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(71) Applicant: **Kabushiki Kaisha Toshiba**
Minato-ku
Tokyo 105-8001 (JP)

(72) Inventors:
- **KANAYA, Kazuhisa**
  Tokyo 105-8001 (JP)
- **OHDA, Yoshiaki**
  Tokyo 105-8001 (JP)
- **KOSHIZUKA, Tadashi**
  Tokyo 105-8001 (JP)
- **ANDO, Masayuki**
  Tokyo 105-8001 (JP)

(74) Representative: **Awapatent AB**
P.O. Box 11394
404 28 Göteborg (SE)

(54) **HYBRID SWITCHING DEVICE**

(57) A complex type switch which is capable of easily achieving a plurality of current breaking performance needed for a high-voltage switch, and which has a short current breaking time is provided. A complex type switch includes at least two switches connected in series. One switch is a vacuum switch 3 with a vacuum valve that includes contact part. One switch is a high-voltage resistant switch 5 includes a contact part that has a dielectric strength larger than the vacuum switch. The high-voltage resistant switch 5 and the vacuum switch 3 include supports 8, 18 maintaining an electrical insulation to a ground while supporting pressure containers 7, 17, in which t contact parts 9, 19 are placed. Movable electrodes 37, 56 of the contact parts 9, 19 connected to the actuation units 10, 20 are in equipotential.

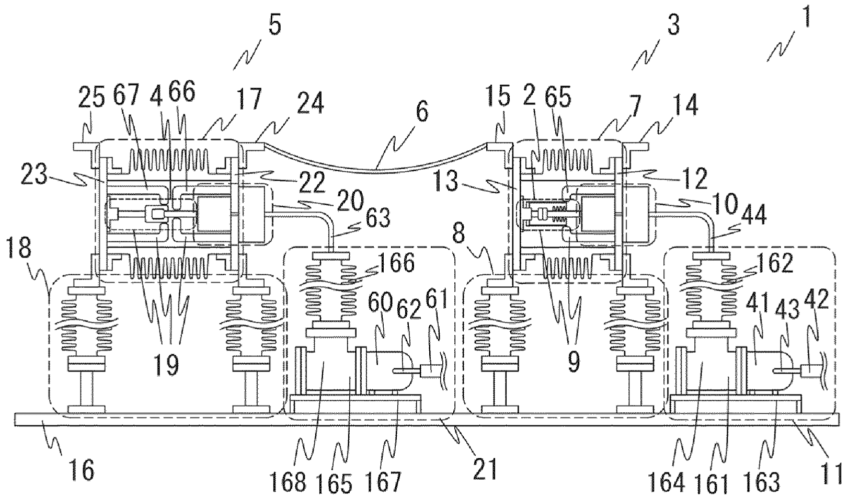

FIG. 1

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Description

FIELD

[0001] Embodiments of the present disclosure relate to a multi-point breaking complex type switch that connects and disconnects a plurality of contacts.

BACKGROUND

[0002] High-voltage switches breaking a fault current are required to certainly break various currents from a small current to a large current. As for the large current, in particular, the following two current breaking performance must be achieved.

(1) Breaking Short-range Line Fault (SLF) current As for this, the switches must have a performance capable of coping with a voltage at the beginning of the rising of the voltage (transient recovery voltage) immediately after current zero, namely, a voltage in a triangular waveform which has keen change rate despite its low absolute value.
(2) Breaking Breaker Terminal short-circuit Fault (BTF) current

[0003] As for this, the switches must have a performance capable of coping with an applied voltage which has a gradual initial rising of the transient recovery voltage but with an absolute value becoming high at the time of termination.

[0004] In recent years, puffer-type switches are widely adopted. This type of switches has one circuit breaker having a contact that can be connected and disconnected, placed in a pressure container in which SF6 gas as an insulation gas is filled. At the time of current breaking, the insulation gas is blown to the contact to extinguish an arc. In this scheme, it is necessary to accomplish both of the two current breaking performance by a single switch.

[0005] In addition, switches achieving the above two current breaking performance by connecting circuit breakers respectively dedicated to each circuit breaking performance are also in development. That is, this type of switches has a plurality of circuit breakers with each circuit breaker bearing an individual current breaking performance. This type of switches has an internal space of the single pressure container divided into two spaces, and the circuit breaker placed in each divided space.

[0006] That is, a puffer-type circuit breaker with an excellent BTF breaking performance is placed in one of the divided internal space, and a puffer-type circuit breaker with an excellent SLF breaking performance is placed in the other divided internal space. In addition, both circuit breakers are electrically connected in series.

CITATION LIST

PATENT LITERATURES

[0007] Patent Document 1: JP 2003-348721 A

[0008] As explained above, in switches that have circuit breakers respectively dedicated to the two current breaking performance connected to each other each circuit breaker has a contact that can be connected and disconnected. However, since an actuator which is a single actuation unit performs the current breaking action and the input action for all contacts, the load of the actuation unit will be heavy. This restricts the type and size of the actuation unit, and when it is difficult to increase the operation energy, the current breaking time becomes long.

[0009] Embodiments of the present disclosure have been proposed in order to address the foregoing technical problems of conventional technologies, and the objective is to provide a complex type switch which is capable of easily achieve a plurality of current breaking performance required for a high-voltage switch, and has a short current breaking time.

[0010] A complex type switch according to an embodiment of the present disclosure is proposed to achieve the above objective, and includes the following features:

(1)at least two switches connected in series;
(2) at least one of the switches is a vacuum switch that has a vacuum valve at a contact part;
(3)at least one of the switches is a high-voltage resistant switch that has a contact part that has a larger dielectric strength than the vacuum switch;
(4)the high-voltage resistant switch and the vacuum switch each include the following features:

(4-1) a sealed container that is filled with an insulative medium, and has the contact therein;
(4-2)a support maintaining an electrical insulation to a ground while supporting the sealed container;
(4-3)an actuation unit driving a movable electrode of the contact part; and
(4-4) a power supply supplying power to the actuation unit, and

(5) the high-voltage resistant switch further includes the following feature:

(5-1) the actuation unit resistant and the movable electrode of the contact part connected to the actuation unit is equipotential.

BRIEF DESCRIPTION OF DRAWINGS

[0011]

FIG. 1 is a cross-sectional view illustrating an entire structure of a complex type switch according to a first embodiment in a input status;

FIG. 2 is a cross-sectional view illustrating an entire structure of the complex type switch according to the first embodiment in a current breaking status;

FIGS. 3A and 3B are partially enlarged cross-sectional views of FIG. 1, where FIG. 3A illustrates a vacuum switch, and FIG. 3B illustrates a high-voltage resistant switch;

FIGS. 4A and 4B are partially enlarged cross-sectional views of FIG. 2, where FIG. 4A illustrates a vacuum switch, and FIG. 4B illustrates a high-voltage resistant switch;

FIG. 5 is a partially enlarged cross-sectional view illustrating a vacuum switch according to a second embodiment in a input status;

FIG. 6 is a partially enlarged cross-sectional view illustrating the vacuum switch according to the second embodiment in a current breaking status;

FIG. 7 is a partially enlarged cross-sectional view of FIG. 5;

FIG. 8 is a partially enlarged cross-sectional view of FIG. 6;

FIG. 9 is a cross-sectional view illustrating an entire structure of a complex type switch according to a third embodiment in a input status;

FIG. 10 is a cross-sectional view illustrating the entire structure of the complex type switch according to the third embodiment in a current breaking status;

FIG. 11 is a partially enlarged cross-sectional view of FIG. 9;

FIG. 12 is a partially enlarged cross-sectional view of FIG. 10;

FIG. 13 is a cross-sectional view illustrating a high-voltage resistant switch according to a fourth embodiment;

FIG. 14 is a cross-sectional view illustrating a high-voltage resistant switch according to a fifth embodiment;

FIG. 15 is a cross-sectional view illustrating an entire structure of a complex type switch according to a sixth embodiment; and

FIG. 16 is a partially enlarged cross-sectional view illustrating a high-voltage resistant switch according to a seventh embodiment.

DETAILED DESCRIPTION

[First Embodiment]

[0012] A structure of a complex type switch according to a first embodiment will be explained with reference to FIGs. 1-4. FIGs. 1, 2 are cross-sectional views illustrating an entire structure of the complex type switch in this embodiment. FIG. 1 illustrates an input status, and FIG. 2 illustrates a current breaking status. FIG. 3 is a partially enlarged cross-sectional views of FIG. 1, and FIG. 4 is a partially enlarged cross-sectional view of FIG. 2.

[Entire Structure]

[0013] First of all, the entire structure according to this embodiment will be explained with reference to FIGs. 1, 2. A complex type switch 1 in the present embodiment includes a vacuum switch 3 and a high-voltage resistant switch 5. The vacuum switch 3 is a switch that includes a vacuum valve 2 as a contact. The high-voltage resistant switch 5 is a switch that includes a contact 4 which has a larger dielectric strength than that of the vacuum switch 3. The vacuum switch 3 and the high-voltage resistant switch 5 are arranged side by side in the horizontal direction on a base 16 that is an installation surface, and are electrically connected in series via an insulated wiring 6.

(Outline of Vacuum Switch)

[0014] The vacuum switch 3 includes a pressure container 7, a support 8, a contact part 9, an actuation unit 10, and a power supply 11. The pressure container 7 is a cylindrical sealed container formed of an insulator and a metal. The openings at both ends of the insulator that is a barrel part of the pressure container 7 are sealed by metal lids 12, 13, respectively. An electrical insulation is achieved between the metal lids 12, 13. Current-carrying plates 14, 15 are installed at respective ends of the metal lids 12, 13. The vacuum switch 3 is connected to an unillustrated bus line via the current-carrying plate 14, and is connected to the high-voltage resistant switch 5 from the current-carrying plate 15 via the insulated wiring 6. The insulated wiring 6 is a wiring that has an ensured insulation from the exterior by, for example, insulative cover.

[0015] The support 8 supports the pressure container 7, and ensures the insulation relative to the ground. The support 8 is installed between the base 16 that fastens the vacuum switch 3, and the pressure container 7 in a high-voltage status. Hence, the support 8 mechanically supports the pressure container 7, and ensures the insulation distance between the base 16 and the pressure container 7. That is, the support 8 ensures the electrical insulation between the pressure container 7 and the ground surface.

[0016] The contact part 9 includes the vacuum valve 2 and a shield 65. The contact part 9 is placed in the pressure container 7, and is connected to the metal lids 12, 13 of the pressure container 7 directly or via the actuation unit 10.

[0017] The actuation unit 10 is a mechanism that actuates the vacuum valve 2 of the contact part 9. The actuation unit 10 is connected to the end of the pressure container 7, and applies kinetic energy to the vacuum valve 2 of the contact part 9, thereby actuating the vacuum valve 2 to connect, disconnect, close and open. This changes the conduction status of the vacuum switch 3. The power supply 11 is installed on the base 16, and is a power supply source to actuate the actuation unit 10.

(Outline of High-Voltage Resistant switch)

[0018] The high-voltage resistant switch 5 includes a pressure container 17, a support 18, a contact part 19, an operation part 20, and a power supply 21. The pressure container 17 is a cylindrical sealed container formed of an insulator and a metal. The openings at both ends of the insulator that is a barrel part of the pressure container 17 are sealed by metal lids 22, 23, respectively. An electrical insulation is achieved between the metal lids 22, 23. Current-carrying plates 24, 25 are installed at respective ends of the metal lids 22, 23. The high-voltage resistant switch 5 is connected to the vacuum switch 3 from the current-carrying plate 24 via the insulated wiring 6, and is connected to the unillustrated bus line via the current-carrying plate 25.

[0019] The support 18 supports the pressure container 17, and ensures the insulation relative to the ground. The support 18 is installed between the base 16 that fix the high-voltage resistant switch 5, and the pressure container 17 in a high-voltage status. The support 18 mechanically supports the pressure container 17, and ensures the insulation distance between the base 16 and the pressure container 17. That is, the support 18 ensures the electrical insulation between the pressure container 17 and the ground surface.

[0020] The contact part 19 includes a contact 4 and shields 66, 67. The contact part 19 is placed in the pressure container 17, and is connected to the metal lids 22, 23 of the pressure container 17 directly or via the actuation unit 20.

[0021] The actuation unit 20 is a mechanism that actuates the contact 4 of the contact part 19. The actuation unit 20 is connected to the end of the pressure container 17, applies kinetic energy to the contact 4 of the contactor 19, thereby actuating the contact 4 to connect, disconnect, close and open. This changes the conduction status of the high-voltage resistant switch 5. The power supply 21 is installed on the base 16, and is a power supply source to actuate the actuation unit 20.

[0022] When the complex type switch 1 as explained above in a input status, as illustrated in FIG. 1, a current introduced from the current-carrying plate 14 flows through the metal lid 12, the actuation unit 10, the vacuum valve 2, the metal lid 13, and the current-carrying plate 15. In addition, the current flows through, the current-carrying plate 24, the metal lid 22, the actuation unit 20, the contact 4, and the metal lid 23 in sequence, and is derived to the current-carrying plate 25, via the insulated wiring 6. In addition, when the complex type switch 1 is in a current breaking status, as illustrated in FIG. 2, the vacuum valve 2 of the vacuum switch 3 and the contact 4 of the high-voltage resistant switch 5 are opened and disconnected, and thus the current will be broken.

[Detailed Structure]

[0023] The detailed structure according to the embodiment will be explained below.

(Vacuum Switch)

[0024] First, the pressure container 7, the support 8, the contact part 9, the actuation unit 10 and the power supply 11 that form the vacuum switch 3 generally explained above will be explained with reference to FIGs. 3A and 4A. Note that FIGs. 3A, 4A are enlarged cross-sectional views of the vacuum switch 3. FIG. 3A illustrates the input status, and FIG. 4A illustrates the current breaking status.

(1) Pressure Container

[0025] The pressure container 7 includes an insulator tank 26 and the metal lids 12, 13. The insulator tank 26 has an insulator tube 27 having both ends opened as a barrel part, and metal flanges 28, 29 are adhered to the respective open ends. The metal flanges 28, 29 are fixed with the metal lids 12, 13, respectively.

