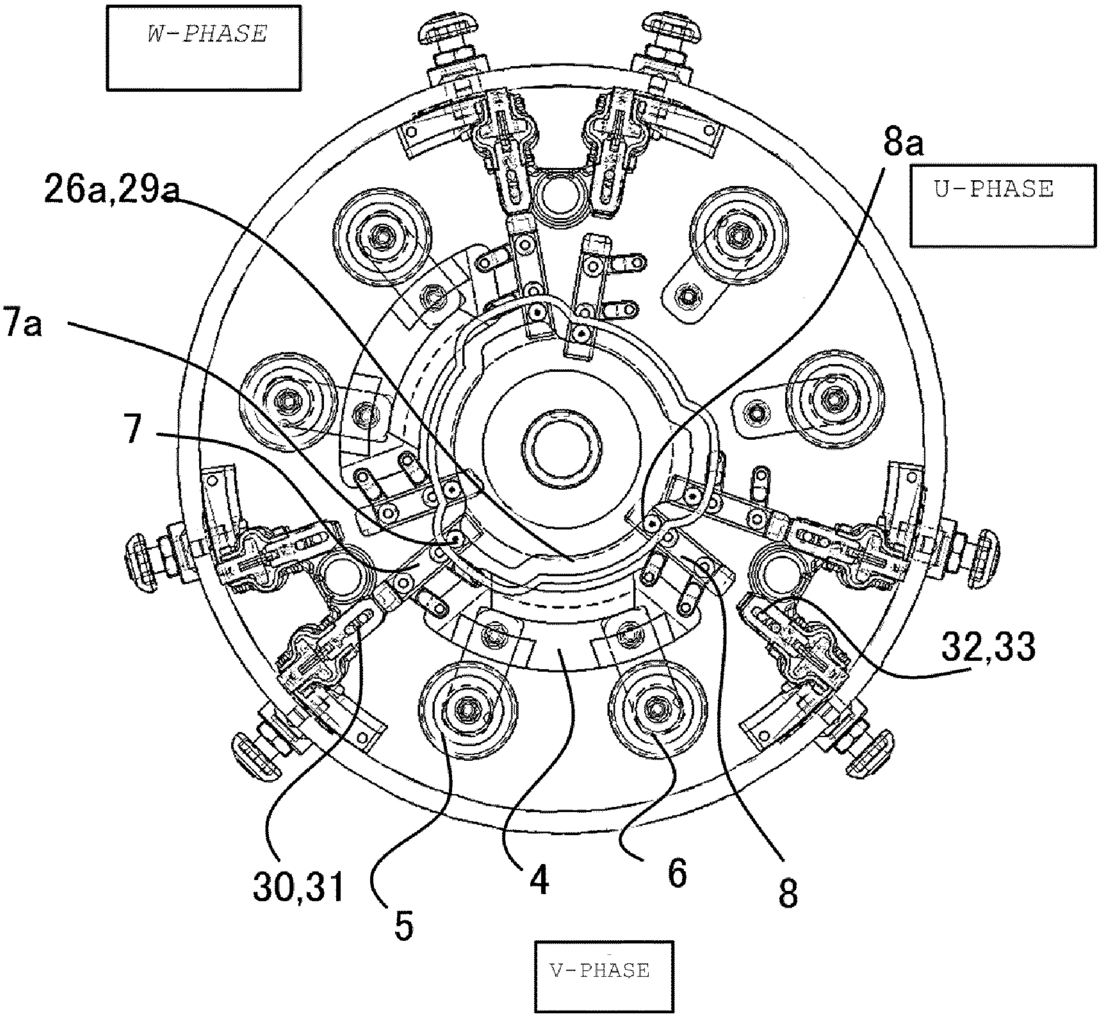

FIG. 8

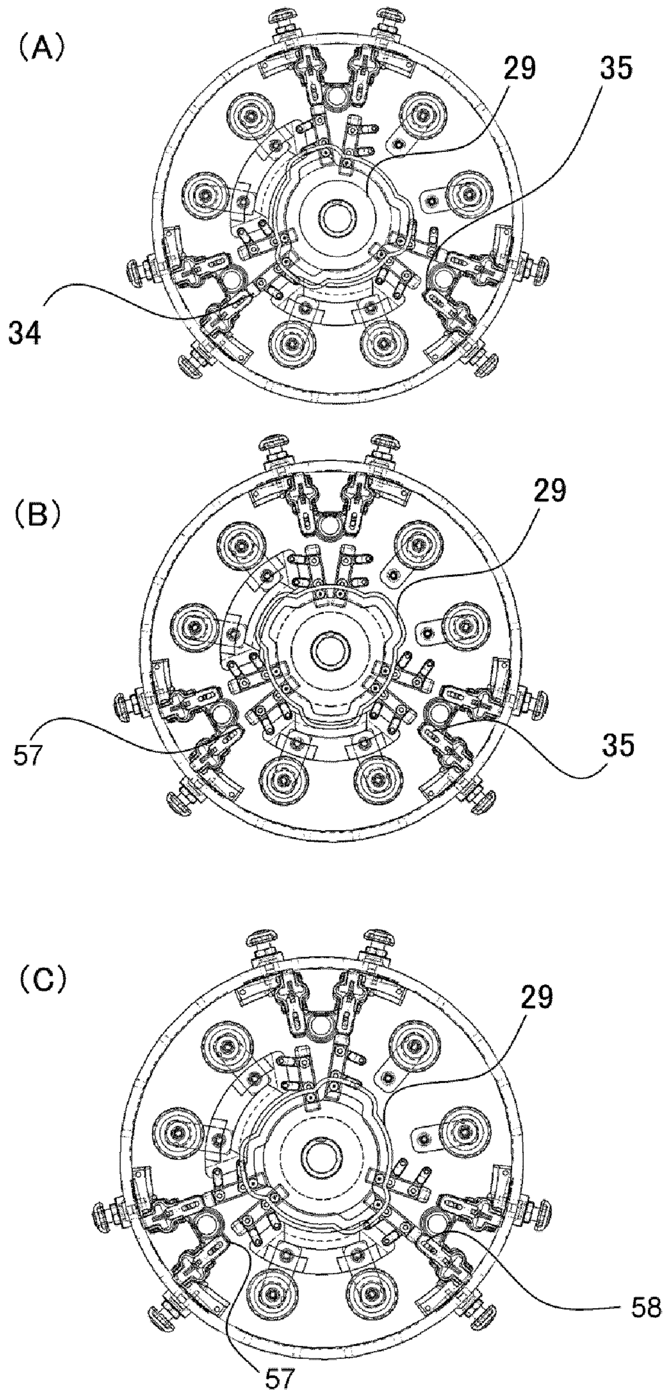

FIG. 9

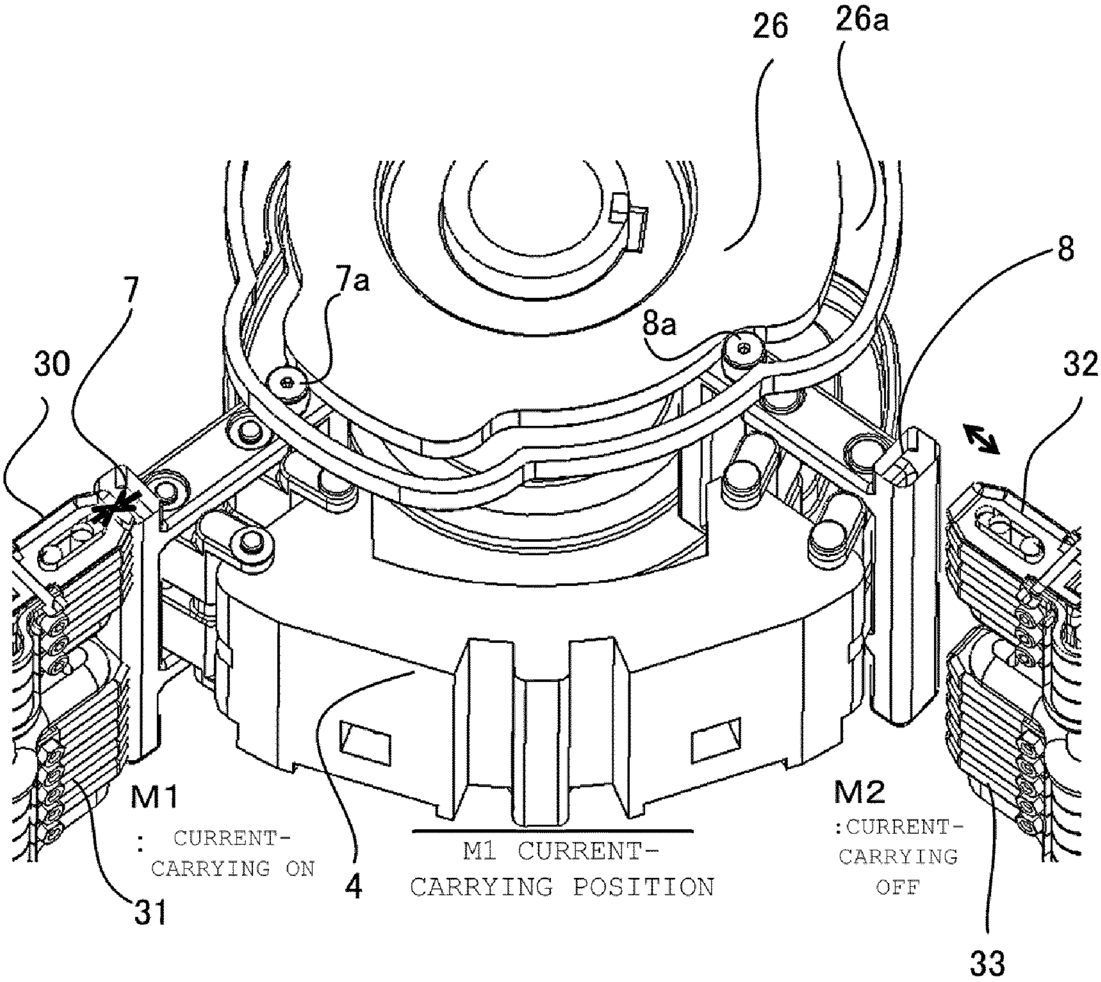
26
26a
8
7a
7
8a
30
32
M1
: CURRENT-
CARRYING ON
31
4
M1 CURRENT-
CARRYING POSITION
M2
:CURRENT-
CARRYING
OFF
33

