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(54) **HIGH-SPEED INPUT DEVICE**

HOCHGESCHWINDIGKEITSEINGABEVORRICHTUNG

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Description

[Technical Field]

[0001] Embodiments of the present invention relate to a high-speed switching device.

[Background Art]

[0002] There is known an switching device that maintains insulation between terminals to which a high voltage is applied in a steady state and rapidly electrically connects the terminals at an arbitrary timing to allow a large current to flow. The input devices are used in various applications such as high-speed grounding devices and bypass switches in power transmission systems, commutation circuit input devices for DC circuit breakers, and current source input devices for generating fusion plasma.

[0003] An example of the switching device is an electrode drive type input device. The electrode drive type input device includes a pair of main electrodes arranged to face each other so that a high voltage is applied therebetween in a steady state. In the pair of main electrodes, one main electrode is a movable electrode and the other main electrode is a fixed electrode. The movable electrode is disposed to movable toward and away from the fixed electrode. The movable electrode is operated in a direction contacting the fixed electrode by a driving portion during an input operation. When the distance between the movable electrode and the fixed electrode becomes equal to or less than the insulation distance for the applied voltage, arc discharge occurs between the movable electrode and the fixed electrode and the input device starts energization. The movable electrode contacts the fixed electrode while continuing the arc discharge. The input device continues the energization while the movable electrode contacts the fixed electrode and ends the input operation.

[0004] However, in the electrode drive type input device, arc discharge occurs between the electrodes and then the input operation ends while the electrodes contact each other. Therefore, when a large current is input, the metal on the electrode surfaces melted by the arc discharge is cooled and the electrodes are spot-welded to each other. The welded electrodes are pulled apart when the circuit is opened, and the welded portion is torn off while forming sharp protrusions on the electrodes. These sharp protrusions become electric field concentration portions in a steady state in which the electrodes are separated from each other and a high voltage is applied, and reduce the insulating performance between the electrodes.

[0005] Patent Document 4 discloses that an end part of a conducting shaft on the fixed side of a vacuum valve is connected to a fixed side terminal while pressing an electrode on the fixed side and an electrode on the movable side by the closing action of the operating part

through a wipe spring. Then, the sliding contacts are provided on the fixed side terminal and the end part of the shaft is made to penetrate the contacts and the spring is fitted on the shaft projected from the valve. In this case, the spring is mounted in a mounting length slightly compressed between a flange and the upper terminal conductor. In this way, the number of the connecting parts and inertia of the operating part are reduced up to a prescribed contact clearance being made after the electrode is dissociated from the electrode, so that opening speed and breaking characteristic of the electrode can be raised while obtaining a small-sized external shape and a long life.

[Citation List]

[Patent Document]

[0006]

[Patent Document 1]

Japanese Unexamined Patent Application, First Publication No. 55-163724

[Patent Document 2]

Japanese Unexamined Patent Application, First Publication No. 2019-186162

[Patent Document 3]

Japanese Examined Utility Model Application, Second Publication No. S57-007127

[Patent Document 4]

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[Summary of Invention]

[Technical Problem]

[0007] An object of the present invention is to provide a high-speed switching device capable of suppressing deterioration of withstand voltage performance due to protrusions caused by welding between electrodes.

[Solution to Problem]

[0008] Accordingly, there is provided a high-speed switching device as set out in independent claim 1. Advantageous developments are defined in the dependent claims.

[Brief Description of Drawings]

[0009]

FIG. 1 is a cross-sectional view showing a high-speed switching device of a first embodiment.

FIG. 2 is a cross-sectional view showing the high-speed switching device of the first embodiment.

FIG. 3 is a cross-sectional view showing the high-speed switching device of the first embodiment.

FIG. 4 is a cross-sectional view showing the high-speed switching device of the first embodiment.
 FIG. 5 is a cross-sectional view showing a high-speed switching device of a second embodiment.
 FIG. 6 is a cross-sectional view showing the high-speed switching device of the second embodiment.
 FIG. 7 is a cross-sectional view showing the high-speed switching device of the second embodiment.
 FIG. 8 is a cross-sectional view showing the high-speed switching device of the second embodiment.
 FIG. 9 is a cross-sectional view showing a high-speed switching device of a third embodiment.
 FIG. 10 is a cross-sectional view showing the high-speed switching device of the third embodiment.
 FIG. 11 is a cross-sectional view showing the high-speed switching device of the third embodiment.
 FIG. 12 is a cross-sectional view showing the high-speed switching device of the third embodiment.
 FIG. 13 is a cross-sectional view showing a high-speed switching device of a fourth embodiment.

[Description of Embodiments]

[0010] Hereinafter, a high-speed switching device of an embodiment will be described with reference to the drawings. In the following description, the same reference numerals are used for components having the same or similar functions. Duplicate descriptions of these configurations may be omitted.

(First embodiment)

[0011] FIGS. 1 to 4 are cross-sectional views showing a high-speed switching device of a first embodiment. FIG. 1 shows a high-speed input device 1 in a steady state which is a non-energized interruption state. FIGS. 2 to 4 show an operation process during an input operation of the high-speed switching device 1 in an energizable input state.

[0012] As shown in FIG. 1, the high-speed switching meet device 1 includes a contact point portion 2, a drive mechanism portion 3, and an impact buffer portion 4. The contact point portion 2 is connected to the drive mechanism portion 3 and the impact buffer portion 4.

[0013] The contact point portion 2 will be described.

[0014] The contact point portion 2 includes a drive electrode 11, a counter electrode 12, and a pressure container 13.

[0015] The drive electrode 11 and the counter electrode 12 are each formed in a bar shape and arranged coaxially. The drive electrode 11 and the counter electrode 12 are arranged so that the tip of the drive electrode 11 and the tip of the counter electrode 12 face each other in a separated state. The drive electrode 11 and the counter electrode 12 are movable to each other. The relative linear moving operations of the drive electrode 11 and the counter electrode 12 can switch an open circuit state in which their tips are separated from each other

and a closed-circuit state in which their tips contact each other. Hereinafter, the extension direction of the drive electrode 11 and the counter electrode 12 is referred to as the axial direction.

[0016] The drive electrode 11 includes a discharge portion 11a which is provided at the tip and a conducting shaft 11b which is connected to the discharge portion 11a. The counter electrode 12 includes a discharge portion 12a which is provided at the tip and a conducting shaft 12b which is connected to the discharge portion 12a. The discharge portions 11a and 12a are made of a material having high wear resistance (arc resistance) to arc discharge. The conducting shafts 11b and 12b are made of a highly conductive material. In this embodiment, the material with high wear resistance to arc discharge is a copper-tungsten alloy. In this embodiment, a highly conductive material is a copper alloy. However, the materials forming the drive electrode 11 and the counter electrode 12 are not limited to the above materials. At least discharge portions 11a and 12a of the drive electrode 11 and the counter electrode 12 may be made of a metal material having high wear resistance to arc discharge and may be made of, for example, a copper-chromium alloy other than the copper-tungsten alloy. Further, each of the drive electrode 11 and the counter electrode 12 may be made of the same material from the discharge portions 11a and 12a to the conducting shafts 11b and 12b.