[0026] An internal space 68 of the pressure container 7 is in a sealed condition. This internal space 68 is filled with an insulative medium. An exemplary insulative medium is a sulfur hexafluoride gas (SF6 gas), carbon dioxide, nitrogen, dry air, a mixture gas thereof, or an insulative oil. In the embodiment, the SF6 gas is applied.

(2) Support

[0027] The support 8 includes support insulators 30, 31, support structures 32, 33, and metal fittings 34, 35. The support structures 32, 33 are metal pedestal that stands upright, and have lower ends fixed to the base 16. The support insulators 30, 31 are support beams that have both metal ends insulated by insulator. The lower ends of the support insulators 30, 31 are fixed to the upper ends of the support structures 32, 33. The upper ends of the support insulators 30, 31 are connected to the metal lids 12, 13 via the metal fittings 34, 35.

[0028] Hence, the support 8 supports the pressure container 7 structurally stable. In addition, the lengths of the support insulators 30, 31 are designed to be longer than the insulation distance between the pressure container 7 and the ground (support structure).[0029] (3) Contact part

[0029] The contact part 9 includes the vacuum valve 2 and the shield 65. The vacuum valve 2 includes a fixed electrode 36, a movable electrode 37, a vacuum container 2a, and a bellows 2b. The fixed electrode 36 is directly fixed to the metal lid 13. The movable electrode 37 is connected to the metal lid 12 via a drive device 38 of the actuation unit 10.

[0030] The vacuum container 2a is a container which contains therein the fixed electrode 36 and the movable electrode 37, and is formed of an insulator sealed in a vacuum condition. The bellows 2b is a flexible stretchable member that attaches the movable electrode 37 to the vacuum container 2a to be movable while maintaining airtight condition. Note that the gas pressure of the internal space 68 is equal to or lower than the gas pressure of an internal space 69 explained later and equal to or higher than the atmospheric pressure. This is the pressure that the bellows 2b can withstand. The shield 65 is disposed so as to ease the concentration of the electric field around the vacuum valve 2, and is connected to the metal lid 12.

(4) Actuation unit

[0031] The actuation unit 10 includes the drive device 38, and a control device 39. The drive device 38 is fixed to the metal lid 12 inside the pressure container 7. The drive shaft of the drive device 38 is connected to the movable electrode 37, and drives the vacuum valve 2 so as to be freely connected and disconnected. In addition, as for the connection between the drive device 38 and the movable electrode 37, not an insulation material but a conductive material is applied. This achieves an equipotential. As for the conductive material, a metal material with high conductivity is preferably used. The control device 39 is fixed to the metal lid 12 outside the pressure container 7, and is connected to the drive device 38 via an insulated wiring 40 that passes through the metal lid 12. Hence, the control device 39 adjusts the power supplied to the drive device 38, thereby controlling the action of the drive device 38.

[0032] The actuation unit 10 pushes and pulls the movable electrode 37 linearly, so as to connect, disconnect, open and close the fixed electrode 36, by applying drive force to the mechanically connected movable electrode 37. Note that the action of the actuation unit 10 may be started by, for example, when the control device 39 receives an instruction signal from an unillustrated signal output device installed outside the vacuum switch 3. In addition, a sealer that includes an unillustrated elastic material is provided at the metal lid 12 of the pressure container 7 in which the insulated wiring 40 passes through, and thus the gas-tightness of the internal space 68 is maintained.

(5) Power Supply

[0033] The power supply 11 includes a transformer 41, the bus line 42, a pressure container 161, and an insulator tube 162. The container of the transformer 41 and the pressure container 161 are fixed to the base 16 via the support structure 163. The opening of the container of the transformer 41 is fixed to the one opening of the pressure container 161. On the other hand, the other opening of the pressure container 161 is fixed to the opening of the insulator tube 162. The transformer 41, the pressure container 161, and the insulator tube 162 share an internal space 164 that is sealed and filled with an insulative medium. The filled insulative medium is the same as the one explained above. The primary side of the transformer 41 is connected to the bus line 42 via an insulated wiring 43. In addition, the secondary side of the transformer 41 is connected to an insulated wiring 44. The insulated wiring 44 passes through the internal space 164, passes through the end of the insulator tube 162 at the actuation unit10 side, and is connected to the control device 39 of the actuation unit 10. Sealers including unillustrated elastic materials are provided to the transformer 41 and the insulator tube 162 in which the insulated wirings 43, 44 pass through, and thus the gas-tightness of the internal space 164 is maintained. The dielectric strength between the primary and secondary sides of the transformer 41 and the dielectric strength between both ends of the insulator tube 162 are designed to be larger than the required dielectric strength between the pressure container 7 and the ground. The bus line 42 is connected to an unillustrated power supply source.

[0034] The power supplied from the power supply source via the bus line 42 is boosted by the transformer 41 up to the necessary voltage to drive the actuation unit 10, and the boosted voltage is supplied thereto. That is, the power supply 11 supplies the power to the actuation unit 10 that has a voltage to ground in a high-voltage status without any short-circuit to the ground.

(High-Voltage Resistant switch)

[0035] Next, the pressure container 17, the support 18, the contact part 19, the actuation unit 20, and the power supply 21 that form the high-voltage resistant switch 5 generally explained above will be explained with reference to FIGs. 3B, 4B. Note that FIGs. 3B, 4B are enlarged cross-sectional views illustrating the high-voltage resistant switch 5, and FIG. 3B illustrates an input status, and FIG. 4B illustrates a current breaking status.

(1) Pressure Container

[0036] The pressure container 17 includes an insulator tank 45 and the metal lids 22, 23. The insulator tank 45 has an insulator tube 46 having both ends opened as a barrel part, and metal flanges 47, 48 are adhered to the respective open ends. The metal flanges 47, 48 are fixed to the metal lids 22, 23, respectively.

[0037] The internal space 69 of the pressure container 17 is in a sealed condition, and is filled with the insulative medium. The insulative medium to be filled is same as the one as explained above.

(2) Support

[0038] The support 18 includes support insulators 49, 50, support structures 51, 52, and metal fittings 53, 54. The support structures 51, 52 are metal pedestal that stands upright, and have the lower ends fixed to the base 16. The support insulators 49, 50 are support beams that have both metal ends insulated by insulator. The lower ends of the support insulators 49, 50 are fixed to the upper ends of the support structures 51, 52. The upper ends of the support insulators 49, 50 are connected to the metal lids 22, 23 via the metal fittings 53, 54.

[0039] Hence, the support 18 supports the pressure container 17 structurally stable. In addition, the lengths of the support insulators 49, 50 are designed to be longer than the insulation distance between the pressure container 17 and the ground (support structure). This ensures the electrical insulation of the pressure container 17 to the ground surface.

(3) Contact part

[0040] The contact part 19 includes the contact 4, and the shields 66, 67. The contact 4 includes a fixed electrode 55 and a movable electrode 56. The stationary electrode 55 is directly fixed to the metal lid 23. The movable electrode 56 is connected to the metal lid 22 via a drive device 57 of the actuation unit 20. The shields 66, 67 are disposed so as to ease the concentration of the electric field around the contact 4, and are connected to the metal lids 22, 23, respectively.

(4) Actuation unit

[0041] The actuation unit 20 includes the drive device 57, and a control device 58. The drive device 57 is fixed to the metal lid 22 inside the pressure container 17. The drive shaft of the drive device 57 is connected to the movable electrode 56, and drives the contact 4 to be freely connected and disconnected. In addition, as for the connection between the drive device 57 and the movable electrode 56, not an insulation material but a conductive material is applied. This achieves an equipotential. As for the conductive material, a metal material with high conductivity is preferably used. The control device 58 is fixed to the metal lid 22 outside the pressure container 17, and is connected to the drive device 57 via an insulated wiring 59 that passes through the metal lid 22. Hence, the control device 58 adjusts the power supplied to the drive device 57, thereby controlling the action of the drive device 57.

[0042] The actuation unit 20 pushes and pulls the movable electrode 56 linearly, so as to connect, disconnect, open and close the fixed electrode 55, by applying drive force to the mechanically connected movable electrode 56. Note that the action of the actuation unit 20 may be started by, for example, when the control device 58 receives an instruction signal from an unillustrated signal output device installed outside the high-voltage resistant switch 5.

[0043] In addition, a sealer that includes an unillustrated elastic material provided at the metal lid 22 of the pressure container 17 in which the insulated wiring 59 passes through, and thus the gas-tightness of the internal space 69 is maintained.

(5) Power Supply

[0044] The power supply 21 includes a transformer 60, the bus line 61, a pressure container 165, and an insulator tube 166. The container of the transformer 60 and the pressure container 165 are fixed to the base 16 via the support structure 167. The opening of the container of the transformer 60 is fixed to the one opening of the pressure container 165. On the other hand, the other opening of the pressure container 165 is fixed to the opening of the insulator tube 166. The transformer 60, the pressure container 165, and the insulator tube 166 share an internal space 168 that is sealed and filled with an insulative medium. The filled insulative medium is the same as the one explained above. The primary side of the transformer 60 is connected to the bus line 61 via an insulated wiring 62. In addition, the secondary side of the transformer 60 is connected to an insulated wiring 63. The insulated wiring 63 passes through the internal space 168, passes through the end of the insulator tube 166 at the actuation unit-20 side, and is connected to the control device 58 of the actuation unit 20. Sealers including unillustrated elastic materials are provided to the transformer 60 and the insulator tube 166 in which the insulated wirings 62, 63 pass through, and thus the gas-tightness of the internal space 168 is maintained. The dielectric strength between the primary and secondary sides of the transformer 60 and the dielectric strength between both ends of the insulator tube 166 are designed to be larger than the required dielectric strength between the pressure container 17 and the ground. The bus line 61 is connected to an unillustrated power supply source.

[0045] The power supplied from the power supply source via the bus line 61 is boosted by the transformer 60 up to the necessary voltage to drive the actuation unit 20, and the boosted voltage is supplied thereto. That is, the power supply 21 supplies the power to the actuation unit 20 that has a voltage to ground in a high-voltage status without any short-circuit to the ground.

[Action]

[0046] The action according to the embodiment explained above will be explained with reference to the input status and the current breaking status, separately. Note that FIGs. 1, 3A, 3B illustrate the input status, and FIGs. 2, 4A, 4B illustrate the current breaking status.

(Input Status)

[0047] First, when the complex type switch 1 is in the input status, the current derived from the current-carrying plate 14 flows through the metal lid 12, the drive device 38, the movable electrode 37, the fixed electrode 36, the metal lid 13, and the current-carrying plate 15. Next, the current flows from the current-carrying plate 15 to, via the insulated wiring 6, the current-carrying plate 24, the metal lid 22, the drive device 57, the movable electrode

56, the fixed electrode 55, and the metal lid 23 in sequence, and is derived to the current-carrying plate 25.

(Current Breaking action)

[0048] On the other hand, when a current breaking command is given from the exterior of the complex type switch 1, driving force is applied to the movable electrodes 37, 56 connected to the drive devices 38, 57. Hence, the movable electrodes 37, 56 are simultaneously opened and disconnected from the fixed electrodes 36, 55, and thus a current breaking action starts.

[0049] More specifically, in the vacuum switch 3, the movable electrode 37 of the vacuum valve 2 are opened and disconnected from the fixed electrode 38. During this action, an arc including evaporated particles from the electrode and electrons is produced between the movable electrode 37 and the fixed electrode 38. However, since the interior of the vacuum valve 2 is in a high vacuum condition, the substances forming the arc are diffused, and are unable to maintain its form, thus being dissipated. Hence, the flowing current is broken.

[0050] On the other hand, in the high-voltage resistant switch 5, the movable electrode 56 of the contact 4 is opened and disconnected from the fixed electrode 55, and an arc is produced between those electrodes, but the arc will be extinguished by ensuring the insulation distance between those electrodes.

[0051] During this current breaking action, in the internal space 69 of the high-voltage resistant switch 5, the separation gas of the SF6 gas produced by the arc is produced. This separation gas has an action of corroding the surface layer of the vacuum container 2a of the vacuum valve 2 formed of the insulator. However, since the vacuum container 2a is placed in the pressure container 7 of the vacuum switch 3, the corrosion thereof by the separation gas produced in the internal space 69 is preventable.

[0052] The bellows 2b of the vacuum valve 2 may have a pressure resistance not so high. In the embodiment, the gas pressure in the internal space 68 is set to be equal to or lower than the gas pressure in the internal space 69 and equal to or higher than the atmospheric pressure which is a pressure the bellows 2b can resist. Accordingly, the bellows 2b of the internal space 68 is protected while the dielectric strength at the contact 4 in the internal space 69 is ensured.

[0053] As explained above, according to the embodiment, during the current breaking action, the vacuum switch 3 bears the keen transient recovery voltage in the SLF breaking performance, and the high-voltage resistant switch 5 that has a high dielectric strength bears a high transient recovery voltage in the BTF breaking performance. Hence, both breaking performances are easily achieved.

[Effects]

[0054] The embodiment explained above has the following effects.

(1) Since the plurality of switches is provided with each having the actuation unit that drives the contact part, a load per an actuation unit is reduced, enabling a fast-speed opening and disconnecting of the contact. That is, since the actuation unit 10 that drives the contact part 9 of the vacuum switch 3 and the actuation unit 20 that drives the contact part 19 of the high-voltage resistant switch 5 are provided, the respective loads to the actuation unit 10 and the actuation unit 20 are reduced, enabling a fast-speed opening and disconnecting.

(2) In the plurality of switches, since at least one of the switches handle the SLF breaking performance, and at least one of the switches handle the BTF breaking performance, both of the performances are easily achieved. That is, the vacuum switch 3 that includes the vacuum valve 2 is applied as one switch, and the high-voltage resistant switch 5 that has a larger dielectric strength than that of the vacuum valve 2 is applied as one switch. Hence, the vacuum switch 3 is capable of coping with the keen transient recovery voltage in the SLF breaking performance during the breaking action. In addition, the high-voltage resistant switch 5 that has a high dielectric strength is capable of coping with the high transient voltage in the BTF breaking performance.