FIG. 10

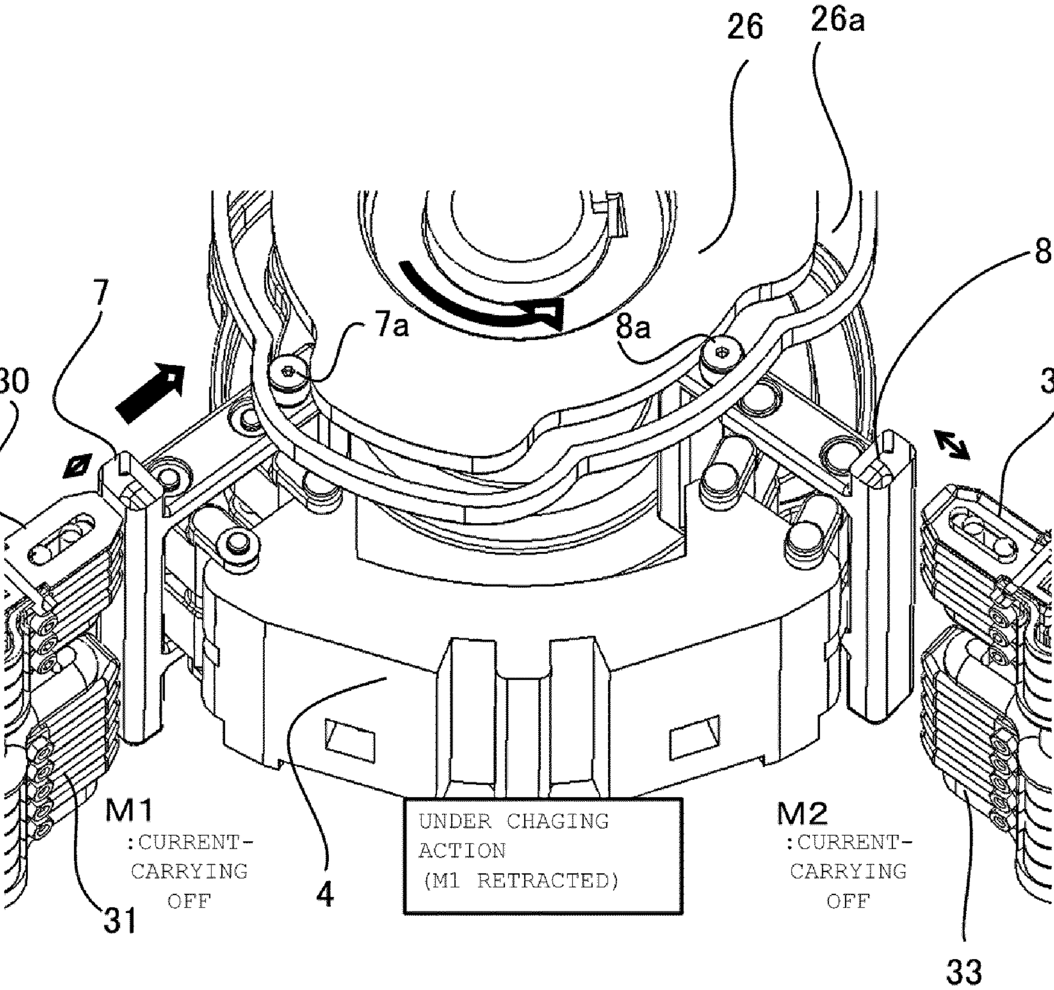
26
26a
8
7
7a
8a
30
32
M1
:CURRENT-
CARRYING
OFF
31
4
UNDER CHAGING
ACTION
(M1 RETRACTED)
M2
:CURRENT-
CARRYING
OFF
33

FIG. 11

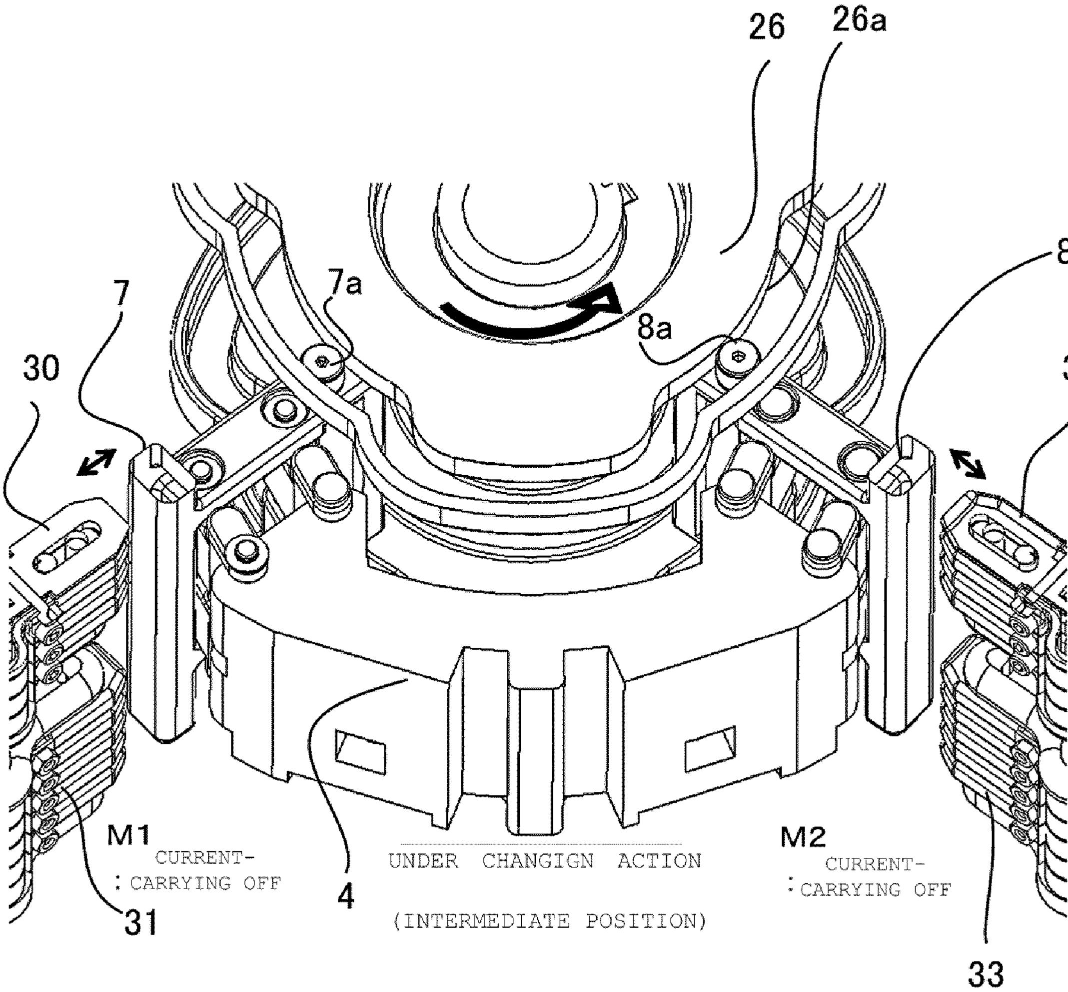
26
26a
7
7a
8a
8
30
32
M1
CURRENT-
: CARRYING OFF
31
4
UNDER CHANGIGN ACTION
(INTERMEDIATE POSITION)
M2
CURRENT-
: CARRYING OFF
33