[0017] The pressure container 13 includes an insulating cylinder 14, a first lid 15, and a second lid 16.

[0018] The insulating cylinder 14 includes a cylindrical insulator container 14a and metallic flanges 14b and 14c fixed to both ends of the insulator container 14a. The first lid 15 is electrically connected to the flange 14b. The second lid 16 is electrically connected to the flange 14c. Each of the first lid 15 and the second lid 16 is a disk-shaped plate material. The first lid 15 and the second lid 16 are airtightly joined to the flanges 14b and 14c over the entire periphery to close the opening of an end portion of the insulating cylinder 14. A through-hole is provided at the center portion of each of the first lid 15 and the second lid 16. An annular seal portion 17 is mounted on the through-hole of the first lid 15. An annular seal portion 18 is mounted on the through-hole of the second lid 16.

[0019] The pressure container 13 accommodates the contact portion between the drive electrode 11 and the counter electrode 12. The pressure container 13 encloses the entire discharge portions 11a and 12a of the drive electrode 11 and the counter electrode 12 and a part of the conducting shafts 11b and 12b of the drive electrode 11 and the counter electrode 12. The conducting shaft 11b penetrates the through-hole of the first lid 15 and extends to the outside of the pressure container 13. The conducting shaft 12b penetrates the through-hole of the second lid 16 and extends to the outside of the pressure container 13. The conducting shaft 11b is in close contact with the inner peripheral surface of the seal portion 17 in the through-hole of the first lid 15. The conducting shaft 11b is movable in the axial direction

while maintaining the pressure container 13 airtight and sliding on the seal portion 17. The conducting shaft 12b is in close contact with the seal portion 18 in the through-hole of the second lid 16. The conducting shaft 12b is movable in the axial direction while maintaining the pressure container 13 airtight and sliding on the seal portion 18.

[0020] The pressure container 13 encloses an insulating gas. For example, a sulfur hexafluoride (SF_6) gas can be used as the insulating gas. However, any one of nitrogen, carbon dioxide, oxygen, and air or a mixed gas thereof may be used as the insulating gas in addition to the sulfur hexafluoride gas. The pressure of the insulating gas enclosed in the pressure container 13 is higher than the atmospheric pressure.

[0021] The first shield 19 and the second shield 20 made of metal are arranged inside the pressure container 13. Each of the shields 19 and 20 is formed in a cylindrical shape. The shields 19 and 20 are concentrically arranged and are axially aligned. The first end of the first shield 19 is coupled and electrically connected to the first lid 15. The first end of the second shield 20 is coupled and electrically connected to the second lid 16. The second end of the first shield 19 and the second end of the second shield 20 face each other inside the pressure container 13. The outer peripheral edges of the second end of the first shield 19 and the second end of the second shield 20 are R-chamfered.

[0022] The first shield 19 surrounds the drive electrode 11. The second shield 20 surrounds the counter electrode 12. The conducting shaft 11b of the drive electrode 11 is movable in the axial direction while sliding on the current collecting portion 21 provided on the inner periphery of the first shield 19 and maintaining the electrical connection state with the first shield 19. The conducting shaft 12b of the counter electrode 12 is movable in the axial direction while sliding on the current collecting portion 22 provided on the inner periphery of the second shield 20 and maintaining the electrical connection state with the second shield 20. Accordingly, the drive electrode 11 is electrically connected to the first shield 19, the first lid 15, and the first flange 14b via the current collecting portion 21. The counter electrode 12 is electrically connected to the second shield 20, the second lid 16, and the second flange 14c via the current collecting portion 22.

[0023] The end portion of the conducting shaft 11b is connected to the insulating operating rod 23 outside the pressure container 13. The conducting shaft 11b is connected to the drive mechanism portion 3 via the insulating operating rod 23. The end portion of the conducting shaft 12b is connected to the insulating operating rod 24 outside the pressure container 13. The conducting shaft 12b is connected to the impact buffer portion 4 via the insulating operating rod 24. The drive mechanism portion 3 and the impact buffer portion 4 are connected to the contact point portion 2 via the insulating operating rods 23 and 24 which are insulators so that the contact point portion 2 and the drive mechanism portion 3 are electrically insu-

lated and the contact point portion 2 and the impact buffer portion 4 are electrically insulated.

[0024] The drive mechanism portion 3 will be described.

[0025] The drive mechanism portion 3 is connected to the drive electrode 11. The drive mechanism portion 3 includes a drive shaft 31, a mechanism box 32, a driving portion 33, a position holding portion 34, and a drive side braking portion 35.

[0026] The drive shaft 31 extends outside the mechanism box 32 while being partially accommodated inside the mechanism box 32. The drive shaft 31 is connected to the conducting shaft 11b of the drive electrode 11 via the insulating operating rod 23 outside the mechanism box 32. Accordingly, the drive shaft 31 is displaced integrally with the drive electrode 11.

[0027] The driving portion 33 is an electromagnetic repulsion operation mechanism. The driving portion 33 includes a metal ring 36 (repulsion body) which is connected to the drive shaft 31 and a coil 37 which is fixed to the mechanism box 32. The ring 36 and the coil 37 are arranged inside the mechanism box 32 to face each other in the axial direction. A good conductor 36a having a particularly low electrical resistivity is fixed to a portion of the ring 36 facing the coil 37. The ring 36 is disposed on the side of the contact point portion 2 with respect to the coil 37. In this embodiment, the good conductor 36a is made of oxygen-free copper and the portion of the ring 36 other than the good conductor 36a is made of high-strength extra super duralumin. By applying a coil current to the coil 37 from an excitation circuit (not shown), an induced current is generated in the ring 36 (especially the good conductor 36a) in the direction opposite to the coil current. A Lorentz force in the repulsion direction is generated between the coil 37 to which the coil current is energized and the ring 36 to which the induced current is energized. The driving portion 33 uses the Lorentz force generated between the coil 37 and the ring 36 as a driving force during an input operation. The driving force generated in the ring 36 displaces the drive electrode 11 in a direction (first direction) approaching the counter electrode 12 via the drive shaft 31 and the insulating operating rod 23.

[0028] The position holding portion 34 includes a drive side return spring 38 (drive side urging portion), a drive side spring receiver 39, and a drive side stopper 40. The drive side spring receiver 39 is coupled to the drive shaft 31. The base 41 is disposed on the side of the contact point portion 2 with respect to the drive side spring receiver 39. The base 41 is disposed to surround the drive shaft 31. The base 41 is fixed to the mechanism box 32. The drive side return spring 38 is a compression coil spring which is provided between the drive side spring receiver 39 and the base 41 in a compressed state. The drive side return spring 38 always applies a spring force in a direction (second direction) to be separated from the contact point portion 2 to the drive side spring receiver 39. Hereinafter, the spring force of the drive side return spring

38 will be referred to as a drive side return force.