(3) Since the plurality of switches has the drive device and the movable electrode in equipotential, it is unnecessary to ensure the insulation distance between the drive device and the movable electrode. Accordingly, a connection formed of an insulation material becomes unnecessary. This reduces the weight of a movable component, enabling a fast-speed opening and disconnecting of the contact. That is, the drive device 38 of the actuation unit 10 of the vacuum switch 3 is equipotential to that of the movable electrode 37, and the drive device 57 of the actuation unit 20 of the high-voltage resistant switch 5 is equipotential to the movable electrode 56. Therefore, a shorter distance between the drive device 38, 57 and the movable electrode 37, 56 is achieved.

In addition, since the connection formed of an insulation material has a lower rigidity than that of a metal material, in the initial stage of the breaking action, the insulation material would have a large elongation, resulting in a response delay of the movable electrode relative to the action of the drive device. In the embodiment, the complex type switch 1 has no such connection formed of the insulation material, and thus a response delay of the movable electrode 37, 56 relative to the action of the drive device 38, 57 can be prevented.

Still further, the drive device 38 is placed in the pressure container 7, and the drive device 57 is placed in the pressure container 17, the distance between the drive device 38, 57 and the movable electrode 37, 56 is furtherly reduced, reducing the weight of the movable component.

Yet still further, since the connection between the drive device and the movable electrode does not pass through the pressure container, a response delay due to a sliding friction between the connection and the pressure container, a gas leakage, and an increase of the number of components due to providing a sealer are preventable.

(4) In the embodiment, in comparison with conventional switches that includes a plurality of puffer-type contact part, the current breaking and the insulation distance are ensured at shorter time , and the current breaking time is reduced. That is, the vacuum switch 3 has the vacuum valve 2 which includes a contact type contact, and the movable electrode 37 is of light weight. This enables a current breaking action at a quite short time. In addition, the high-voltage resistant switch 5 includes the designated actuation unit 20 as the puffer type gas contact part. Hence, as a whole composite type switch 1, the load per an actuation unit 10, 20 is reduced, enabling the contact 4 to be opened and disconnected at fast speed. Still further, when the high-voltage resistant switch does not have puffer cylinder and nozzle in the movable electrode, in comparison with a puffer type contact, a weight of the driven movable component of the drive device 57 can be reduced. Hence, the drive device 57 is capable of driving the movable electrode 56 at faster speed, and thus a time required to ensure the insulation distance is remarkably reduced.

(5) Since a structure is employed in which the contact parts are divided into the individual switches, and the space placing each contact part is independent, those spaces may have a different pressure. More specifically, the gas pressure in the internal space 68 is set to be equal to or lower than the gas pressure in the internal space 69, and is equal to or higher than the atmospheric pressure. Hence, the dielectric strength of the contact in the internal space 69 is ensured, while at the same time, the bellows 2b of the internal space 68 is protected. In addition, the vacuum container 2a is placed in the pressure container 7. This prevents the separation gas of the SF6 gas produced by an arc in the internal space 69 from directly contacting the vacuum container 2a of the vacuum valve 2 formed of an insulator, thereby suppressing a corrosion by the separation gas.

[Second Embodiment]

[Structure]

[0055] A second embodiment will be explained with reference to FIGs. 5-8. Note that FIGs. 5, 6 are enlarged cross-sectional views of the vacuum switch 3 according to the second embodiment, and FIG. 5 illustrates the input status of the vacuum switch 3, and FIG. 6 illustrates the current breaking status of the vacuum switch 3. FIGs. 7, 8 are enlarged cross-sectional views of an electromagnetic repulsion drive device 71 in FIGs. 5, 6, respectively.

[0056] In this embodiment, the basic structure is same as that of the first embodiment. Hence, only the differences between the first embodiment will be explained, and the same part as that of the first embodiment will be denoted by the same reference numeral, and the detailed explanation will be omitted.

[0057] In the embodiment, as the drive device 38 of the actuation unit 10 for the vacuum switch 3, the electromagnetic repulsion drive device 71 is applied. The electromagnetic repulsion drive device 71 utilizes electromagnetic repulsion force for the drive force of the electrode opening action, and has a high responsiveness in the electrode opening action. This electromagnetic repulsion drive device 71 includes a mechanism box 72, a fast-speed electrode opening unit 73, a wiping mechanism unit 74, and a holding mechanism unit 75. Each component will be explained in detail below.

(Mechanism Box)

[0058] The mechanism box 72 is a box with a hollow interior which has one end opened at the vacuum-valve-2 side. A support 80 that is a wall surface separating the mechanism box 72 from the exterior is fixed to the opening of the mechanism box 72. A hole 80a that slidably supports the movable electrode 37 of the vacuum valve 2 is formed in the center of the support 80.

[0059] The bottom of the mechanism box 72 opposite to the support-80 side is fixed and connected to the wall surface of the metal lid 12 inside the pressure container 7. The fast-speed electrode opening unit 73, the wiping mechanism unit 74, and the holding mechanism 75 are placed in such mechanism box 72.

(Fast-Speed Electrode Opening Unit)

[0060] The fast-speed electrode opening unit 73 includes a movable shaft 76, an electromagnetic repulsion coil 77, a repulsion ring 78, and a repulsion ring catcher 79.

[0061] The movable shaft 76 is a bar member coaxially connected to the movable electrode 37 of the vacuum valve 2. The repulsion ring catcher 79 is an annular member that is fitted in the movable shaft 76 and is integrated therewith. The repulsion ring 78 is an annular body formed of a good conductor. The repulsion ring 78 is coaxially fixed to the surface of the repulsion ring catcher 79 at the vacuum-valve-2 side.

[0062] The electromagnetic repulsion coil 77 is a coil formed of a good conductor, and fixed to the surface of the support 80 facing the repulsion ring 78. In this case, the repulsion ring 78 is an opposing good conductor that opposes to the electromagnetic repulsion coil 77. The electromagnetic repulsion coil 77 is connected to the control device 39 via the insulated wiring 40. The control device 39 is a coil exciter, and excites the electromagnetic repulsion coil 77 by supplying power via the capacitor built in the control device 39.

[0063] That is, the electromagnetic repulsion coil 77 is excited by the power from the control device 39, produces electromagnetic repulsion force that is repulsive force relative to the repulsion ring 78, and drives the movable shaft 76 in the rightward direction in the figure. Note that exemplary good conductors applied for the electromagnetic repulsion coil 77 and the repulsion ring 78 are copper, silver, gold, aluminum, and iron.

(Wiping Mechanism Unit)

[0064] The wiping mechanism unit 74 transmits the electromagnetic repulsion force produced by the fast-speed electrode opening unit 73 to the holding mechanism 75. The wiping mechanism unit 74 includes a flange 81, a coupling 82, a wiping spring 83, a flange holder 84, and a shock absorber 85.

[0065] The flange 81 is a tabular member in an annular shape engaged coaxially with the movable shaft 76. The coupling 82 is a flat plate disposed to face the flange 81, and is fixed to the end of a leg 89a of a movable component 89 explained later. The wiping spring 83 has one end abutted to the flange 81 and another end abutted to the coupling 82 with pushing force being applied to the flange 81 and the coupling 82.

[0066] The flange holder 84 is a cylindrical body with a bottom. The flange holder 84 has an end opposite to the bottom fixed to the coupling 82 to encircle the flange 81 and the wiping spring 83. Hence, the bottom of the flange holder 84 serves as a stopper for the flange 81. Note that an opening is formed in the bottom of the flange holder 84 in which the movable shaft 76 is inserted in a movable manner.

[0067] The shock absorber 85 is fixed to the coupling 82. The shock absorber 85 has an elasticity and a strength capable of absorbing shock from the movable component 89. Hence, the shock absorber 85 suppresses a shock when the movable shaft 76 collides.

(Holding Mechanism 75)

[0068] The holding mechanism 75 includes a permanent magnet 86, a circuit-opening spring 87, an electromagnetic solenoid 88, the movable component 89, and a shock absorber 90. These permanent magnet 86, the circuit-opening spring 87, the electromagnetic solenoid 88, the movable component 89, and the shock absorber 90 are housed in an apace opposite to the fast-speed electrode opening unit 73 formed by the support 91 and the internal surface of the mechanism box 72. This support 91 is a partition wall provided on the internal surface of the mechanism box 72 and divides the internal space of the mechanism box 72 in the orthogonal direction to the axis.

[0069] The movable component 89 is a ferromagnetic body that has attraction force with the permanent magnet 86. The movable component 89 has a cross-section formed in a substantially T shape, has the leg 89a that is an axis inserted in an opening 91a provided in the center of the support 91, protruding toward the fast-speed electrode opening unit 73, and fixed to the coupling 82. The leg 89a is slidably supported by the opening 91a of the support 91. In addition, a barrel 89c which has a larger diameter than that of the leg 89a and a smaller diameter than that of a spreading portion 89b is formed at the basal end of the leg 89a relative to the T-shaped spreading portion 89b of the movable component 89. The electromagnetic solenoid 88 to be explained later is provided around the barrel 89c.

[0070] The permanent magnet 86 is fixed to a wall surface opposite to the fast-speed electrode opening unit 73 side, of the support 91, and faces the both ends 89b of the movable component 89. This permanent magnet 86 produces attraction force to a gap of the T-shaped spreading portion 89b of the movable component 89. The permanent magnet 86 and the electromagnetic solenoid 88 produce thrust force in a direction closing and contacting the movable electrode 37 that forms a contact of the vacuum valve 2, relative to the spreading portion 89b of the movable component 89.

[0071] The circuit-opening spring 87 is placed between the spreading portion 89b of the movable component 89 and the wall surface of the support 91 where the permanent magnet 86 is provided, so as to apply pushing force to the movable component 89. The applied circuit-opening spring 87 has the pushing force larger than a total of the self-closing force of the vacuum valve 2 and the attraction force of the permanent magnet 86 in the circuit opening condition, and has a smaller than the attraction force of the permanent magnet 86 relative to the movable component 89 in the circuit closing condition.

[0072] The electromagnetic solenoid 88 is a winding formed of a conductive member, and is wound around and fixed to the barrel 89c of the movable component 89. The electromagnetic solenoid 88 is connected to the control device 39 via the insulated wiring 40 like the electromagnetic coil 77, has power supplied from the power supply in the control device 39, and can be excited.

[0073] The shock absorber 90 is fixed to the internal surface of the mechanism box 72 facing the spreading portion 89b of the movable component 89. The shock absorber 90 has an elasticity and a strength capable of absorbing shock from the movable component 89. Hence, the shock absorber 90 suppresses a shock when the movable component 89 collides.

[Action]

[0074] The action according to the embodiment will be explained with reference to the input status and the current breaking status, separately. Note that FIGs. 5, 7 illustrate the input status, and FIGs. 6, 8 illustrate the current breaking status.

(Input Status)

[0075] First, the input status of the embodiment will be explained. In the input status, the fixed electrode 36 of the vacuum valve 2 and the movable electrode 37 are in contact with each other at a predetermined load.

[0076] The attraction force by the permanent magnet 86 in the circuit closing direction acting on the movable component 89 is larger than the force by the wiping spring 83 and the circuit-opening spring 87 in the circuit opening direction. Hence, the attraction force by the permanent magnet 86 causes the spreading portion 89b of the movable component 89 to compress the circuit-opening spring 87, abuts the support 91, and the movable component 89 is in a condition fixed to the support 91.

[0077] On the other hand, this attraction force causes the movable electrode 37 to abut the fixed electrode 36 via the movable shaft 76, and the pushing force in the circuit closing direction is applied by the wiring spring 83.

[0078] Hence, the fixed electrode 36 of the vacuum valve 2 and the movable electrode 37 are in contact with each other by the load from the wiping spring 83, and maintain the input status (circuit closing condition) by the attraction force of the permanent magnet 86 acting on the movable component 89.

(Current Breaking action)

[0079] Next, an explanation for an electrode opening action of the electromagnetic repulsion drive device 71 in the current breaking action of the embodiment will be given. First, in the circuit closing condition in which the fixed electrode 36 of the vacuum valve 2 and the movable electrode 37 are in contact with each other, an electrode opening instruction is given to the control device 39 from the exterior of the switch. This causes the capacitor of the control device 39 to start supplying the power to the electromagnetic repulsion coil 77, and thus the electromagnetic repulsion coil 77 is excited.

[0080] Thus, electromagnetic repulsion force is produced between the electromagnetic coil 77 and the repulsion ring 78, and the movable electrode 37 opens in high-speed in the direction toward the electromagnetic repulsion drive device 71 from the fixed electrode 36 via the repulsion ring catcher 79 and the movable shaft 76. The direction in which the electrode is opened in the vacuum valve 2 will be hereafter referred to as a circuit opening direction. In addition, the opposite direction will be referred to as a circuit closing direction.

[0081] The movable shaft 76 moves in the circuit opening direction, the flange 81 compresses the wiping spring 83, while colliding the shock absorber 85. At this time, the movable shaft 76 has a reduced bounce in the circuit closing direction by the shock absorber 85, and the coupling 82 is pushed in the circuit opening direction via the wiping spring 83 and the shock absorber 85.

[0082] On the other hand, the power is supplied from the control device 39 to the electromagnetic solenoid 88 of the holding mechanism 75 prior to a timing at which the movable shaft 76 pushes in the coupling 82 in the circuit opening direction. Hence, the electromagnetic solenoid 88 is excited in the direction in which the magnetic flux of the permanent magnet 86 is canceled, and the attraction force produced in the gap between the spreading portion 89b of the movable component 89 and the permanent magnet 86 is reduced. In this case, the movable component 89 is driven in the circuit opening direction by the pushing force of the circuit-opening spring 87.

[0083] Next, when the flange holder 84 abuts the flange 81 via the coupling 82, the movable component 89 integrally pulls the coupling 82, the flange holder 84, and the flange 81, and the movable electrode 37 is further opened via the movable shaft 76.

[0084] Subsequently, by the inertial force of the movable electrode 37 and the movable shaft 76, and the pushing force of the circuit-opening spring 87, the movable electrode 37 is opened and disconnected until a predetermined gap relative to the fixed electrode 36 is obtained, and the movable component 89 collides the shock absorber 90. This shock is absorbed by the shock absorber 90, and the movable component 89 stops.