FIG. 12

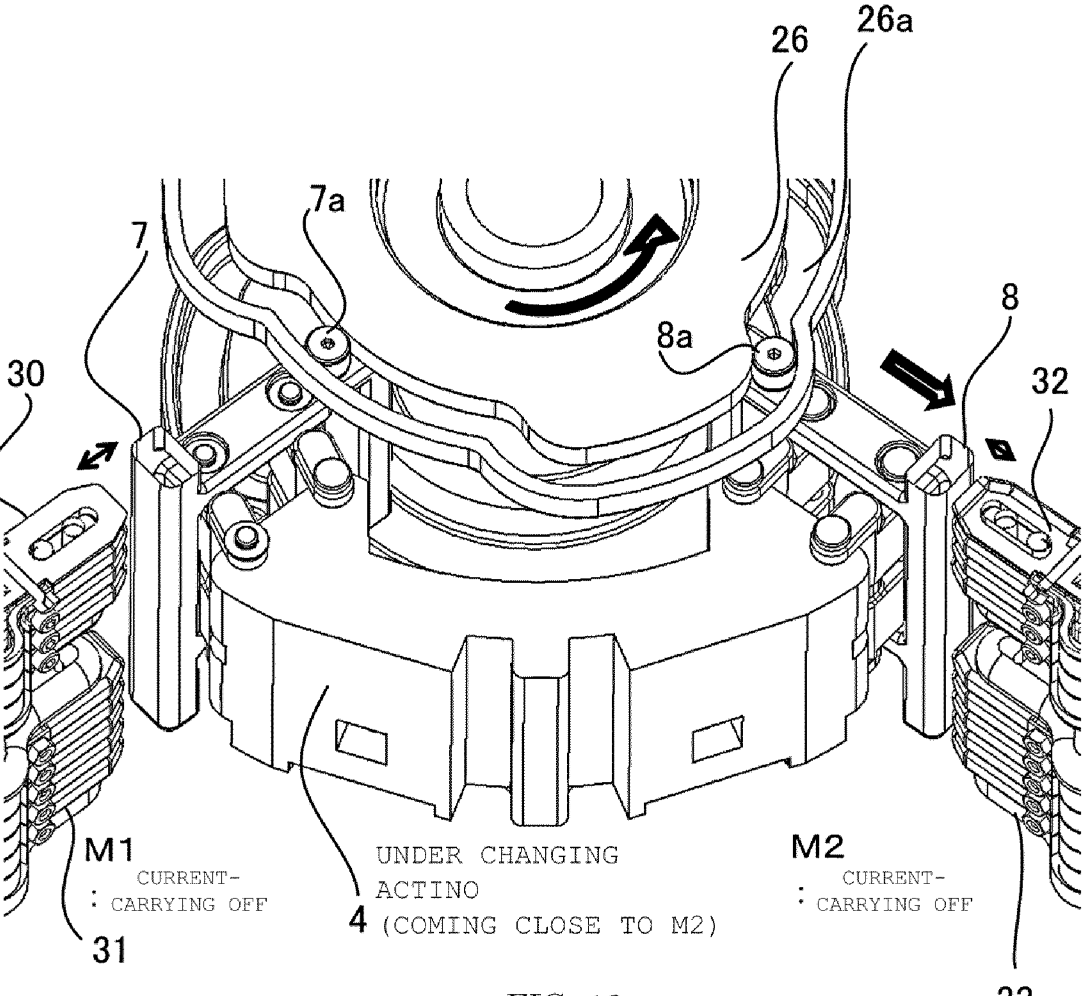
26
26a
7a
7
8
8a
30
32
M1
: CURRENT-CARRYING OFF
UNDER CHANGING ACTINO
4 (COMING CLOSE TO M2)
M2
: CURRENT-CARRYING OFF
31
33