[0029] The drive side stopper 40 is fixed to the base 41. The drive side stopper 40 is disposed on the side opposite to the contact point portion 2 with respect to the drive side spring receiver 39. The drive side stopper 40 is disposed to surround the drive shaft 31. The drive side stopper 40 positions the drive shaft 31 and the drive electrode 11 in a steady state by contacting the drive side spring receiver 39 that receives the drive side return force.

[0030] The drive side braking portion 35 includes a cylinder 42 and a piston 43. In this embodiment, the drive side braking portion 35 is a shock absorber. The inside of the cylinder 42 is filled with hydraulic oil. When the piston 43 is pressed into the cylinder 42, an attenuation force is generated in the piston 43 according to the amount of displacement and speed due to the viscous resistance of the hydraulic oil. The attenuation force is generated in a direction opposite to the pressing direction of the piston 43. Further, when the pressed piston 43 is released, the piston 43 is stopped at a predetermined position while being pressed from the cylinder 42 due to a return spring (not shown) provided inside the cylinder 42. The cylinder 42 is fixed to the mechanism box 32. The piston 43 is installed to contact the end portion of the drive shaft 31 and to be pressed into the cylinder 42 in a steady state in which the drive side spring receiver 39 is stopped by contacting the drive side stopper 40.

[0031] The impact buffer portion 4 will be described.

[0032] The impact buffer portion 4 is connected to the counter electrode 12. The impact buffer portion 4 includes a counter shaft 51, a mechanism box 52, a position holding portion 53, and a counter side braking portion 54.

[0033] The counter shaft 51 extends outside the mechanism box 52 while being partially accommodated inside the mechanism box 52. The counter shaft 51 is connected to the conducting shaft 12b of the counter electrode 12 via the insulating operating rod 24 outside the mechanism box 52. Accordingly, the counter shaft 51 is displaced integrally with the counter electrode 12.

[0034] The position holding portion 53 includes a counter side return spring 55 (counter side urging portion), a counter side spring receiver 56, a counter side stopper 57, and a base 58. The counter side spring receiver 56 is coupled to the counter shaft 51. The base 58 is disposed on the side opposite to the contact point portion 2 with respect to the counter side spring receiver 56. The base 58 is fixed to the mechanism box 52. The counter side return spring 55 is a compression coil spring which is provided between the counter side spring receiver 56 and the base 58 in a compressed state. The counter side return spring 55 is disposed to always give a spring force in a direction approaching the contact point portion 2 to the counter side spring receiver 56. Hereinafter, the spring force of the counter side return spring 55 will be referred to as a counter side return force.

[0035] The counter side stopper 57 is fixed to the base

58. The counter side stopper 57 is disposed on the side of the contact point portion 2 with respect to the counter side spring receiver 56. The counter side stopper 57 is disposed to surround the counter shaft 51. The counter side stopper 57 positions the counter shaft 51 and the counter electrode 12 in a steady state by contacting the counter side spring receiver 56 that receives the counter side return force.

[0036] The counter side braking portion 54 includes a cylinder 59, a piston 60, and a stopper 61. In this embodiment, the counter side braking portion 54 is a shock absorber similarly to the drive side braking portion 35. The configurations of the cylinder 59 and the piston 60 are the same as those of the cylinder 42 and the piston 43 of the drive side braking portion 35.

[0037] The cylinder 59 is fixed to the mechanism box 52 via the base 58. The piston 60 is installed not to contact the counter side spring receiver 56 and to stop at a predetermined position while being pressed out from the cylinder 59 in a steady state in which the counter side spring receiver 56 is stopped by contacting the counter side stopper 57.

[0038] The stopper 61 is fixed to the base 58. The stopper 61 is disposed to contact the counter side spring receiver 56 in the process in which the counter side spring receiver 56 presses the piston 60 into the cylinder 59 and limits the amount of pressing the piston 60 within a certain value.

[0039] The high-speed switching device 1 of this embodiment is connected to an external circuit by using the first lid 15 and the second lid 16 of the pressure container 13 of the contact point portion 2 as terminals. The drive electrode 11, the insulating operating rod 23, the drive shaft 31, the ring 36, and the drive side spring receiver 39 form a drive side movable portion 71 which is integrally operated. The counter electrode 12, the insulating operating rod 24, the counter shaft 51, and the counter side spring receiver 56 form a counter side movable portion 72 which is integrally operated.

[0040] A steady state in which the high-speed switching device 1 is in a non-energized interruption state will be described.

[0041] As shown in FIG. 1, the drive side movable portion 71 is stopped at a position in which the drive side spring receiver 39 is pressed against the drive side stopper 40 by the drive side return spring 38. The end surface of the discharge portion 11a of the drive electrode 11 is disposed at a position flush with the R-chamfered end surface of the shield 19.

[0042] The counter side movable portion 72 is stopped at a position in which the counter side spring receiver 56 is pressed against the counter side stopper 57 by the counter side return spring 55. The end surface of the discharge portion 12a of the counter electrode 12 is disposed at a position flush with the R-chamfered end surface of the shield 20.

[0043] When the high-speed switching device 1 is connected to the external circuit, a voltage is applied

between the first lid 15 and the second lid 16 which are terminals. The first lid 15 is electrically connected to the drive electrode 11 and the first shield 19 and has the same potential. The second lid 16 is electrically connected to the counter electrode 12 and the second shield 20 and has the same potential. Thus, the voltage applied to the high-speed input device 1 is applied between the drive electrode 11 and the first shield 19 and the counter electrode 12 and the second shield 20 inside the pressure container 13.

[0044] In a steady state, the drive electrode 11 and the counter electrode 12 are in an open circuit state to be sufficiently separated from each other and the electric field near the drive electrode 11 and the counter electrode 12 is sufficiently lower than the dielectric breakdown electric field of the insulating gas enclosed in the pressure container 13. Therefore, the drive electrode 11 and the counter electrode 12 are electrically insulated. Thus, the high-speed input device 1 is in an interruption state in which terminals are not electrically connected.

[0045] An input operation in which the high-speed input device 1 changes from a steady state as a non-energized interruption state to an energizable input state and finally returns to a steady interruption state will be described. Additionally, in the following description of the input operation, a state in which the high-speed input device 1 is connected to the external circuit and a high voltage is applied to the drive electrode 11 and the counter electrode 12 will be described.

[0046] The input operation is started by applying a coil current from an excitation circuit (not shown) to the coil 37 of the driving portion 33 in a steady state of FIG. 1 and generating a driving force in the ring 36. The input operation includes an approaching step, a contacting step, and a separating step in this order.