[0085] Note that a predetermined gap is a necessary gap between the fixed electrode 36 and the movable electrode 37 to break the current. After the predetermined gap between the movable electrode 37 and the fixed electrode 36 is obtained, the power supply to the electromagnetic repulsion coil 77 and the electromagnetic solenoid 88 is terminated, thereby canceling the excitation thereof.

[0086] For example, a capacitor that has accumulated charges may be applied as a power supply source from the control device 39, so as to release the accumulated charges, and thereby canceling the excitation upon depletion of the accumulated charges.

[0087] As other schemes, for example, an unillustrated position sensor may measure the driven distance of the movable electrode 37, and the excitation may be cancelled by cutting of the power supply after confirming by the control device 39 that the movable electrode 37 has been moved equal to or longer than the predetermined gap. After the excitation cancel, since the pushing force by the circuit-opening spring 87 is larger than the total of the self-closing force by the vacuum valve 2 and the attraction force by the permanent magnet 86, the contact of the vacuum valve 2 maintains the circuit opening condition.

[Effects]

[0088] The embodiment explained above is capable of achieving the following effects in addition to the effects of the first embodiment.

(1) The drive device of the vacuum valve 2 is the electromagnetic repulsion drive device 71. Hence, because the vacuum valve 2 has a short movement distance (stroke) for the movable electrode 37 necessary to breaking the current and the moving component is lightweight, a high responsiveness in the electrode opening action is achieved, and thus the required time to break the current is further shortened.

(2) As the electromagnetic repulsion drive device 71, the fast-speed electrode opening unit 73 that includes the electromagnetic repulsion coil 77, the support 80 that fix the electromagnetic repulsion coil 77, the repulsion ring 78 facing the electromagnetic repulsion coil 77, and the repulsion ring catcher 79 that supports the repulsion ring 78, is provided. By the electromagnetic repulsion force acting between the excited electromagnetic repulsion coil 77 and the repulsion ring 78, the electromagnetic repulsion drive device 71 that opens the electrode has a quite fast drive-force rise, thereby achieving an excellent responsiveness in comparison with the drive devices that have a drive source which is spring force and hydraulic pressure. Hence, an excellent SLF breaking performance for a keen transient recovery voltage is achieved.

(3) The electromagnetic repulsion drive device 71 is provided with a thrust force applier that applies thrust force to the movable electrode 37 of the vacuum valve 2. More specifically, the movable component 89 formed of a ferromagnetic material which is indirectly connected to the movable shaft 76 via the coupling 82, the wiping spring 83, the flange holder 84, and the flange 81, etc., the permanent magnet 86, and the electromagnetic solenoid 88 are provided. This causes the attraction force by the permanent magnet 86 and the excited electromagnetic solenoid 88 to act on the movable component 89, and thus thrust force in the circuit closing direction acting on the movable component 89 and the movable shaft 76 is produced, thereby driving the movable electrode 37 to be in contact with the fixed electrode 36.

[Third Embodiment]

[Structure]

[0089] An explanation will be given of a third embodiment with reference to FIGs. 9-12. Note that FIGs. 9, 10 are cross-sectional views illustrating an entire structure of a complex type switch 1 according to the embodiment, and FIG. 9 illustrates a input status, and FIG. 10 illustrates a current breaking status. FIGs. 11, 12 are respective partially enlarged views of a high-voltage resistant switch 5 in FIG. 9 and FIG. 10.

[0090] The embodiment basically employs the same structure to that of the first embodiment. Hence, only the differences between the first embodiment will be explained, and the same component to that of the first embodiment will be denoted by the same reference numeral, and the detailed explanation thereof will be omitted.

[0091] In the embodiment, an actuation unit 101 and a power supply 102 are added to the complex type switch 1 of the first embodiment. In addition, according to the first embodiment, the fixed electrode 55 is fixed to the metal lid 23. In this embodiment, however, the electrode corresponding to the fixed electrode 55 of the first embodiment is movable, and is connected to the actuation unit 101. Hence, in the following explanation, this electrode will be referred to as a movable electrode 105.

[0092] The structure of the high-voltage resistant switch 5 in the embodiment will be explained below. First, the actuation unit 101 includes a drive device 103, and a control device 104. The drive device 103 is fixed to the metal lid 23 in the pressure container 17, is connected to the movable electrode 105, and drives the contact 4 to be freely contacted and disconnected.

[0093] The control device 104 is fixed to the metal lid 23 outside the pressure container 17, and is connected to the drive device 103 via an insulated wiring 106 that passes through the metal lid 23. The control device 104 adjusts the power supplied to the drive device 103, thereby controlling the action of the drive device 103.

[0094] That is, the actuation unit 101 applies drive force to the mechanically connected movable electrode 105 to linearly pushes and pulls the movable electrode 105, thereby causing the movable electrode 105 to connect, disconnect, open, and close relative to the movable electrode 56.

[0095] Note that the action of the actuation unit 101 may be started by, for example, the control device 104 which receives an instruction signal from an unillustrated signal output device installed outside the high-voltage resistant switch 5. In addition, a sealer that is an unillustrated elastic packing material is provided at opening of the metal lid 23 of the pressure container 17 where the insulated wiring 106 passes through, and thus the gas-tightness of the internal space 69 is maintained.

[0096] The power supply 102 is a power supplier that supplies power to the actuation unit 101 that has the ground voltage in a high-voltage status, without any short-circuit to the ground. The power supply 102 includes a transformer 107, a bus line 108, a pressure container 169, and an insulator tube 170. The transformer 107 and the pressure container 169 are fixed to the base 16 via a support structure 171. The opening of the container of the transformer 107 is fixed to the one opening of the pressure container 169. On the other hand, the other opening of the pressure container 169 is fixed to the opening of the insulator tube 170. The transformer 107, the pressure container 169, and the insulator tube 170 share an internal space 172 which is sealed and filled with an insulative medium. The filled insulative medium is same as the one as explained above. The primary side of the transformer 107 is connected to the bus line 108 via an insulated wiring 109. In addition, the secondary side of the transformer 107 is connected to an insulated wiring 110. The insulated wiring 110 passes through the internal space 172, passes through the actuation unit 101-side end of the insulator tube 170, and is connected to the control device 104 of the actuation unit 101. Sealers that are unillustrated elastic packing materials are provided to the transformer 107 and the insulator tube 170 in which the insulated wirings 109, 110 pass through, and thus the gas-tightness of the internal space 172 is maintained. The dielectric strength between the primary and secondary sides of the transformer 107 and the dielectric strength between both ends of the insulator tube 170 are designed to be larger than the required dielectric strength between the pressure container 17 and the ground.

[0097] The bus line 108 is connected to an unillustrated power supply source. The power supplied from the power supply source via the bus line 108 is boosted up to the voltage required to drive the actuation unit 101 by the transformer 107, and is supplied to the actuation unit 101.

[Action]

[0098] The action according to the embodiment explained above will be explained with reference to the input status and the current breaking status, separately.

(Input Status)

[0099] First, when the complex type switch 1 is in the input status, the current derived from the current-carrying plate 14 flows through the metal lid 12, the drive device 38, the movable electrode 37, the fixed electrode 36, the metal lid 13, and the current-carrying plate 15. Next, the current flows from the current-carrying plate 15 to, via the insulated wiring 6, the current-carrying plate 24, the metal lid 22, the drive device 57, the movable electrode 56, the movable electrode 105, the drive device 103, and the metal lid 23 in sequence, and is derived to the current-carrying plate 25.

(Current Breaking Action)

[0100] On the other hand, when a current breaking instruction signal is given from the exterior of the complex type switch 1, drive force is applied to the movable electrodes 37, 56, 105 connected to the drive devices 38, 57, 103. This causes the movable electrode 37 of the vacuum switch 3 to be opened and disconnected from the fixed electrode 36 in the vacuum switch 3, and the movable electrodes 56, 105 of the high-voltage resistant switch 5 to be opened and disconnected from each other, and thus a current breaking action starts. As explained above, what is different from the first embodiment is that the movable electrode 56 and the movable electrode 105 of the contact 4 of the high-voltage resistant switch 5are opened and disconnected from each other. The other action is the same as that of the first embodiment.

[Effect]

[0101] The embodiment explained above achieves the following effects. That is, since the movable electrodes 56, 105 that form the contact 4 of the high-voltage resistant switch 5 include the individual actuation units 20, 101, the movable electrodes 56, 105 are simultaneously driven, enabling the contact 4 to be opened and disconnected at fast speed. This remarkably reduces the time required to ensure the insulation distance.

[0102] In particular, in comparison to the conventional switches that include a plurality of puffer-type contact parts, the current breaking and the insulation distance are ensured at shorter time, enabling a reduction of the time required to break the current.

[Fourth Embodiment]

[Structure]

[0103] A fourth embodiment will be explained with reference to FIG. 13. Note that FIG. 13 is a cross-sectional view of the high-voltage resistant switch 5 of a complex type switch 1 according to this embodiment.

[0104] This embodiment basically employs the same structure as that of the first embodiment. Hence, only the difference from the first embodiment will be explained, and the same component as that of the first embodiment will be denoted by the same reference numeral, and the detailed explanation thereof will be omitted.

[0105] According to the complex type switch 1 of the embodiment, the member corresponding to the support 18 of the high-voltage resistant switch 5 in the first embodiment is a support 111. This support 111 is installed between the base 16 that fix the high-voltage resistant switch 5 and the pressure container 17 in the high-voltage status, like the support 18 of the first embodiment. The support 111 mechanically supports the pressure container 17, and ensures the insulation distance between the base 16 and the pressure container 17.

[0106] More specifically, the support 111 includes a large-size support insulator 112, small-size support insulators 113, 114, an insulator connection 115, a support structure 116, and metal fittings 117, 118. The large-size support insulator 112 and the small-size support insulators 113, 114 are support beams that have both metal ends insulated by an insulator.

[0107] The insulator connection 115 is a metal block that has connection portions to the support insulators disposed at three locations in a Y shape. The respective one ends of the large-size support insulator 112 and the small-size support insulators 113, 114 are connected to the insulator connection 115, and thus a support insulator 119 in a Y shape is formed.

[0108] The support structure 116 is a metal pedestal, and is fixed to the base 16. The support structure 116 is also fixed to the other end of the large-size support insulator 112 corresponding to the leg part of the Y-shaped support insulator 119 standing upright. The other ends of the small-size support insulators 113, 114 corresponding to the arm parts of the Y-shape are connected to the metal lids 22, 23 via the metal fittings 117, 118.

[0109] Such structure enables the support 111 to structurally stably support the pressure container 17. In addition, when the respective dielectric strengths of the large-size support insulator 112, the small-size support insulators 113 and 114 are defined as A, B, and C, the lengths of the large-size support insulator 112, the small-size support insulators 113, and 114 are designed in such way that A+B and A+C are equal to or longer than the insulation distance between the pressure container 17 and the ground. In addition, These lengths are also designed in such way that B+C is equal to or longer than the insulation distance between both ends of the pressure container 17.

[Action and Effect]

[0110] The action and effect according to the embodiment explained above will be explained. First of all, as a presumption, it is expected that the type of switch with the pressure container including the contact not electrically grounded is used in a high-voltage system. In this case, the potential difference between the pressure container and the ground becomes larger than the potential difference between both ends of the pressure container, and thus a large-size support insulator that has a high dielectric strength might be necessary needed. Since such support insulator is expensive, there is a demand to reduce the number of applied support insulators as much as possible.

[0111] According to the embodiment, the Y-shaped support insulator 119 that includes the large-size support insulator 112 and the small-size support insulators 113, 114 is applied for the support 111 of the high-voltage resistant switch 5. This enables reducing of the number of applied large-size support insulators. The large-size support insulator 112 ensures the most part of the dielectric strength between the pressure container 17 and the ground, and the small-size support insulators 113, 114 ensure the dielectric strength between both ends of the pressure container 17. By reducing the number of applied large-size support insulators for a single switch as explained above, the manufacturing costs of the switch is reduced.

[Fifth Embodiment]

[Structure]

[0112] An explanation will be given of a fifth embodiment with reference to FIG. 14. Note that FIG. 14 is a cross-sectional view of the high-voltage resistant switch 5 of the complex type switch 1 according to this embodiment. This embodiment basically employs the same structure as that of the fourth embodiment. Hence, only the difference between the fourth embodiment will be explained, and the same component as that of the fourth embodiment will be denoted by the same reference numeral, and the detailed explanation thereof will be omitted.

[0113] According to the complex type switch 1 of the embodiment, the member corresponding to the support 111 of the high-voltage resistant switch 5 in the fourth embodiment is a support 121. The support 121 is installed between the base 16 that fix the high-voltage resistant switch 5 and the pressure container 17 in the high-voltage status, like the support 111 of the fourth embodiment. The support 121 mechanically supports the pressure container 17, and ensures the insulation distance between the base 16 and the pressure container 17.

[0114] In addition, the support 121 of the embodiment includes the large-size support insulator 112, the small-size support insulators 113, 114, an insulator connection plate 122, the support structure 116, and metal fittings 123, 124. The large-size support insulator 112 and the small-size support insulators 113, 114 are support beams that have both metal ends insulated by an insulator. The large-size support insulator 112 is longer than the small-size support insulators 113, 114.

[0115] The insulator connection plate 122 is a metal plate disposed horizontally. The insulator connection plate 122 has two connections for the small-size support insulators 113, 114 on the upper surface, and a connection for the large-size support insulator 112 on the lower surface. The lower surface of the insulator connection plate 122 is connected to the upper end of the large-size support insulator 112, and the upper surface of the insulator connection plate 122 is connected to the lower ends of the small-size support insulators 113, 114, thereby forming a fork-shape support insulator 125.

[0116] The support structure 116 is a metal pedestal, and is fixed to the base 16. The lower end of the large-size support insulator 112 that corresponds to the leg part of the fork-shape support insulator 125 is fixed to the support structure 116. The upper ends of the small-size support insulators 113, 114 that correspond to the arm parts of the fork-shape support insulator 125 are connected to the metal lids 22, 23 via the metal fittings 123, 124.