FIG. 13

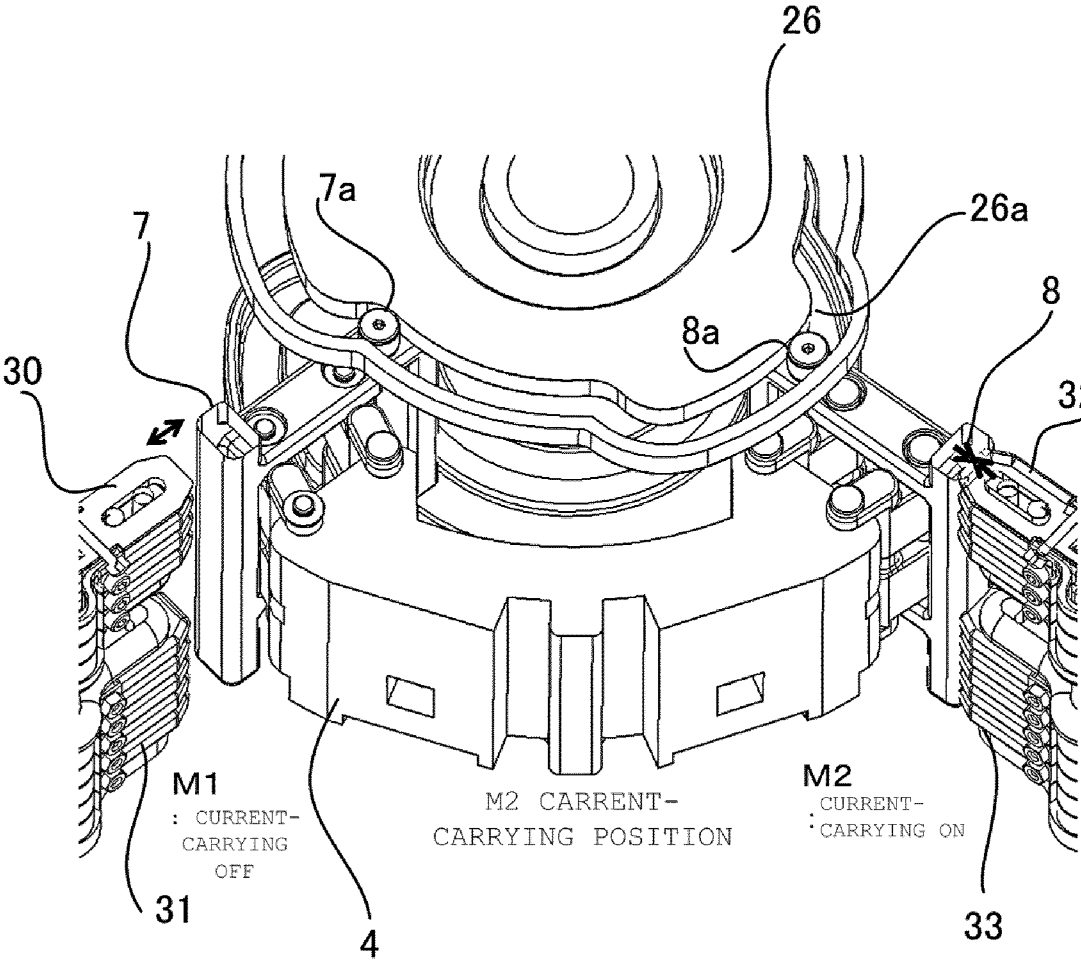
26
7a
26a
7
8
8a
30
32
M1
: CURRENT-
CARRYING
OFF
M2 CARRENT-
CARRYING POSITION
M2
: CURRENT-
CARRYING ON
31
4
33

FIG. 14

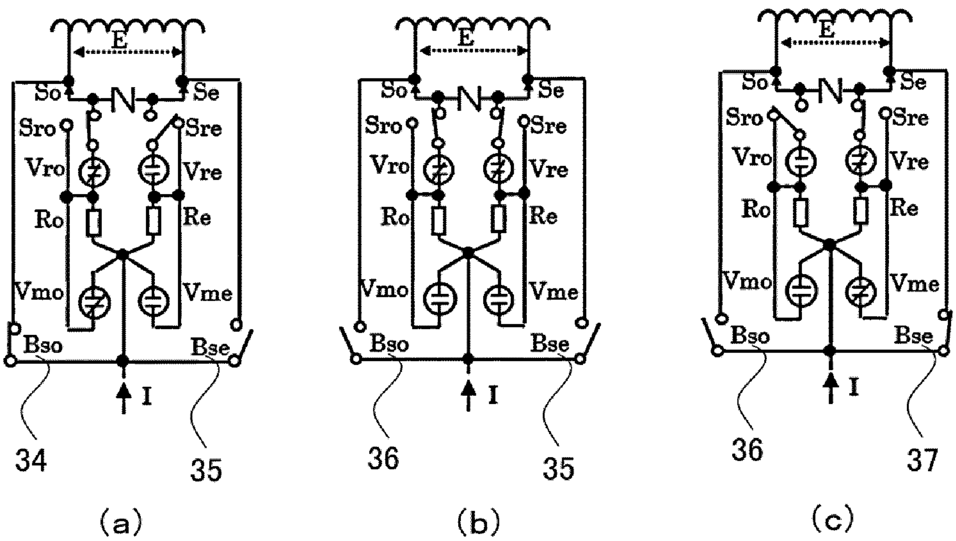
E
So
N
Se
Sro
Sre
Vro
Vre
Ro
Re
Vmo
Vme
Bso
Bse
I
34
35
36
37
(a)
(b)
(c)