[0047] The approaching step will be described. In the approaching step, the state of FIG. 1 reaches the state of FIG. 3 through the state of FIG. 2.

[0048] The drive side movable portion 71 receives the driving force of the driving portion 33. Here, the driving force of the driving portion 33 is sufficiently larger than the drive side return force of the drive side return spring 38. The drive side movable portion 71 starts the displacement of the drive electrode 11 in a direction approaching the counter electrode 12 while compressing the drive side return spring 38 by the driving force of the driving portion 33.

[0049] When the drive electrode 11 approaches the counter electrode 12, the electric field near the drive electrode 11 and the counter electrode 12 increases. Since the electric field near the drive electrode 11 and the counter electrode 12 becomes higher than the dielectric breakdown electric field of the insulating gas enclosed in the pressure container 13, dielectric breakdown occurs between the discharge portion 11a of the drive electrode 11 and the discharge portion 12a of the counter electrode 12. When the drive electrode 11 approaches the counter electrode 12 to the position shown

in FIG. 2, arc discharge 73 is generated between the discharge portion 11a of the drive electrode 11 and the discharge portion 12a of the counter electrode 12 by dielectric breakdown. Since the drive electrode 11 and the counter electrode 12 are electrically connected to each other by the arc discharge 73, the first lid 15 and the second lid 16 are also electrically connected to each other. Since the first lid 15 and the second lid 16 which are the connection terminals with the external circuit are electrically connected, the high-speed switching device 1 changes to the input state and starts energization.

[0050] Then, the drive side movable portion 71 independently changes until the drive electrode 11 contacts the counter electrode 12 as shown in FIG. 3. At this time, the piston 43 of the drive side braking portion 35 is pressed out from the cylinder 42 by a return spring (not shown) provided inside the cylinder 42 in accordance with the displacement of the drive side movable portion 71.

[0051] The contacting step will be described. In the contacting step, the state of FIG. 3 returns to the state of FIG. 3 again through the state of FIG. 4.

[0052] As shown in FIG. 3, the discharge portion 11a of the drive electrode 11 contacts the discharge portion 12a of the counter electrode 12. Accordingly, the electrical connection between the drive electrode 11 and the counter electrode 12 is maintained through the contact portion between the drive electrode 11 and the counter electrode 12. Thus, the high-speed input device 1 also continues the energizable input state. At this time, the piston 43 which is pressed out from the cylinder 42 is stopped at a predetermined position. However, the piston 43 may be stopped at the approaching step.

[0053] After the discharge portion 11a of the drive electrode 11 contacts the discharge portion 12a of the counter electrode 12, the counter side movable portion 72 is pressed by the drive side movable portion 71 accelerated by the driving force of the driving portion 33. Accordingly, as shown in FIG. 4, both the drive side movable portion 71 and the counter side movable portion 72 are displaced in the driving force output direction while the drive electrode 11 contacts the counter electrode 12.

[0054] The driving force of the driving portion 33 is attenuated after the drive electrode 11 contacts the counter electrode 12. The driving force decreases as the distance between the ring 36 and the coil 37 increases. Further, the driving force decreases as the coil current is attenuated. Additionally, the driving force of the driving portion 33 may start to be attenuated from before the drive electrode 11 contacts the counter electrode 12. On the other hand, the drive side movable portion 71 compresses the drive side return spring 38 and the counter side movable portion 72 is displaced while compressing the counter side return spring 55. Therefore, the drive side return force and the counter side return force applied in a direction opposite to the driving force with respect to the drive side movable portion 71 and the counter side movable portion 72 increase. Furthermore, the counter

side spring receiver 56 of the counter side movable portion 72 receives an attenuation force in a direction opposite to the pressing direction when the piston 60 of the counter side braking portion 54 is pressed into the cylinder 59. Further, when the drive side movable portion 71 contacts and accelerates the counter side movable portion 72, the drive side movable portion is decelerated by distributing the momentum. Thus, the drive side movable portion 71 is largely decelerated while being displaced together with the counter side movable portion 72 after contacting the counter side movable portion 72, is stopped when the counter side spring receiver 56 of the counter side movable portion 72 contacts the stopper 61 after the drive side movable portion is sufficiently decelerated, and enters the state of FIG. 4.

[0055] Additionally, in the process in which the state of FIG. 3 changes to the state of FIG. 4, even when the drive electrode 11 and the counter electrode 12 are temporarily separated due to the repulsion force at the time of contact, the electrical connection is maintained via the arc discharge and the electrical connection via the contact portion is resumed at the time of re-contact. Thus, the high-speed input device 1 also continues the energizable input state.

[0056] After the drive side movable portion 71 and the counter side movable portion 72 stop, the displacement direction is reversed by the drive side return force of the drive side return spring 38 and the counter side return force of the counter side return spring 55. The drive side movable portion 71 and the counter side movable portion 72 are accelerated and displaced in a direction opposite to the driving force output direction and enter the state of FIG. 3 again. Here, the counter side movable portion 72 is stopped when the counter side spring receiver 56 contacts the counter side stopper 57.

[0057] Furthermore, in the process in which the state of FIG. 4 returns to the state of FIG. 3, the drive electrode 11 and the counter electrode 12 are basically in a contact state and maintain the electrical connection via the contact portion. Even when the drive electrode 11 and the counter electrode 12 are temporarily separated, the electrical connection is maintained via the arc discharge. Thus, the high-speed input device 1 also continues the energizable input state.

[0058] The separating step will be described. In the separating step, the state of FIG. 3 reaches the state of FIG. 1 through the state of FIG. 2.

[0059] As shown in FIGS. 3 and 2, the drive side movable portion 71 is independently displaced by the drive side return force of the drive side return spring 38 since the displacement of the counter electrode 12 is regulated by the counter side stopper 57 after the counter side movable portion 72 is stopped. Here, the drive side movable portion 71 starts to be decelerated by receiving an attenuation force in a direction opposite to the pressing direction when the drive shaft 31 presses the piston 43 of the drive side braking portion 35 against the cylinder 42.

[0060] In the process in which the state of FIG. 3 returns to the state of FIG. 2, the counter side movable portion 72 is stopped and the discharge portion 11a of the drive electrode 11 is separated from the discharge portion 12a of the counter electrode 12. On the other hand, the drive electrode 11 and the counter electrode 12 maintain the electrical connection via the arc discharge 73 and the high-speed input device 1 also continues the energizable input state.

[0061] Finally, the drive side movable portion 71 is decelerated by receiving the attenuation force of the drive side braking portion 35, is stopped when the drive side spring receiver 39 contacts the drive side stopper 40, and returns to the state of FIG. 1. At this time, the driving force of the driving portion 33 is completely attenuated or is sufficiently smaller than the drive side return force and the drive side movable portion 71 is maintained in the state of FIG. 1.