[0117] Such structure enables the support 121 to support the pressure container 17 structurally stable. In addition, when the dielectric strengths of the large-size support insulator 112, the small-size support insulators 113 and 114 are defined as A, B, and C, the lengths of the large-size support insulator 112, the small-size support insulators 113, and 114 are designed in such way that A+B and A+C are equal to or longer than the insulation distance between the pressure container 17 and the ground. In addition, these lengths are also designed in such way that B+C is equal to or longer than the insulation distance between both ends of the pressure container 17.

[Action and Effect]

[0118] The embodiment as explained above achieves the following actions and effects. First, according to the embodiment, the fork-shape support insulator 125 that includes the large-size support insulator 112, the small-size support insulators 113, 114 is applied to the support 121 of the high-voltage resistant switch 5. Hence, like the fourth embodiment, the numbers of applied large-size support insulators is reduced.

[0119] The large-size support insulator 112 ensures the most part of the dielectric strength between the pressure container 17 and the ground, and the small-size support insulators 113, 114 ensure the dielectric strength between both ends of the pressure container 17. Hence, the numbers of applied large-size support insulators for a single switch is reduced, thus reducing the manufacturing costs of the switch.

[Sixth Embodiment]

[Structure]

[0120] An explanation will be given of a sixth embodiment with reference to FIG. 15. Note that FIG. 15 is a cross-sectional view illustrating an entire structure of the complex type switch 1 according to this embodiment. This embodiment basically employs the same structure as the first embodiment. Hence, only the differences between the first embodiment will be explained, and the same component of the first embodiment will be denoted by the same reference numeral, and the detailed explanation thereof will be omitted.

[0121] The complex type switch 1 of the embodiment has no insulated wiring 6 that connects the vacuum switch 3 and the high-voltage resistant switch 5 in the first embodiment, and has the direction of the vacuum switch 3 in left-right reverse. In addition, the actuation unit 10 of the vacuum switch 3 and the actuation unit 20 of the high-voltage resistant switch 5 are disposed to face with each other.

[0122] Still further, the connection side of the support 8 to the metal lid 12 and the connection side of the support 18 to the metal lid 22 are unified by a single common support 131. The common support 131 mechanically supports the pressure containers 7, 17, and ensures the respective insulation distances between the base 16 and the pressure container 7, and between the base 16 and the pressure container 17. Yet still further, the power supply 11, 21 are unified into a single power supply 132.

[0123] The common support 131 includes a support insulator 133, a support structure 134, and metal fittings 34, 53, 135. The support structure 134 is a metal pedestal, and is fixed to the base 16. The support insulator 133 is a support beam that has both metal ends insulated by an insulator. The one end of the support insulator 133 is fixed to the support structure 134. The other end of the support insulator 134 is connected to the metal lid 12 via the metal fittings 135, 34, and also the metal lid 22 via the connection metal fittings 135, 53.

[0124] As explained above, according to the embodiment, the support insulator 30 and the support structure 32 of the support 8, and the support insulator 50 and the support structure 52 of the support 18 in the first embodiment are unified into the single support insulator 133 and the single support structure 134, respectively, and are shared via the metal fitting 135.

[0125] Hence, the common support 131 structurally stably supports the one ends of the pressure containers 7, 17. In addition, the length of the support insulator 133 is designed to be longer than the insulation distance between the groundings (support structures) of the pressure containers 7, 17.

[0126] The power supply 132 includes a transformer 136, a bus line 137, a pressure container 173, and an insulator tube 174. The transformer 136 and the pressure container 173 are fixed to the base 16 via the support structure 175. The opening of the container of the transformer 136 is fixed to the one opening of the pressure container 173. On the other hand, the other opening of the pressure container 173 is fixed to the opening of the insulator tube 174. The transformer 136, the pressure container 173, and the insulator tube 174 share an internal space 176 that is sealed and filled with an insulative medium. The filled insulative medium is same as the one explained above. The primary side of the transformer 136 is connected to the bus line 137 via an insulated wiring 138. In addition, the secondary side of the transformer 136 is connected to an insulated wiring 139. The insulated wiring 139 passes through the internal space 176, passes through the upper-side end of the insulator tube 174, and is connected to both of the control device 39 of the actuation unit 10 and the control device 58 of the actuation unit 20. Sealers that are unillustrated elastic packing materials are provided at the transformer 136 and the insulator tube 174 in which the insulated wirings 138, 139 pass through, and thus the gas-tightness of the internal space 176 is maintained. The dielectric strength between the primary and secondary sides of the transformer 136 and the dielectric strength between both ends of the insulator tube 174 are designed to be larger than the required dielectric strength between the pressure container 7 and the ground. The bus line 137 is connected to an unillustrated power supply source.

[0127] The power supplied via the bus line 137 is boosted by the transformer 136 up to the voltage required to drive the actuation units 10, 20, and the boosted voltage is supplied thereto. In this way, the power supply 132 supplies the power to the actuation units 10, 20 that have respective voltages to ground in a high-voltage status without any short-circuit to the ground.

[Action and Effect]

[0128] The embodiment as explained above achieves the following actions and effects. That is, according to the embodiment, since the numbers of supports and power supplies are reduced in comparison with the first embodiment, the manufacturing costs are reduced.

[0129] More specifically, according to the embodiment, the single common support 131 simultaneously supports the pressure containers 7, 17. That is, the plurality of switches share the common support 131. Hence, the numbers of support insulators and support structures applied to the support of the complex type switch 1 are reduced, and thus the manufacturing costs are reduced.

[0130] In addition, since the actuation units 10, 20 connected to the metal lids 12, 22 and supported by the common support 131 become equipotential, the power supply is enabled by the single power supply 132. That is, the plurality of switches share the power supply 132. Hence, the number of power supplies applied to the complex type switch 1 is reduced, and thus the manufacturing costs are reduced.

[Seventh Embodiment]

[Structure]

[0131] An explanation will be given of a seventh embodiment with reference to FIG. 16. Note that FIG. 16 is a cross-sectional view of the high-voltage resistant switch 5 of the complex type switch 1 according to this embodiment.

[0132] This embodiment basically employs the same structure as the first embodiment. Hence, only the difference between the first embodiment will be explained, and the same component of the first embodiment will be denoted by the same reference numeral, and the detailed explanation thereof will be omitted.

[0133] The high-voltage resistant switch 5 of the complex type switch 1 according to the embodiment includes, instead of a power feeder of the first embodiment that is the power supply 21, a power supply 141. In addition, a part corresponding to the support insulator 49 of the first embodiment is a support insulator tube 142 that has a sealed internal space. This sealed internal space of the support insulator tube 142 is filled with an insulative medium. The filled insulative medium is the same as the one as explained above.

[0134] The power supply 141 includes a power feeding coil 143, a power receiving coil 144, a power-feeding-coil support 145, a power-receiving-coil support 146, a coil exciting device 147, and a bus line 148.

[0135] The power feeding coil 143 and the power receiving coil 144 are coils for power demand and supply, and are disposed inside the support insulator tube 142 coaxially in the vertical direction. The power feeding coil 143 and the power receiving coil 144 face each other to be apart from each other by the insulation distance. The power receiving coil 144 is connected to the control device 58 of the actuation unit 20 via an insulated wiring 149.

[0136] The power-feeding-coil support 145 is a bar-shape support member that has one end fixed to the power feeding coil 143. The other end of the power-feeding-coil support 145 is fixed to the suppor-structure-51 side in the support insulator tube 142.

[0137] The power-receiving-coil support 146 is a bar-shape support member that has one end fixed to the power receiving coil 144. The other end of the power-receiving-coil support 146 is fixed to the pressure-container-17 side in the support insulator tube 142.

[0138] The coil exciting device 147 is fixed to the base 16, and is connected to the power feeding coil 143 via an insulated wiring 151. The bus line 148 is connected to an unillustrated power supply source, and is connected to the coil exciting device 147 via an insulated wiring 150.

[0139] The coil exciting device 147 excites the power feeding coil 143 by power supplied from the bus line 148, and produces an induced current to the power receiving coil 144. Hence, power is supplied to the actuation unit 20. In addition, the coil exciting device 147 controls the power to be supplied to the power feeding coil 143 to make the induced current continuously flow through the power receiving coil 144. That is, the power supply 141 is capable of supplying power to the actuation unit 20 that has the voltage to ground in a high-voltage status without any short-circuit to the ground.

[0140] Note that the insulated wirings 149, 150 pass through the support insulator tube 142, and a sealer that is an unillustrated elastic packing material is provided at each passing location, and thus the gas-tightness of the sealed space is maintained.

[Action and Effect]

[0141] The embodiment as explained above achieved the following actions and effects. That is, a part of the power supply 141 is downsized in comparison with the first embodiment.

[0142] More specifically, the high-voltage resistant switch 5 of the complex type switch 1 utilizes the power supply 141 that is capable of supplying power at remote two sites by electromagnetic induction. Hence, a power supply to the actuation unit 20 that has the voltage to ground in a high-voltage status is enabled without any short-circuit to the ground.

[0143] In addition, the power supply 141 has the power feeding coil 143 and the power receiving coil 144 placed in the support insulator tube 142 in which the insulative medium is filled, thereby downsizing the power supply 141.

[0144] Still further, there are also effects such as the improved power feeding efficiency by the reduction of the distance between the power feeding coil 143 and the power receiving coil 144, the prevention of the positional displacement of both coils, and an block of an effect from the external environment, which are all achieved by the insulative medium.

[Other Embodiments]

[0145] Several embodiments of the present disclosure have been explained in the description, but those embodiments are merely presented as examples, and are not intended to limit the scope of the present disclosure. More specifically, the present disclosure also covers a combination of all of or some of the first to seventh embodiments. The foregoing embodiments 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 and spirit of the present disclosure, and also within the scope of the invention as recited in the appended claims and the equivalent ranges thereto.

[0146] For example, the following forms are also covered by the present disclosure.

(1) In the first embodiment, in the current breaking action, the movable electrodes 37, 56 are simultaneously moved apart from the fixed electrodes 36, 55 by the drive force from the actuation units 10, 20. Alternatively, the movable electrode 37 of the vacuum valve 2 may be moved apart from the fixed electrode 36 to open the circuit and to break the flowing current. Subsequently, the movable electrode 56 of the contact 4 may be moved apart from the fixed electrode 55 to open the circuit, thereby ensuring the insulation distance between both electrodes 55, 56.

(2) In the second embodiment, the movable component 89 of the holding mechanism 75 is indirectly connected to the movable shaft 76 of the fast-speed electrode opening unit 73 via the wiping mechanism unit 74. Alternatively, the movable component 89 may be directly connected to the movable shaft 76.

REFERENCE SIGNS LIST

[0147]

1 Complex type switch
2 Vacuum valve
2a Vacuum container
2b Bellows
3 Vacuum switch
4 Contact
5 High-voltage switch
6 Insulated wiring
7, 17, 161, 165, 169, 173 Pressure container
8, 18, 91, 111, 121 Support
9, 19 Contact part
10, 20, 101 Actuation unit
11, 21, 102, 132, 141 Power supply
12, 13, 22, 23 Metal lid
14, 15, 24, 25 Current-carrying plate
16 Base
26, 45 Insulator tank
27, 46, 162, 166, 170, 174 Insulator tube
28, 29, 47, 48 Metal flange
30, 31, 49, 50, 133 Support insulator
32, 33, 51, 52, 116, 134, 163, 167, 171, 175 Support structure
34, 35, 53, 54, 117, 118, 123, 124, 135 Metal fitting
36, 55 Fixed electrode
37, 56, 105 Movable electrode
38, 57, 103 Drive device
39, 58, 104 Control device
40, 43, 44, 59, 62, 63, 106, 109, 110, 138, 139, 149, 150, 151 Insulated wiring
41, 60, 107, 136 Transformer
42, 61, 108, 137, 148 Bus line
65, 66, 67 Shield
68, 69, 164, 168, 172, 176 Internal space
71 Electromagnetic repulsion drive device
72 Mechanism box
73 Fast-speed electrode opening unit
74 Wiping mechanism unit
75 Holding mechanism unit
76 Movable shaft
77 Electromagnetic repulsion coil
78 Repulsion ring
79 Repulsion ring catcher
80 Support
80a Hole
81 Flange
82 Coupling
83 Wiping spring
84 Flange holder
85, 90 Shock absorber
86 Permanent magnet
87 Circuit opening spring
88 Electromagnetic solenoid
89 Movable component
89a Leg
89b Spreading portion
89c Barrel
112 Large-size support insulator
113, 114 Small-size support insulator
115 Insulator connector
119 Y-shape support insulator
122 Insulator connection plate
125 Fork-shape support insulator
131 Common support
142 Support insulator tube
143 Power feeding coil
144 Power receiving coil
145 Power-feeding-coil support
146 Power-receiving-coil support
147 Coil exciting device

Claims

1. A composite type switch comprising at least two switches connected in series, at least one of the

switches comprising a vacuum switch with a contactor that is a vacuum valve, and at least one of the switches comprising a high-voltage resistant switch with a contactor that has a larger dielectric strength than the vacuum switch, wherein:

the high-voltage resistant switch and the vacuum switch each comprise:

a sealed container filled with an insulative medium, and housing therein the contactor;
a support maintaining an electrical insulation to a ground while supporting the sealed container;
an actuation unit driving a movable electrode of the contactor; and
a power supply supplying power to the actuation unit, and
the actuation unit of the high-voltage resistant switch is at an equal potential to the movable electrode of the contactor connected to the actuation unit.

2. The composite type switch according to claim 1, wherein:

the sealed container comprises:

an insulative barrel portion having both ends opened; and
metal lids sealing the respective openings at the both ends,
the actuation unit comprises:

a drive device applying drive force to the contactor; and
a control device controlling an action of the drive device,
the drive device is provided in the sealed container, connected to the metal lid, and also connected to the contactor;
the drive device is provided outside the sealed container, and connected to the power supply in such a way that power to drive the actuation unit is supplied from the power supply; and
a connection portion between the drive device of the high-voltage resistant switch and the movable electrode of the contactor is formed of a conductive material.