FIG. 15

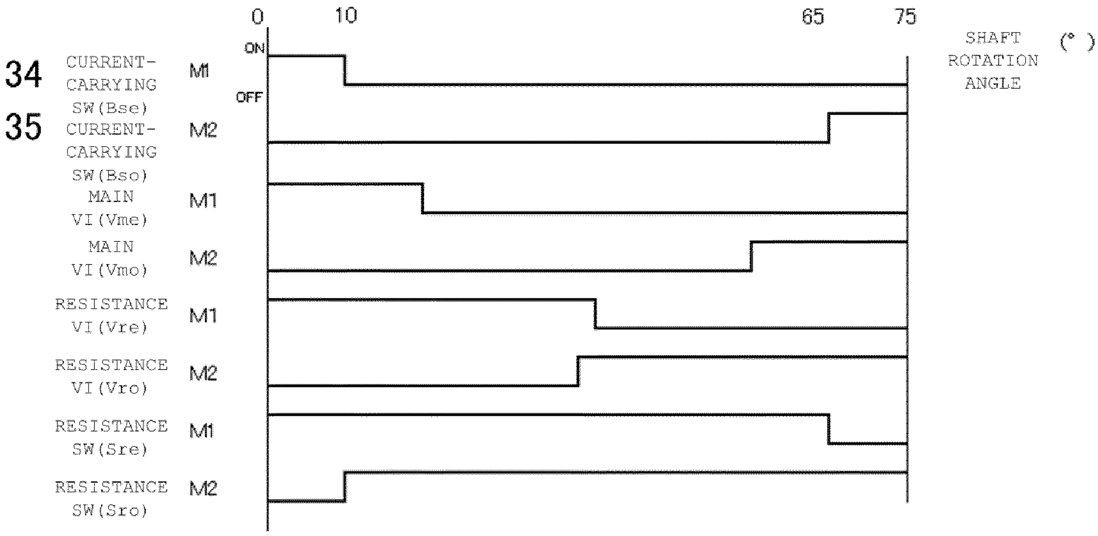
0
10
65
75
SHAFT ROTATION ANGLE
(°)
ON
OFF
34
CURRENT-CARRYING SW(Bse)
M1
35
CURRENT-CARRYING SW(Bso)
M2
MAIN VI(Vme)
M1
MAIN VI(Vmo)
M2
RESISTANCE VI(Vre)
M1
RESISTANCE VI(Vro)
M2
RESISTANCE SW(Sre)
M1
RESISTANCE SW(Sro)
M2