[0062] In the process in which the state of FIG. 2 returns to the state of FIG. 1 or after the state returns to the state of FIG. 1, the arc discharge generated between the drive electrode 11 and the counter electrode 12 is extinguished by interrupting or attenuating the current in the external circuit. Accordingly, the drive electrode 11 and the counter electrode 12 are electrically insulated again. As described above, the high-speed switching device 1 returns to an interruption state in which terminals are not electrically connected and ends the input operation.

[0063] As described above, in the high-speed switching device 1 of this embodiment, the drive electrode 11 first approaches the counter electrode 12 by applying a driving force to the drive electrode 11 using the driving portion 33. When the drive electrode 11 approaches the counter electrode 12, arc discharge is generated between the discharge portion 11a of the drive electrode 11 and the discharge portion 12a of the counter electrode 12 to start energization. Next, the drive electrode 11 contacts the counter electrode 12 while continuing energization and is displaced in the driving force output direction together with the counter electrode 12. At this time, the drive electrode 11 and the counter electrode 12 are decelerated by the return force of the drive side return spring 38 and the counter side return spring 55. Next, the drive electrode 11 and the counter electrode 12 reverse the displacement direction by the return force. Next, since the displacement of the counter electrode 12 is regulated by the counter side stopper 57, the drive electrode 11 is separated from the counter electrode 12 by the return force of the drive side return spring 38. In a process in which the drive electrode 11 is separated from the counter electrode 12, arc discharge is generated between the drive electrode 11 and the counter electrode 12 to continue energization. Next, since the displacement of the drive electrode 11 is regulated by the drive side stopper 40, the drive electrode 11 returns to a position in a steady state. The energization ends when the arc discharge is extinguished in a process in which the drive

electrode 11 is separated from the counter electrode 12 or a state in which the drive electrode returns to a position in a steady state. As described above, the high-speed switching device 1 of this embodiment is operated as an electrode drive type high-speed input device. Thus, according to this embodiment, since the trigger electrode as in the trigger discharge type high-speed input device is not necessary, it is possible to provide the high-speed input device 1 capable of operating more times than the trigger discharge type. Further, according to this embodiment, since the trigger discharge type high-speed input device does not require an expensive pulse power source that has to be used, it is possible to provide the high-speed input device 1 at a lower equipment cost than the trigger discharge type.

[0064] Further, in the high-speed switching device 1 of this embodiment, the momentum of the drive side movable portion 71 is distributed to the counter side movable portion 72 in such a manner that the drive side movable portion 72 is displaced in the driving force output direction together with the counter side movable portion 72 after the drive electrode 11 contacts the counter electrode 12 during an input operation. Further, the drive side movable portion 71 is largely decelerated by receiving the counter side return force of the counter side return spring 55 and the attenuation force of the counter side braking portion 54 in addition to the drive side return force of the drive side return spring 38. According to this configuration, the drive electrode 11 is allowed to approach the counter electrode 12 for the electrical connection by the arc discharge between the discharge portions 11a and 12a, the drive electrode 11 is allowed to contact the counter electrode 12, and then the drive side movable portion 71 is decelerated during an input operation. Thus, since the electric field between the discharge portions 11a and 12a can be rapidly increased without substantially decelerating the drive side movable portion 71 until the electrical connection starts by the arc discharge, an arc discharge generation start time can be shortened and variations can be reduced. Accordingly, it is possible to provide the high-speed switching device 1 with a shorter input time and less variations in the input time. Further, according to the configuration, since the counter electrode 12 is operated in the driving force output direction together with the drive electrode 11 after contacting the drive electrode 11 during an input operation, the impact force at the time of contact can be reduced. Thus, it is possible to provide the high-speed input device 1 capable of suppressing the damage to the device due to the impact force when the drive electrode 11 and the counter electrode 12 contact each other and operating many times.

[0065] Further, the high-speed switching device 1 starts energization by generating the arc discharge between the discharge portion 11a of the drive electrode 11 and the discharge portion 12a of the counter electrode 12 during an input operation. Further, the discharge portion 11a is separated from the discharge portion 12a while continuing the energization after the discharge portion

11a of the drive electrode 11 contacts the discharge portion 12a of the counter electrode 12 and the input operation ends. According to this configuration, the discharge portion 11a of the drive electrode 11 and the discharge portion 12a of the counter electrode 12 each having metal surfaces partially melted by the arc discharge contact each other and are separated from each other again before being cooled during an input operation, and then the input operation ends. Therefore, it is possible to suppress the occurrence of welded portions in the discharge portions 11a and 12a. Thus, it is possible to suppress sharp protrusions generated when separating the welded portions from being formed on the surfaces of the discharge portions 11a and 12a. Accordingly, it is possible to prevent the generation of an electric field concentration portion due to the sharp protrusions in a steady state in which the electrodes are separated from each other and a high voltage is applied. Thus, it is possible to provide the high-speed switching device 1 capable of maintaining the insulating performance between the electrodes and suppressing deterioration of withstand voltage performance.

[0066] Further, the high-speed switching device 1 generates arc discharge between the discharge portions 11a and 12a when the discharge portion 11a of the drive electrode 11 is separated from the discharge portion 12a of the counter electrode 12 in an input operation. According to this configuration, even if welded portions occur when the discharge portions 11a and 12a contact each other and sharp protrusions are formed when the discharge portions 11a and 12a are separated from each other, arc discharge can evaporate and remove sharp protrusions. Accordingly, it is possible to prevent the generation of an electric field concentration portion due to sharp protrusions in a steady state in which the electrodes are separated from each other and a high voltage is applied. Thus, it is possible to provide the high-speed switching device 1 capable of maintaining the insulating performance between the electrodes and suppressing deterioration of withstand voltage performance.

[0067] The driving portion 33 is an electromagnetic repulsion operation mechanism including the metal ring 36 and the coil 37 fixed to the mechanism box 32 and applies a driving force to the drive electrode 11 due to an induced repulsive force generated in the ring 36. According to this configuration, it is possible to start the electrical connection by the arc discharge between the discharge portions 11a and 12a by allowing the drive electrode 11 to approach the counter electrode 12 in a shorter time than the configuration in which the driving operation is performed by a hydraulic pressure, a restoring force of a spring, an electromagnetic force of a motor, and the like during an input operation. Thus, it is possible to provide the high-speed switching device 1 having a short input time.

[0068] The drive side return spring 38 and the counter side return spring 55 are coil springs. According to this configuration, a linear return force can be applied to the

drive electrode 11 and the counter electrode 12. Thus, it is possible to stably hold the drive electrode 11 and the counter electrode 12 at a stop position in a steady state and to reliably decelerate the drive electrode 11 and the counter electrode 12 during an input operation.