3. The composite type switch according to claim 2, wherein:

the actuation unit comprises:

a coil;
a coil fastener fastening the coil;
an opposing good conductor provided opposite to the coil;
a movable shaft passing completely through the opposing good conductor, and fixed to the opposing good conductor; and
a coil exciter supplying a current to the coil to excite the coil, and
thrust force is applied to the movable shaft by repulsion force produced between the excited coil by the coil exciter and the opposing good conductor.

4. The composite type switch according to any one of claims 1-3, wherein:

the support comprises:

a support insulator comprising an insulator formed of an insulative material and held between two metal portions; and
a support structure fixed to the ground, and the support insulator is fixed between the support structure and the sealed container, mechanically connects the support structure with the sealed container, and electrically insulate the support structure therefrom.

5. The composite type switch according to claim 4, wherein:

the support comprises a Y-shape support insulator connected with the three support insulators in a Y-shape by an insulator connection;
the insulator connection comprises a metal block with connection portions to the support insulators at three locations;
respective one ends of the three support insulators are fixed to the insulator connection;
an other end of one of the support insulators is fixed to the support structure to form a leg portion standing upright; and
respective other ends of the other two support insulators are connected to the sealed space to form arm portions at both sides.

6. The composite type switch according to claim 4, wherein:

the support comprises a fork-shape support insulator comprising the three support insulators and an insulator connection plate;
the insulator connection plate comprises a metal plate having two connection portions to the support insulators on an upper surface, and a connection portion to the support insulator on a lower surface;
the fork-shape support insulator is formed by fastening respective one ends of the three sup-

port insulators to the connection portions of the insulator connection plate;
an other end of the one support insulator is fixed to the support structure to form a leg portion standing upright; and
respective other ends of the two support insulator are connected to the sealed container to form arm portions standing upright at both sides.

7. The composite type switch according to any one of claims 1-6, wherein the adjoining two switches among the plurality of switches share the support.

8. The composite type switch according to any one of claims 1-7, wherein the adjoining two switches among the plurality of switches share the power supply.

9. The composite type switch according to any one of claims 1-8, wherein the high-voltage resistant switch comprises a pair of movable electrodes which forms the contactor, and which is connected to the individual actuation unit.

10. The composite type switch according to any one of claims 1-9, wherein the power supply for the switch comprises a transformer and an insulator tube.

11. The composite type switch according to any one of claims 1-9, wherein:

the power supply comprises:

a power supply source capable of supplying power;
a power feeding coil electrically connected to the power supply source; and
a power receiving coil electrically connected to the control device of the actuation unit,

the insulator of the support insulator is a hollow tube having an internal space gas-tightly sealed by metal portions at both ends, and filled with the insulative medium;
the power feeding coil and the power receiving coil are coaxially disposed so as to be apart from each other by an insulation distance inside the support insulator;
the power feeding coil is fixed to the metal portion of the support insulator at the ground side via a power-feeding-coil support; and
the power receiving coil is fixed to the metal portion of the support insulator at the sealed-container side via a power-receiving-coil support.

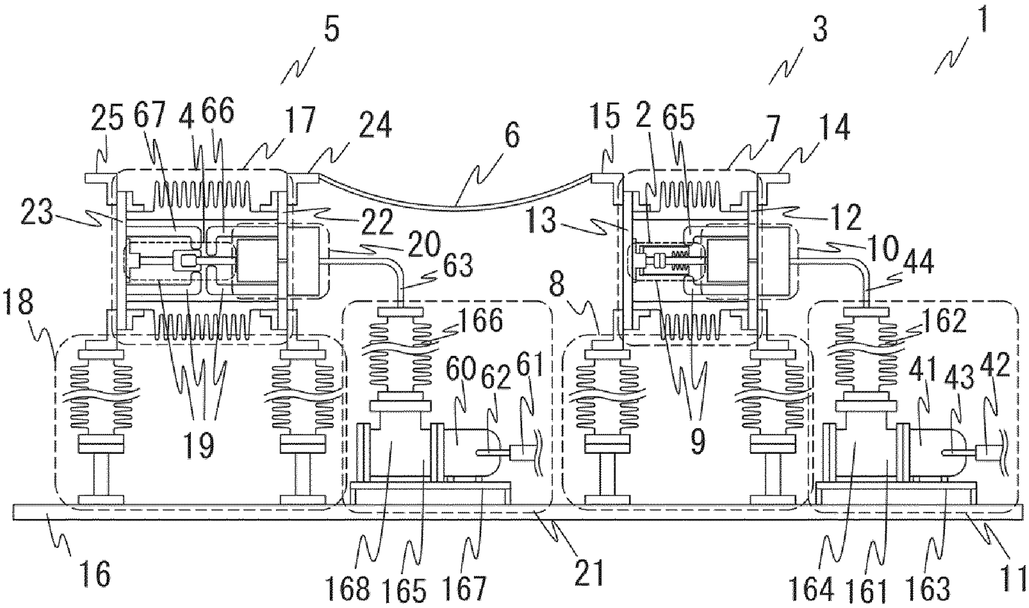
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FIG. 1

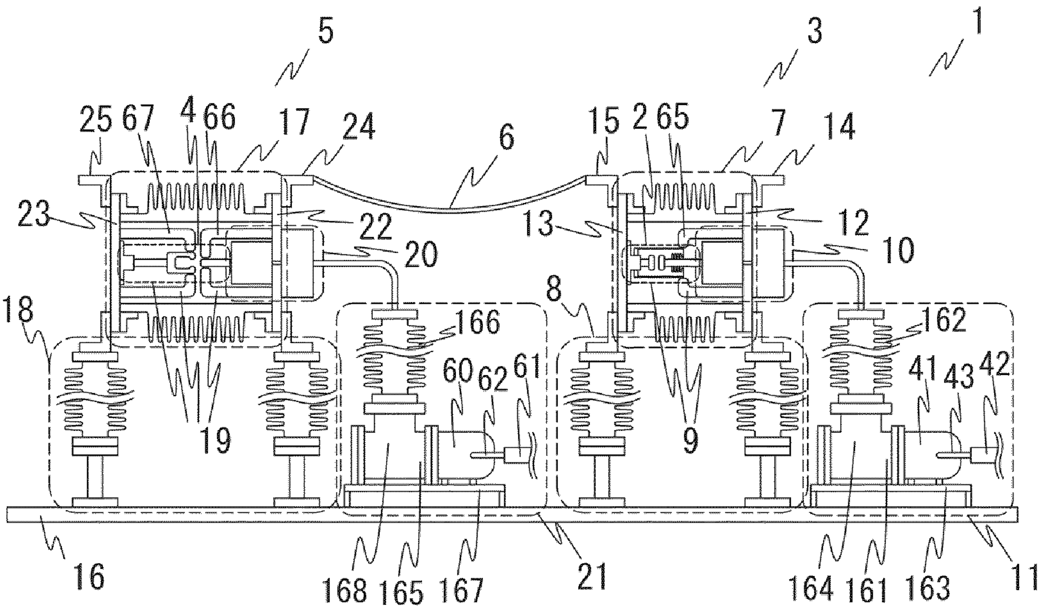
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FIG. 2

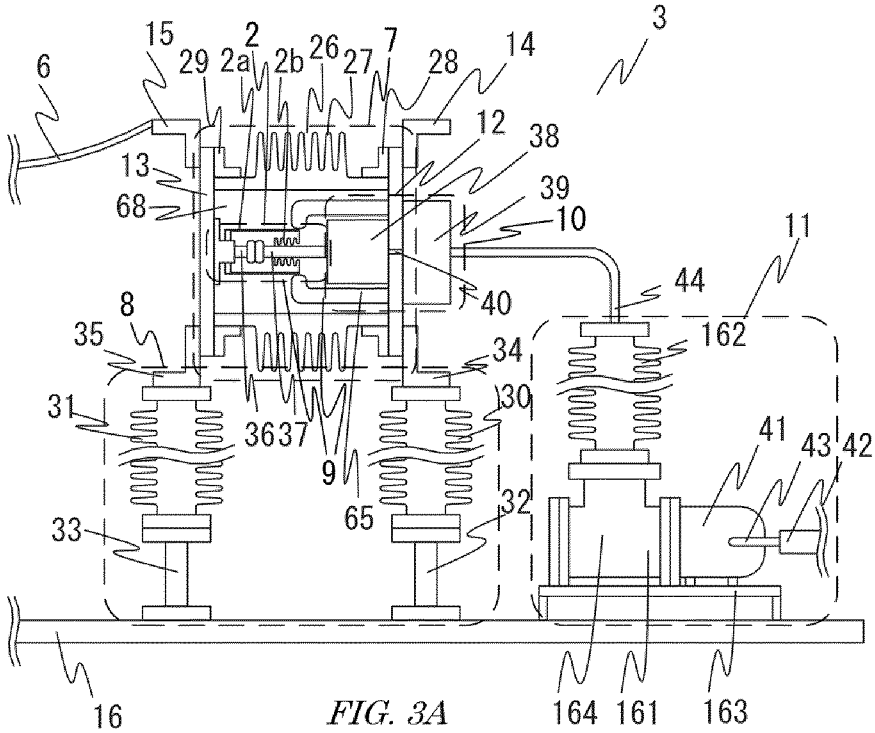
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FIG. 3A

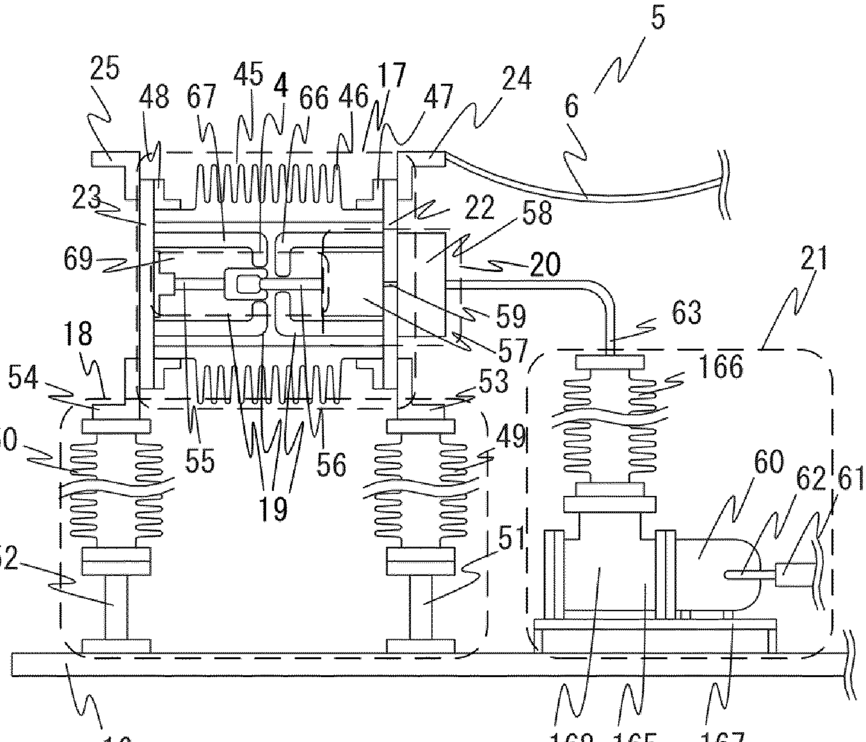
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FIG. 3B

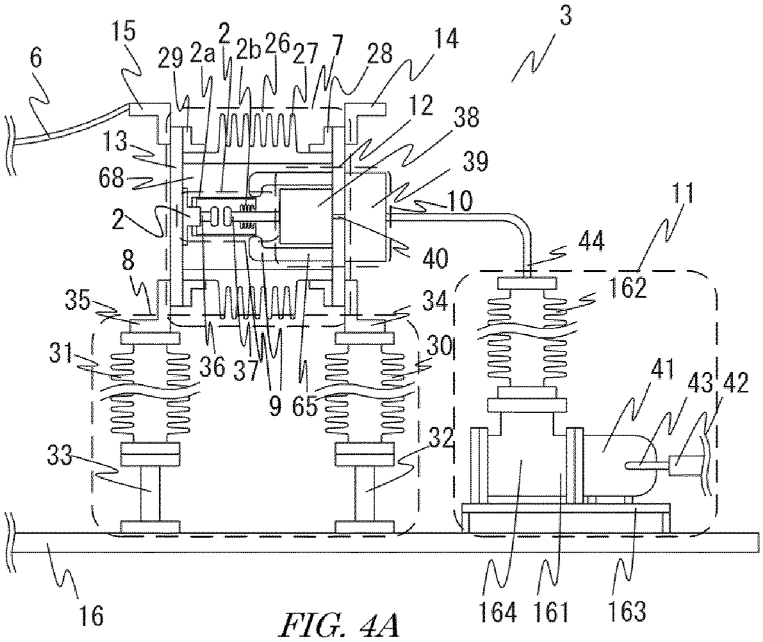
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FIG. 4A

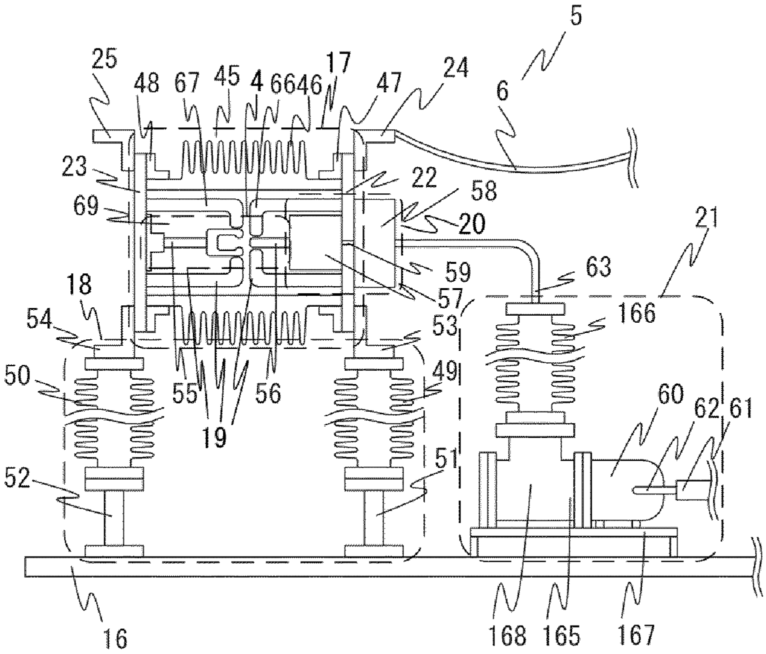
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FIG. 4B