FIG. 16

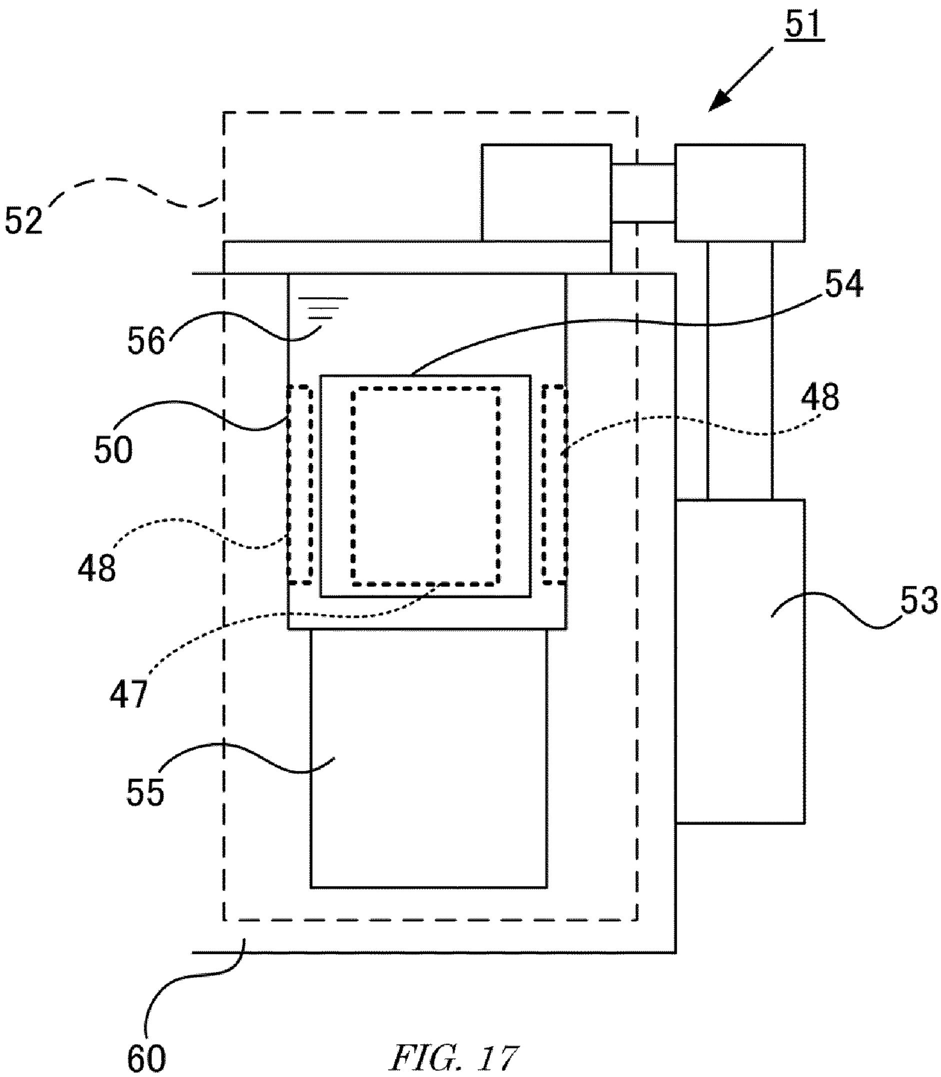
51
52
54
56
48
50
48
53
47
55
60

FIG. 17

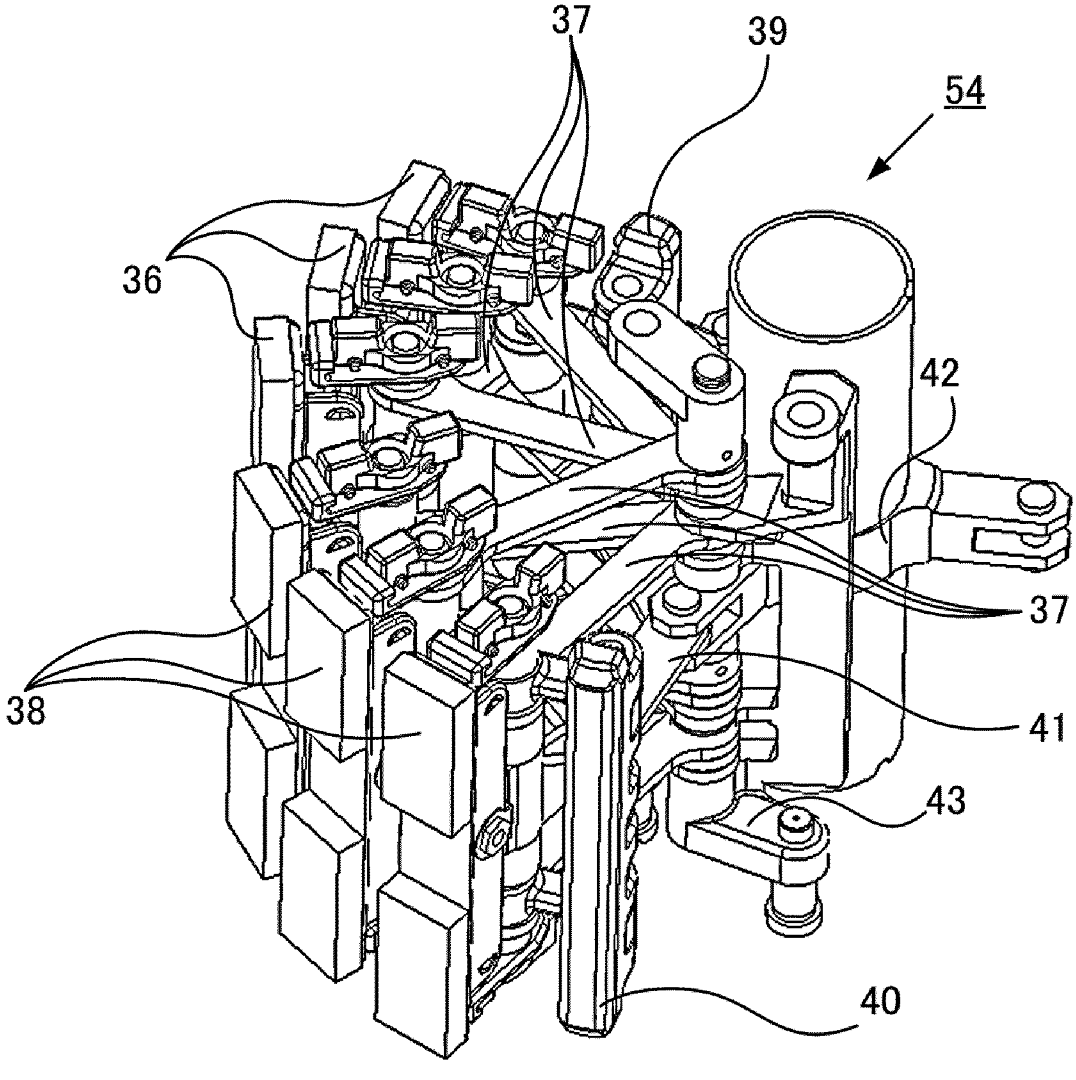

FIG. 18

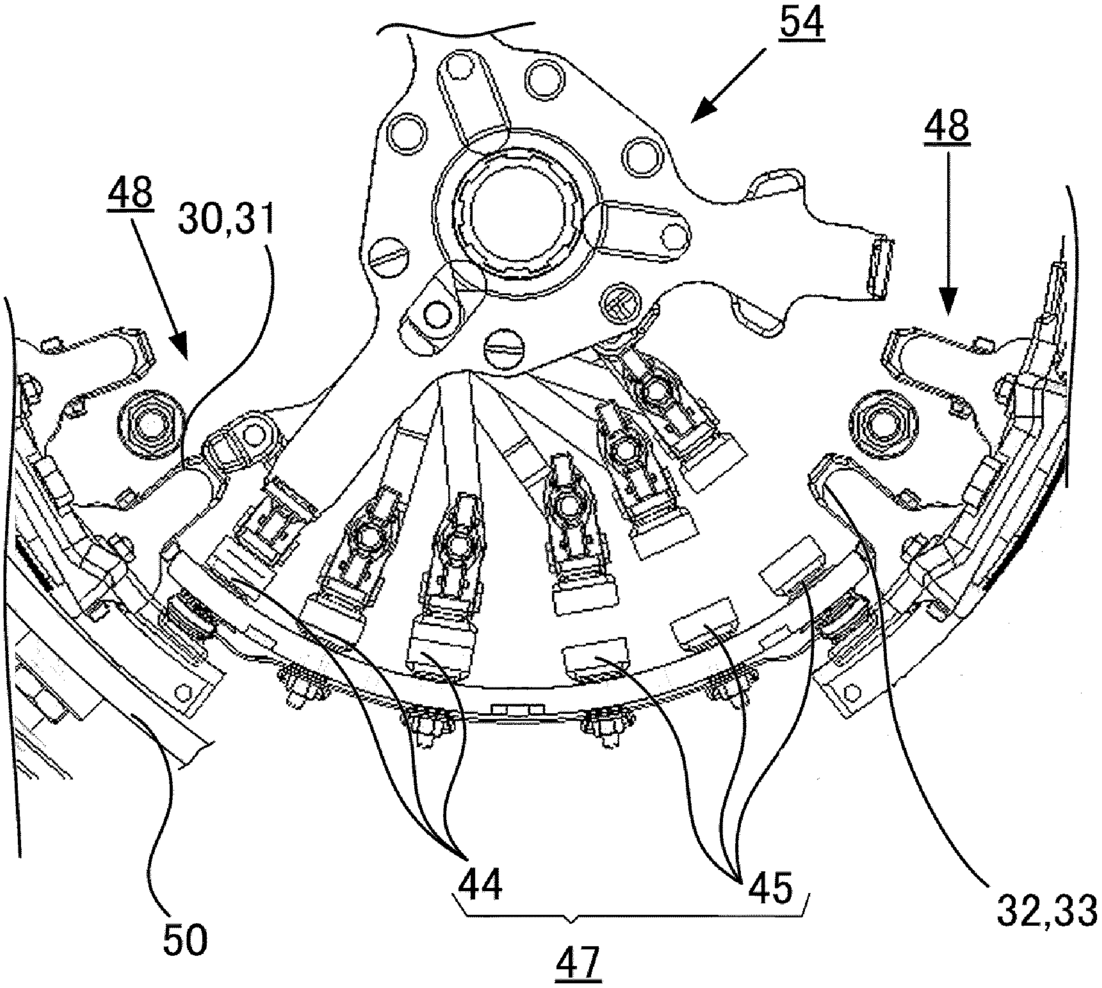

FIG. 19

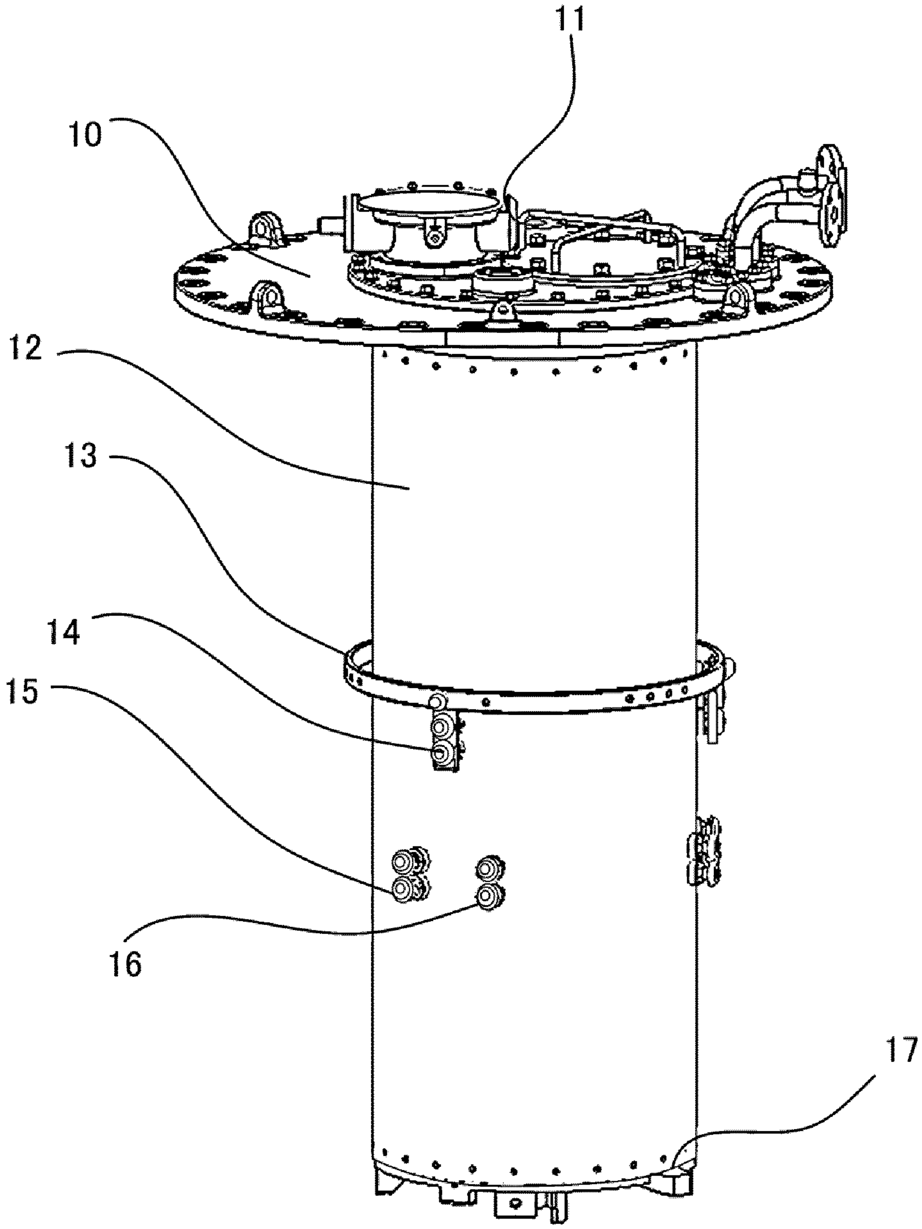

FIG. 20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/068802

A. CLASSIFICATION OF SUBJECT MATTER
H01F29/04(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)
H01F29/04

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2015
Kokai Jitsuyo Shinan Koho	1971-2015	Toroku Jitsuyo Shinan Koho	1994-2015

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2012-238653 A (Toshiba Corp.), 06 December 2012 (06.12.2012), entire text; all drawings (Family: none)	1-5
A	JP 2013-243194 A (Toshiba Corp.), 05 December 2013 (05.12.2013), entire text; all drawings (Family: none)	1-5

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

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
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"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
07 September 2015 (07.09.15)	15 September 2015 (15.09.15)

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

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/068802

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2013-526772 A (Maschinenfabrik Reinhausen GmbH), 24 June 2013 (24.06.2013), entire text; all drawings & US 2013/0112541 A1 & WO 2011/141082 A1 & EP 2569789 A & DE 102010020180 A & CA 2798086 A & CN 102893357 A & KR 10-2013-0064070 A & RU 2012153216 A & UA 107588 C	1-5
A	JP 2012-238683 A (Toko Electric Corp.), 06 December 2012 (06.12.2012), entire text; all drawings (Family: none)	1-5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006520535 A **[0014]**
- JP H11504755 A **[0014]**