[0069] The high-speed switching device 1 includes the drive side braking portion 35. The drive side braking portion 35 decelerates the drive electrode 11 by contacting the drive electrode 11 displaced in a direction opposite to the driving force output direction of the driving portion 33 by the return force of the counter side return spring 55 during an input operation. According to this configuration, it is possible to attenuate the momentum of the drive electrode 11 displaced toward a stop position in a steady state. Thus, it is possible to suppress the damage to the device due to the impact force when the drive electrode 11 is stopped.

[0070] The high-speed switching device 1 includes the counter side braking portion 54. The counter side braking portion 54 decelerates the counter electrode 12 by contacting the counter electrode 12 which contacts the drive electrode 11 and is displaced together with the drive electrode 11 by the driving force of the driving portion 33 during an input operation. According to this configuration, it is possible to attenuate the momentum of the drive electrode 11 and the counter electrode 12 displaced toward the reversed position during an input operation. Thus, it is possible to suppress the damage to the device due to the impact force when the drive electrode 11 and the counter electrode 12 are reversed.

[0071] The high-speed switching device 1 includes the pressure container 13 which encloses an insulating gas. The pressure container 13 accommodates the contact portion between the drive electrode 11 and the counter electrode 12. A part of each of the drive electrode 11 and the counter electrode 12 extends to the outside of the pressure container 13 while maintaining the pressure container 13 airtight. According to this configuration, the movable portion linked to each of the drive electrode 11 and the counter electrode 12 can be disposed outside the pressure container 13. Accordingly, it is possible to improve the ability to perform work, such as maintenance work, on the high-speed input device 1. Further, it is possible to miniaturize the pressure container 13 compared to a configuration in which at least one of the drive electrode and the counter electrode is wholly accommodated in the pressure container. Thus, it is possible to reduce the amount of the insulating gas in use.

[0072] The discharge portion 11a of the drive electrode 11 and the discharge portion 12a of the counter electrode 12 are made of a metal material having arc resistance. According to this configuration, it is possible to suppress the surfaces of the discharge portions 11a and 12a from being melted due to the arc discharge during an input operation. Therefore, it is possible to suppress the occurrence of welded portions in the discharge portions 11a and 12a. Thus, it is possible to suppress sharp protrusions generated when separating welded portions from

being formed on the surfaces of the discharge portions 11a and 12a. Accordingly, it is possible to prevent the generation of an electric field concentration portion due to the sharp protrusions in a steady state in which the electrodes are separated from each other and a high voltage is applied. Thus, it is possible to provide the high-speed switching device 1 capable of maintaining the insulating performance between the electrodes and suppressing deterioration of withstand voltage performance.

(Second embodiment)

[0073] FIGS. 5 to 8 are cross-sectional views showing a high-speed switching device of a second embodiment. FIG. 5 shows a high-speed switching device 101 in a steady state which is a non-energized interruption state. FIGS. 6 to 8 show an operation process during an input operation of the high-speed switching device 101 in an energizable input state.

[0074] The second embodiment shown in FIG. 5 is different from the first embodiment in that the contact portion between the drive electrode 11 and the counter electrode 12 is accommodated in a vacuum container 112. Additionally, configurations other than those described below are the same as those of the first embodiment.

[0075] As shown in FIG. 5, the high-speed switching device 101 includes a contact point portion 102 instead of the contact point portion 2 of the first embodiment. The contact point portion 102 is connected to the drive mechanism portion 3 and the impact buffer portion 4. The contact point portion 102 includes the drive electrode 11, the counter electrode 12, a pressure container 111, and the vacuum container 112.

[0076] The configuration of the pressure container 111 is basically the same as that of the pressure container 13 of the first embodiment. The relationship of the pressure container 111, the drive electrode 11, and the counter electrode 12 is also the same as that of the first embodiment. The difference from the pressure container 13 of the first embodiment is that the vacuum container 112 is enclosed inside the pressure container 111 of this embodiment. The pressure container 111 encloses an insulating gas similarly to the first embodiment. The pressure of the insulating gas is preferably atmospheric pressure to about three times the atmospheric pressure in order to reduce the pressure difference with the inside of the vacuum container 112.

[0077] The inside of the vacuum container 112 is maintained in a vacuum state. The vacuum container 112 includes an insulating cylinder 113, a first end plate 114, a second end plate 115, a first bellows 116, and a second bellows 117.

[0078] The insulating cylinder 113 is a cylindrical insulator container. The first end plate 114 and the second end plate 115 are made of metal. Each of the first end plate 114 and the second end plate 115 is a disk-shaped plate material. The first end plate 114 is airtightly joined to

the insulating cylinder 113 to close the opening of the first end of the insulating cylinder 113. The second end plate 115 is airtightly joined to the insulating cylinder 113 to close the opening of the second end of the insulating cylinder 113. A through-hole is provided at the center portion of each of the first end plate 114 and the second end plate 115. The first end of the first bellows 116 is airtightly joined to the through-hole of the first end plate 114. The first end of the second bellows 117 is airtightly joined to the through-hole of the second end plate 115. The first bellows 116 and the second bellows 117 are bellows-structured metal tubes that can expand and contract in the axial direction and are made of thin plates. The vacuum container 112 is fixed to the pressure container 111 in such a manner that the second end plate 115 is connected to the second lid 16 of the pressure container 111 through the support portion 118.

[0079] The vacuum container 112 accommodates the contact portion between the drive electrode 11 and the counter electrode 12. The vacuum container 112 encloses the entire discharge portions 11a and 12a of the drive electrode 11 and the counter electrode 12 and a part of each of the conducting shafts 11b and 12b of the drive electrode 11 and the counter electrode 12. The conducting shaft 11b penetrates the through-hole of the first end plate 114 and extends to the outside of the vacuum container 112. The conducting shaft 12b penetrates the through-hole of the second end plate 115 and extends to the outside of the vacuum container 112.

[0080] The conducting shaft 11b of the drive electrode 11 is airtightly joined to the second end of the first bellows 116. The conducting shaft 11b is movable in the axial direction while maintaining the vacuum container 112 airtight. The conducting shaft 12b of the counter electrode 12 is airtightly joined to the second end of the second bellows 117. The conducting shaft 12b is movable in the axial direction while airtightness of the vacuum container 112 is maintained.