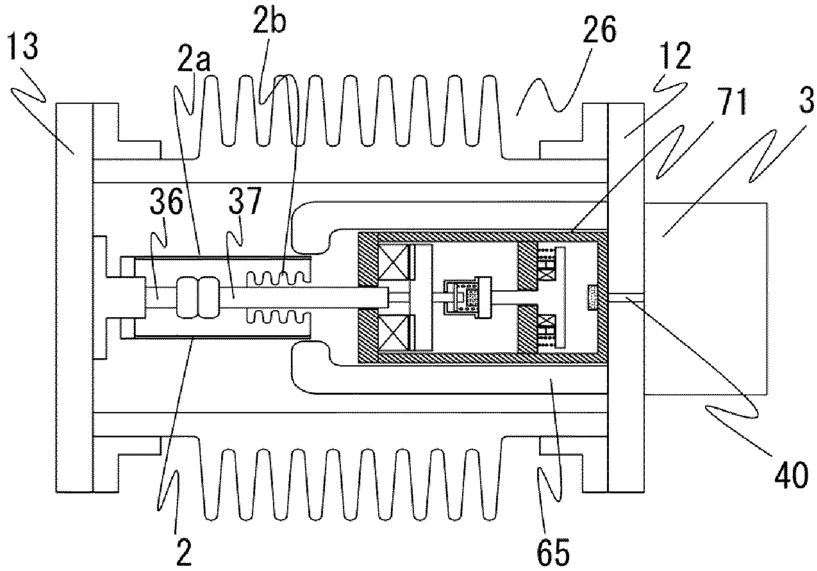

FIG. 5

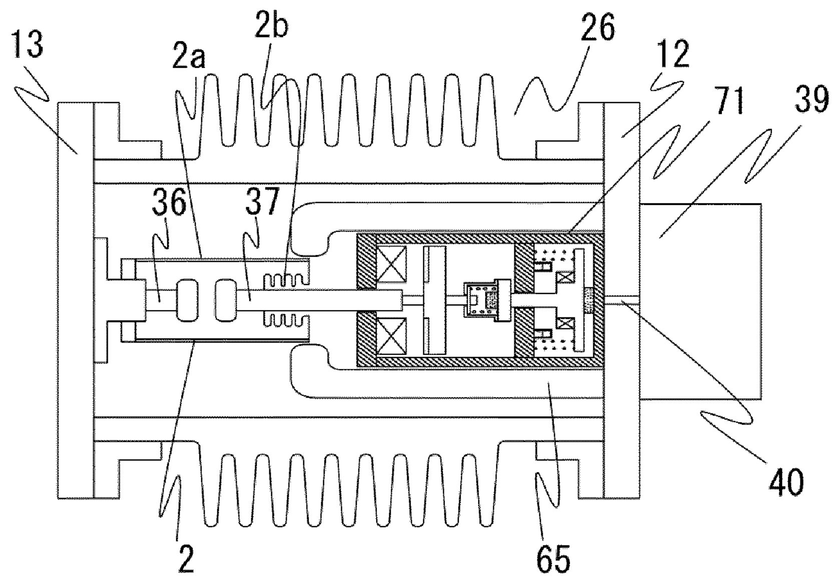

FIG. 6

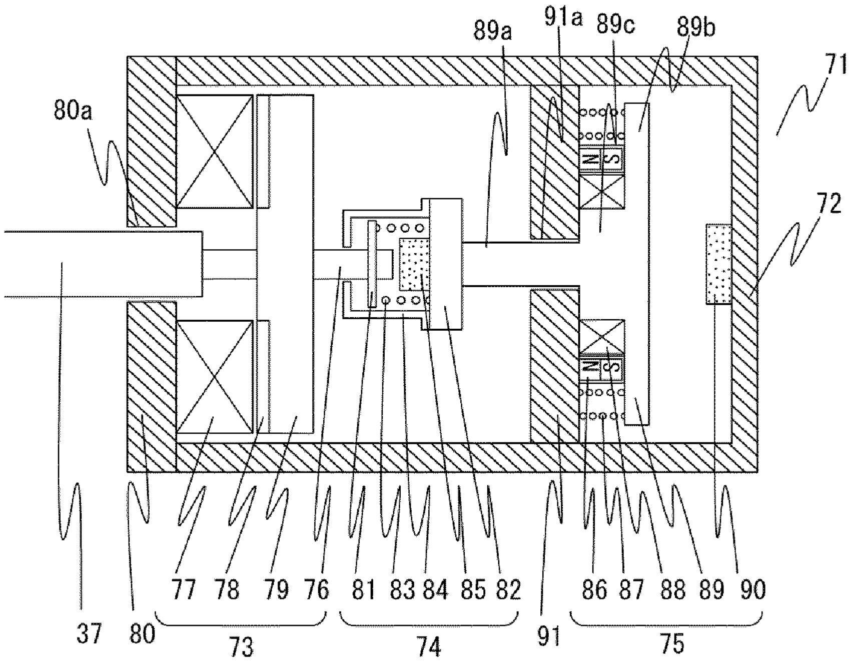
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FIG. 7

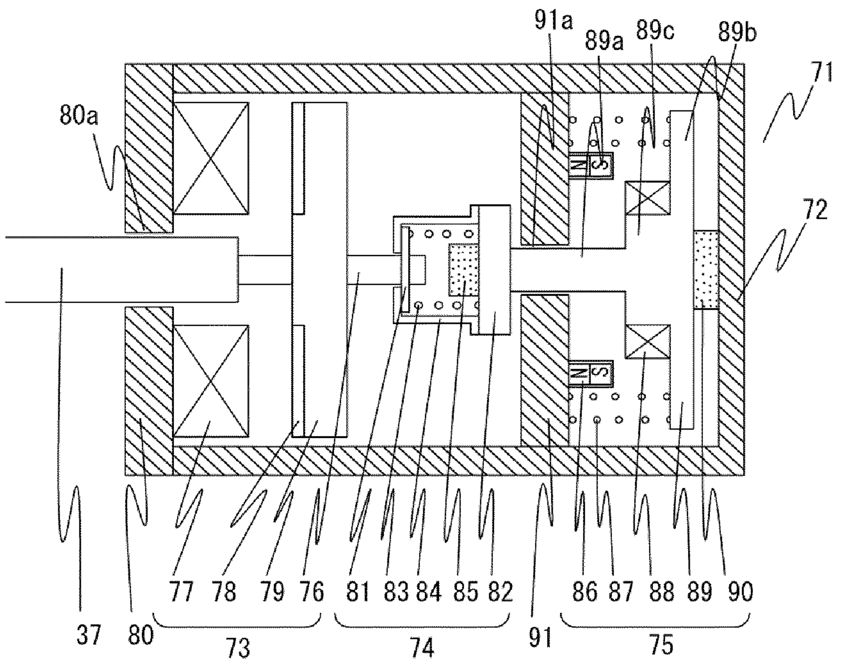
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FIG. 8

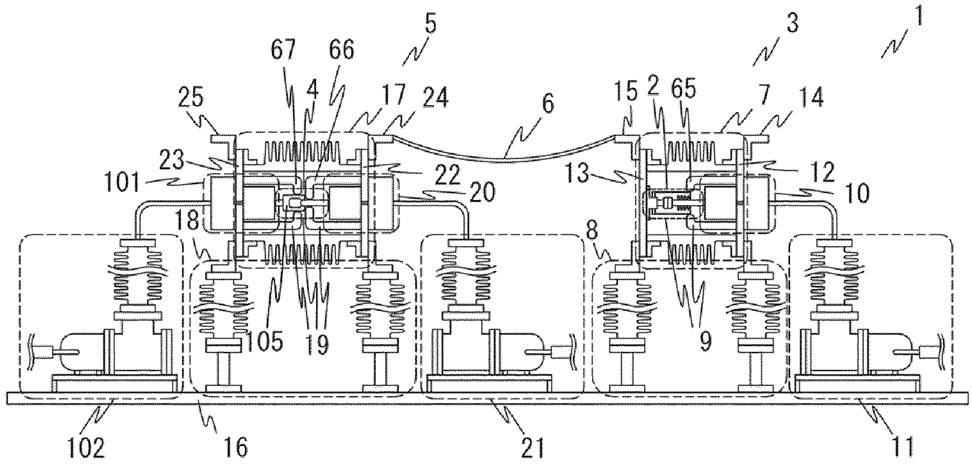
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FIG. 9

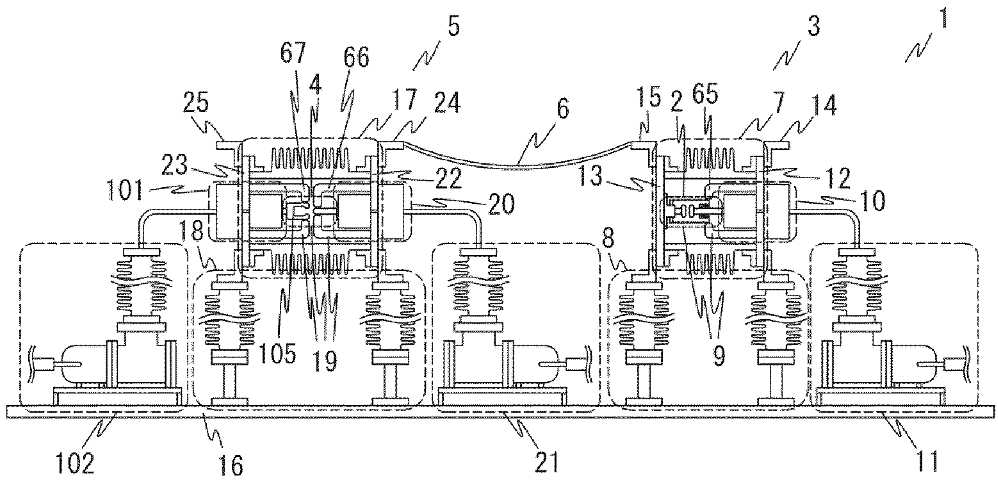
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FIG. 10

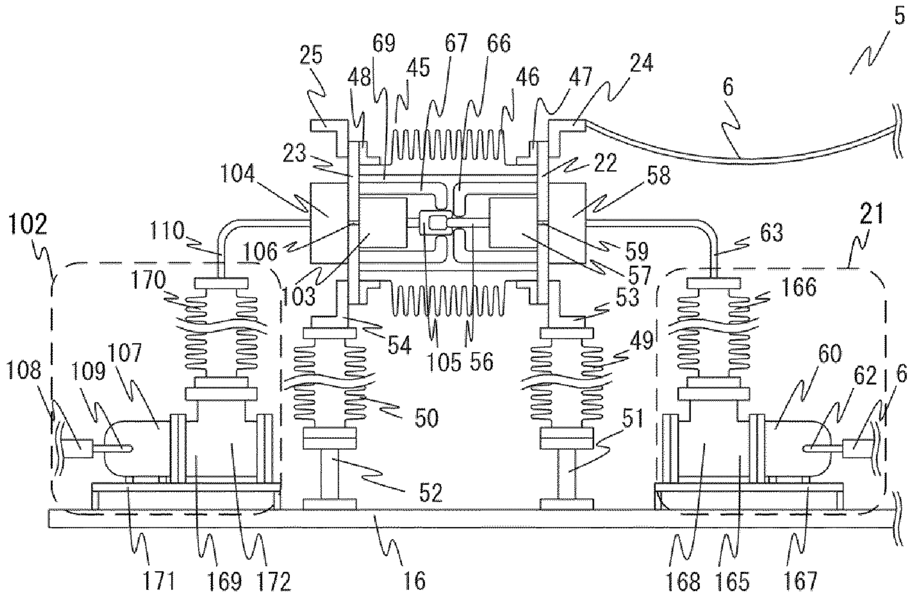
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FIG. 11

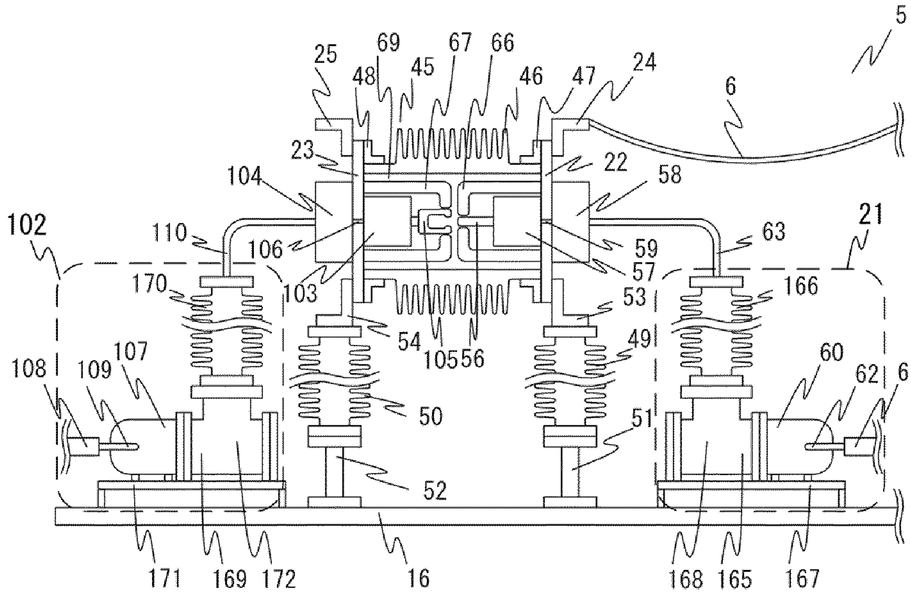
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FIG. 12