[0081] The first current collecting flange 119 and the second current collecting flange 120 made of metal are arranged inside the pressure container 111 instead of the shields 19 and 20 of the first embodiment. Each of the current collecting flanges 119 and 120 is formed in an annular shape. The current collecting flanges 119 and 120 are concentrically arranged. The first current collecting flange 119 is fixed adjacent to the first lid 15 and is electrically connected to the first lid 15. The second current collecting flange 120 is fixed adjacent to the second lid 16 and is electrically connected to the second lid 16. The drive electrode 11 penetrates the inside of the first current collecting flange 119. The counter electrode 12 penetrates the inside of the second current collecting flange 120. The conducting shaft 11b of the drive electrode 11 is movable in the axial direction while sliding on the current collecting portion 21 provided on the inner periphery of the first current collecting flange 119 and maintaining the electrical connection state with the first current collecting flange 119. The conducting shaft 12b of

the counter electrode 12 is movable in the axial direction while sliding on the current collecting portion 22 provided on the inner periphery of the second current collecting flange 120 and maintaining the electrical connection state with the second current collecting flange 120. Accordingly, the drive electrode 11 is electrically connected to the first current collecting flange 119, the first lid 15, and the flange 14b via the current collecting portion 21. The counter electrode 12 is electrically connected to the second current collecting flange 120, the second lid 16, and the second flange 14c via the current collecting portion 22. Further, the drive electrode 11 is electrically connected to the first bellows 116 and the first end plate 114. Further, the counter electrode 12 is electrically connected to the second bellows 117, the second end plate 115, and the support portion 118.

[0082] The end portion of the conducting shaft 11b of the drive electrode 11 is connected to the insulating operating rod 23 outside the pressure container 111. The drive electrode 11 is connected to the drive mechanism portion 3 via the insulating operating rod 23. The end portion of the conducting shaft 12b of the counter electrode 12 is connected to the insulating operating rod 24 outside the pressure container 111. The counter electrode 12 is connected to the impact buffer portion 4 via the insulating operating rod 24. The drive mechanism portion 3 and the impact buffer portion 4 are connected to the contact point portion 102 via the insulating operating rods 23 and 24 which are insulators so that the contact point portion 102 and the drive mechanism portion 3 are electrically insulated and the contact point portion 102 and the impact buffer portion 4 are electrically insulated.

[0083] The high-speed input device 101 of this embodiment is connected to an external circuit by using the first lid 15 and the second lid 16 of the pressure container 111 of the contact point portion 102 as terminals. The drive electrode 11, the insulating operating rod 23, the drive shaft 31, the ring 36, and the drive side spring receiver 39 form the drive side movable portion 71 which is integrally operated. The counter electrode 12, the insulating operating rod 24, the counter shaft 51, and the counter side spring receiver 56 form the counter side movable portion 72 which is integrally operated.

[0084] A steady state in which the high-speed input device 101 is in a non-energized interruption state will be described.

[0085] As shown in FIG. 5, the drive side movable portion 71 is stopped at a position in which the drive side spring receiver 39 is pressed against the drive side stopper 40 by the drive side return spring 38. The counter side movable portion 72 is stopped at a position in which the counter side spring receiver 56 is pressed against the counter side stopper 57 by the counter side return spring 55.

[0086] When the high-speed input device 101 is connected to the external circuit, a voltage is applied between the first lid 15 and the second lid 16 which are terminals. The first lid 15 is electrically connected to the

drive electrode 11 and has the same potential. The second lid 16 is electrically connected to the counter electrode 12 and has the same potential. Thus, the voltage applied to the high-speed input device 101 is applied between the drive electrode 11 and the counter electrode 12 inside the vacuum container 112.

[0087] In a steady state, the drive electrode 11 and the counter electrode 12 are in an open circuit state to be sufficiently separated from each other and the electric field near the drive electrode 11 and the counter electrode 12 is sufficiently lower than the dielectric breakdown electric field of the vacuum inside the vacuum container 112. Therefore, the drive electrode 11 and the counter electrode 12 are electrically insulated. Thus, the high-speed input device 101 is in an interruption state in which terminals are not electrically connected.

[0088] An input operation in which the high-speed switching device 101 changes from a steady state as a non-energized interruption state to an energizable input state and finally returns to a steady interruption state will be described. Additionally, in the following description of the input operation, a state in which the high-speed switching device 101 is connected to the external circuit and a high voltage is applied to the drive electrode 11 and the counter electrode 12 will be described.

[0089] The input operation of the high-speed switching device 101 is basically the same as the input operation of the high-speed switching device 1 of the first embodiment. The input operation of the high-speed switching device 101 is also started by applying a coil current from an excitation circuit (not shown) to the coil 37 and generating a driving force in the ring 36 in a steady state of FIG. 5.

[0090] The high-speed switching device 101 during an input operation is sequentially operated from the state of FIG. 5 to the state of FIG. 8 through the state of FIGS. 6 and 7, is sequentially operated from the state of FIG. 8 to the state of FIG. 5 through the state of FIGS. 7 and 6, and finally returns to the state of FIG. 5. This corresponds to a series of operations in which the high-speed switching device 1 during an input operation is operated from the state of FIG. 1 to the state of FIG. 4, is operated from the state of FIG. 4 to the state of FIG. 1, and finally returns to the state of FIG. 1 in the first embodiment.

[0091] The high-speed switching device 101 during an input operation is different from the high-speed switching device 1 of the first embodiment in that arc discharge is generated inside the vacuum container 112. In the high-speed switching device 101, when the drive side movable portion 71 is displaced so that the drive electrode 11 and the counter electrode 12 approach each other, the electric field near the drive electrode 11 and the counter electrode 12 increases. Since the electric field near the drive electrode 11 and the counter electrode 12 is higher than the dielectric breakdown electric field of the vacuum inside the vacuum container 112, dielectric breakdown occurs between the discharge portion 11a of the drive electrode 11 and the discharge portion 12a of the counter

electrode 12. When the drive electrode 11 approaches the counter electrode 12 to the position shown in FIG. 6, the arc discharge 73 is generated between the discharge portion 11a of the drive electrode 11 and the discharge portion 12a of the counter electrode 12 due to dielectric breakdown.

[0092] As described above, according to the high-speed switching device 101 of this embodiment, since the drive electrode 11 and the counter electrode 12 are operated as in the first embodiment, the same operation and effect as those of the first embodiment can be obtained.

[0093] Further, in this embodiment, the vacuum container 112 accommodates the contact portion between the drive electrode 11 and the counter electrode 12. According to this configuration, arc discharge is generated inside the vacuum container 112 during an input operation of the high-speed switching device 101. Accordingly, it is possible to suppress decomposition of the insulating gas due to arc discharge unlike arc discharge in an insulating gas atmosphere. Accordingly, it is possible to provide the high-speed switching device 101 capable of preventing unintended dielectric breakdown due to deterioration of the insulating performance of the insulating gas and maintaining the insulating performance between the electrodes in a steady state in which the electrodes are separated from each other and a high voltage is applied.

(Third embodiment)

[0094] FIGS. 9 to 12 are cross-sectional views showing a high-speed switching device of a third embodiment. FIG. 9 shows a high-speed input device 201 in a steady state which is a non-energized interruption state. FIGS. 10 to 12 show an operation process during an input operation of the high-speed switching device 201 in an energizable input state.

[0095] The third embodiment shown in FIG. 9 is different from the second embodiment in that an impact buffer portion 204 is accommodated in a vacuum container 212. Additionally, configurations other than those described below are the same as those of the second embodiment.