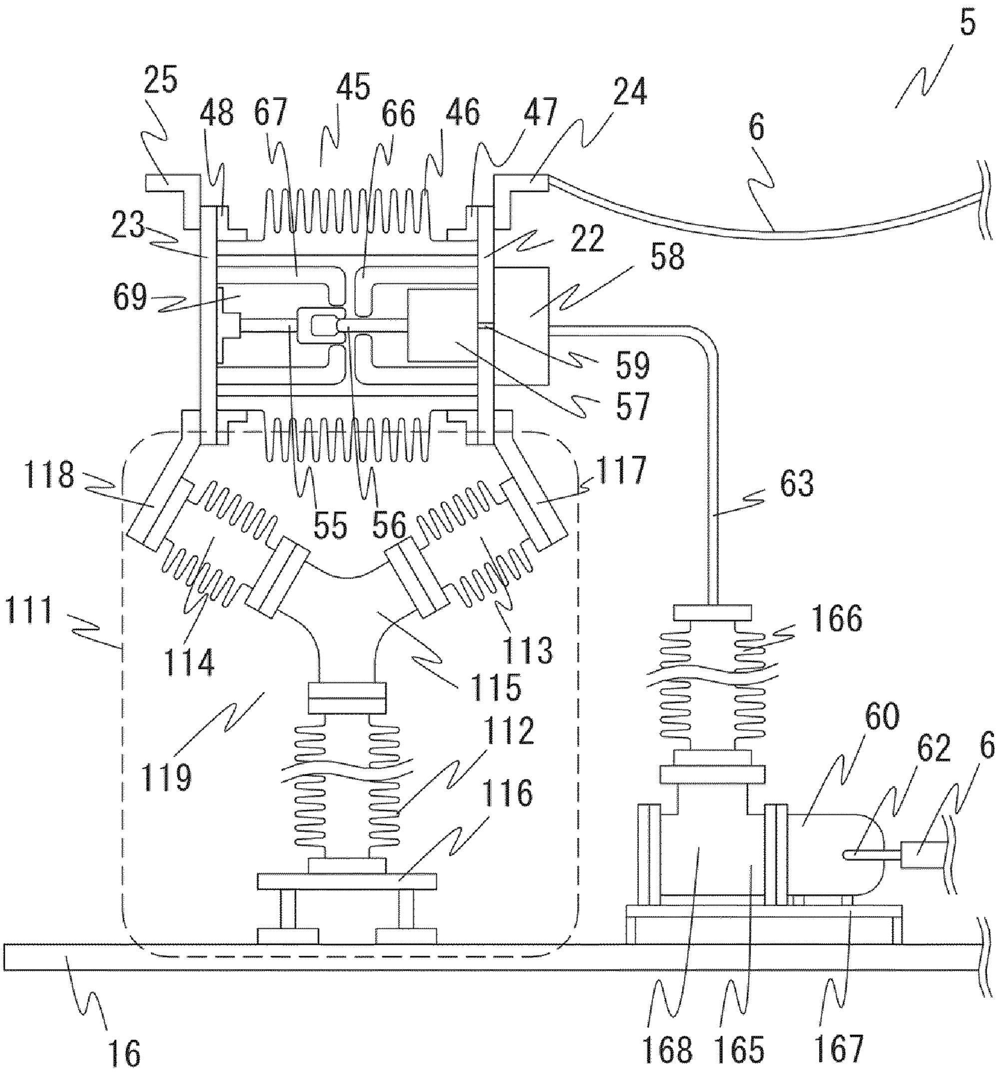
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FIG. 13

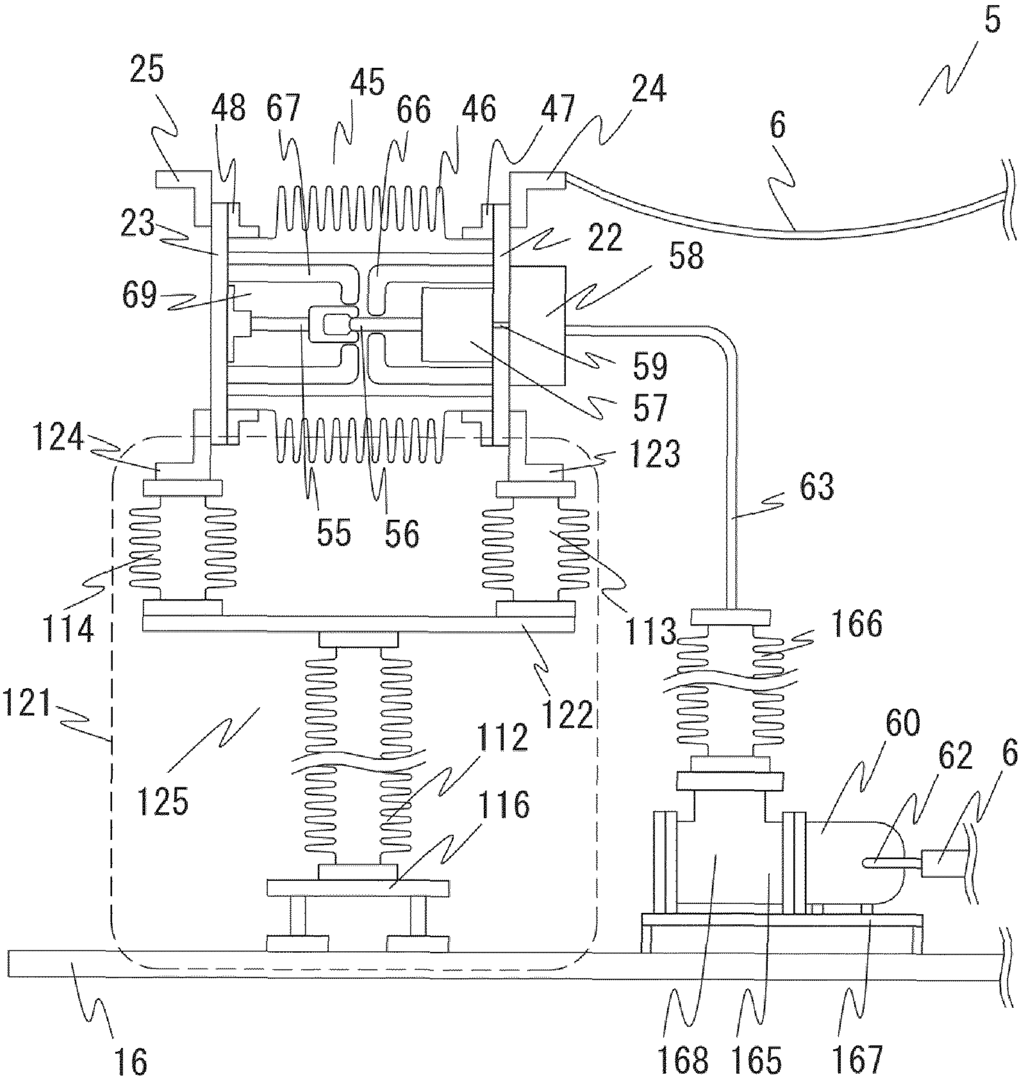
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FIG. 14

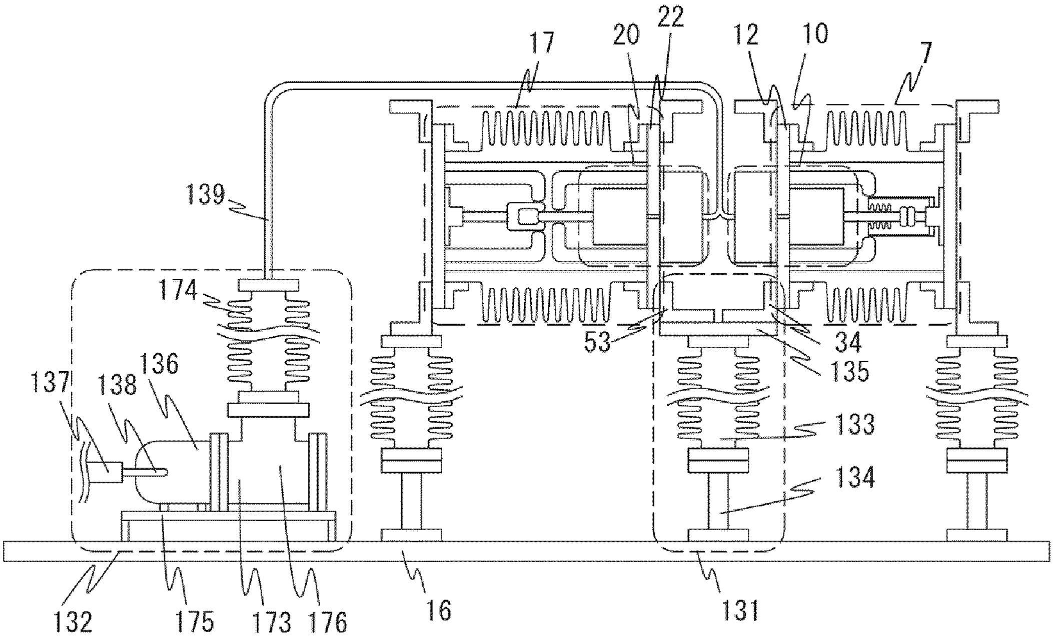
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FIG. 15

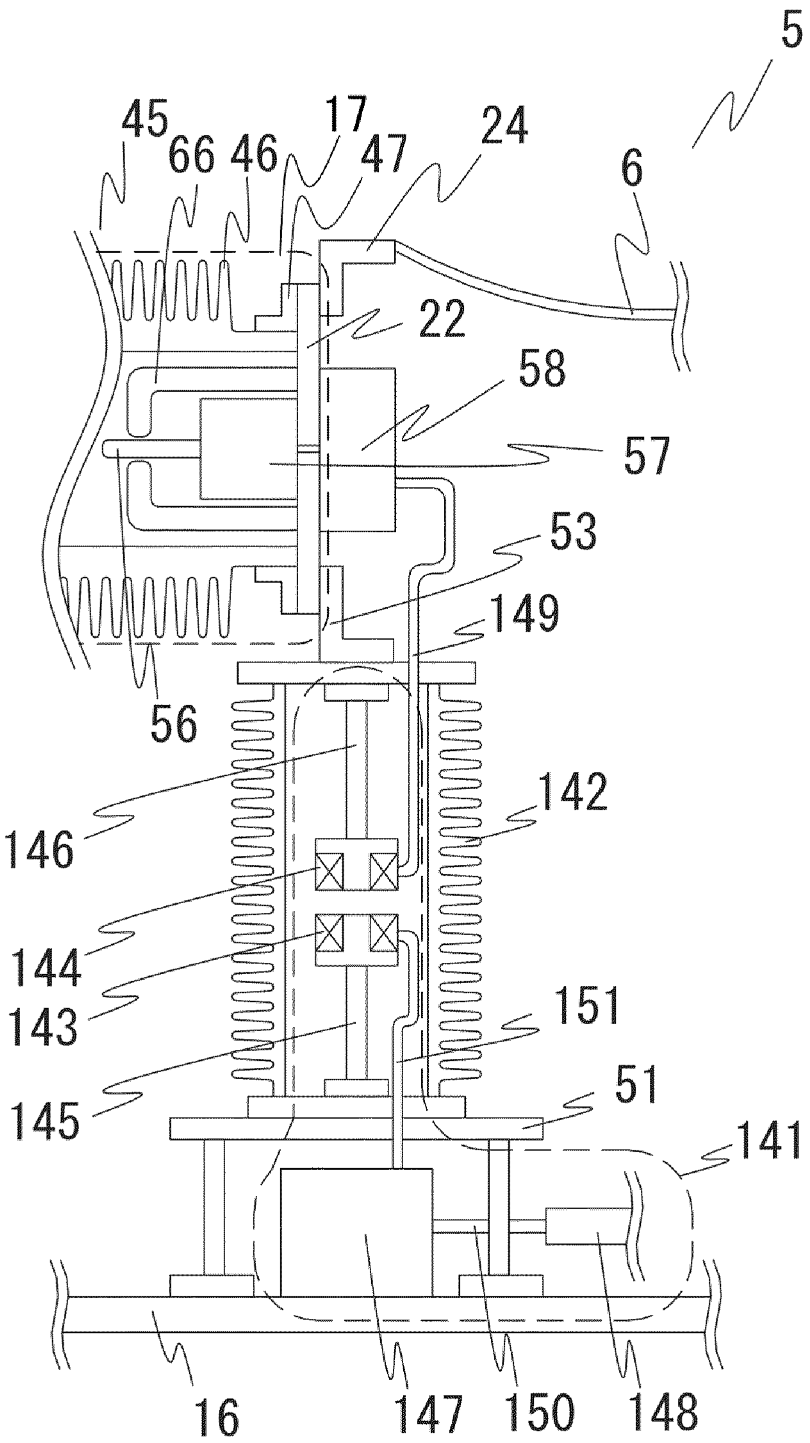
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FIG. 16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/081567

A. CLASSIFICATION OF SUBJECT MATTER
H01H13/04(2006.01)i, *H01H33/42*(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)
H01H13/04, H01H33/42, H01H33/66-33/668

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	1996-2014
Kokai Jitsuyo Shinan Koho	1971-2014	Toroku Jitsuyo Shinan Koho	1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 61-77216 A (Hitachi, Ltd.), 19 April 1986 (19.04.1986), entire text; drawings (Family: none)	1,3,7,8 2,4-6,9-11
Y	JP 2005-38630 A (Toshiba Corp.), 10 February 2005 (10.02.2005), entire text; fig. 1 to 5 (Family: none)	1,3,7,8
Y	JP 2000-331576 A (Mitsubishi Electric Corp.), 30 November 2000 (30.11.2000), entire text; fig. 1 to 5 (Family: none)	7,8

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

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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search	Date of mailing of the international search report
12 December 2014 (12.12.14)	22 December 2014 (22.12.14)

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2014/081567

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 58-181218 A (Hitachi, Ltd.), 22 October 1983 (22.10.1983), entire text; fig. 1 to 4 & US 4538039 A & EP 0092205 A2	1-11
A	JP 60-189130 A (Hitachi, Ltd.), 26 September 1985 (26.09.1985), entire text; fig. 1 to 3 (Family: none)	1-11
A	JP 51-95281 A (Tokyo Shibaura Electric Co., Ltd.), 20 August 1976 (20.08.1976), entire text; fig. 1 to 3 (Family: none)	1-11

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Patent documents cited in the description

- JP 2003348721 A **[0007]**