[0096] As shown in FIG. 9, the high-speed switching device 201 includes a contact point portion 202 and the impact buffer portion 204 instead of the contact point portion 102 and the impact buffer portion 4 of the second embodiment.

[0097] The contact point portion 202 will be described.

[0098] The contact point portion 202 is connected to the drive mechanism portion 3 and the impact buffer portion 204. The contact point portion 202 includes a pressure container 211 and the vacuum container 212 instead of the pressure container 111 and the vacuum container 112 of the second embodiment.

[0099] The pressure container 211 includes a second lid 213 instead of the second lid 16 of the second embodiment. The second lid 213 is different from the second lid

16 in that the through-hole and the seal portion are not provided. The second lid 213 completely closes the opening of the insulating cylinder 14. The relationship of the pressure container 211 and the drive electrode 11 is the same as that of the second embodiment. The pressure container 211 accommodates the entire counter electrode 12. The vacuum container 212 is enclosed inside the pressure container 211 of this embodiment. The pressure container 211 encloses an insulating gas similarly to the pressure container 111 of the second embodiment. The pressure of the insulating gas is preferably atmospheric pressure to about three times the atmospheric pressure in order to reduce the pressure difference with the inside of the vacuum container 212.

[0100] The inside of the vacuum container 212 is maintained in a vacuum state. The vacuum container 212 includes a second end plate 214 instead of the second end plate 115 of the second embodiment. The second end plate 214 is airtightly joined to the insulating cylinder 113 to close the opening of the second end of the insulating cylinder 113. The second end plate 214 is different from the second end plate 115 in that the through-hole is not provided and the bellows are not fixed. The second end plate 214 is fixed adjacent to the second lid 213 of the pressure container 211 and is electrically connected to the second lid 213.

[0101] The vacuum container 212 accommodates the contact portion between the drive electrode 11 and the counter electrode 12. The vacuum container 212 encloses the entire discharge portion 11a of the drive electrode 11, a part of the conducting shaft 11b of the drive electrode 11, the entire counter electrode 12, and the impact buffer portion 204. The conducting shaft 12b of the counter electrode 12 is connected to the impact buffer portion 204 inside the vacuum container 212. The impact buffer portion 204 will be described later.

[0102] The current collecting flange 120 disposed inside the pressure container 111 of the second embodiment is not disposed inside the pressure container 211. In the second embodiment, the current collecting portion 22 provided in the current collecting flange 120 is disposed in the impact buffer portion 204.

[0103] The impact buffer portion 204 will be described.

[0104] The impact buffer portion 204 is accommodated in the vacuum container 212. The impact buffer portion 204 is fixed to the second end plate 214 of the vacuum container 212. The impact buffer portion 204 does not include the counter shaft 51, the mechanism box 52, and the counter side braking portion 54 of the above other embodiments and includes a position holding portion 221 instead of the position holding portion 53.

[0105] The position holding portion 221 includes a counter side stopper 222 and a base 223 instead of the counter side stopper 57 and the base 58 of the above other embodiments. Further, in this embodiment, the conducting shaft 12b of the counter electrode 12 is directly coupled to the counter side spring receiver 56. The base 223 is disposed on the side opposite to the contact

point portion 202 with respect to the counter side spring receiver 56. The base 223 is fixed adjacent to the second end plate 214. The base 223 is electrically connected to the second end plate 214. The counter side stopper 222 is fixed to the base 223. The counter side stopper 222 is disposed on the side of the contact point portion 202 with respect to the counter side spring receiver 56. The counter side stopper 222 is disposed to surround the counter electrode 12. The current collecting portion 22 is provided on the inner periphery of the counter side stopper 222. The conducting shaft 12b of the counter electrode 12 is movable in the axial direction while sliding on the current collecting portion 22 and maintaining the electrical connection state with the impact buffer portion 204. Accordingly, the counter electrode 12 is electrically connected to the impact buffer portion 204, the second end plate 214, the second lid 213, and the second flange 14c via the current collecting portion 22.

[0106] The high-speed switching device 201 of this embodiment is connected to the external circuit by using the first lid 15 and the second lid 213 of the pressure container 211 of the contact point portion 202 as terminals. The drive electrode 11, the insulating operating rod 23, the drive shaft 31, the ring 36, and the drive side spring receiver 39 form the drive side movable portion 71 which is integrally operated. The counter electrode 12 and the counter side spring receiver 56 form a counter side movable portion 272 which is integrally operated.

[0107] A steady state in which the high-speed switching device 201 is in a non-energized interruption state will be described.

[0108] As shown in FIG. 9, the drive side movable portion 71 is stopped at a position in which the drive side spring receiver 39 is pressed against the drive side stopper 40 by the drive side return spring 38. The counter side movable portion 272 is stopped at a position in which the counter side spring receiver 56 is pressed against the counter side stopper 222 by the counter side return spring 55.

[0109] When the high-speed switching device 201 is connected to the external circuit, a voltage is applied between the first lid 15 and the second lid 213 which are terminals. The first lid 15 is electrically connected to the drive electrode 11 and has the same potential. The second lid 213 is electrically connected to the counter electrode 12 and has the same potential. Thus, the voltage applied to the high-speed input device 201 is applied between the drive electrode 11 and the counter electrode 12 inside the vacuum container 212.

[0110] A steady state is an open circuit state in which the drive electrode 11 and the counter electrode 12 are sufficiently separated from each other and the electric field near the drive electrode 11 and the counter electrode 12 is sufficiently lower than the dielectric breakdown electric field of the vacuum inside the vacuum container 212. Therefore, the drive electrode 11 and the counter electrode 12 are electrically insulated. Thus, the high-speed input device 201 is in an interruption state in which

terminals are not electrically connected.

[0111] An input operation in which the high-speed switching device 201 changes from a steady state as a non-energized interruption state to an energizable input state and finally returns to a steady interruption state will be described. Additionally, in the following description of the input operation, a state in which the high-speed input device 201 is connected to the external circuit and a high voltage is applied to the drive electrode 11 and the counter electrode 12 will be described.

[0112] The input operation of the high-speed switching device 201 is basically the same as the input operation of the high-speed input device 101 of the second embodiment. The input operation of the high-speed input device 201 is also started by applying a coil current from an excitation circuit (not shown) to the coil 37 and generating a driving force in the ring 36 in a steady state of FIG. 9.

[0113] The high-speed switching device 201 during an input operation is sequentially operated from the state of FIG. 9 to the state of FIG. 12 through the state of FIGS. 10 and 11, is sequentially operated from the state of FIG. 12 to the state of FIG. 9 through the state of FIGS. 11 and 10, and finally returns to the state of FIG. 9. This corresponds to a series of operations in which the high-speed switching device 101 during an input operation is operated from the state of FIG. 5 to the state of FIG. 8, is operated from the state of FIG. 8 to the state of FIG. 5, and finally returns to the state of FIG. 5 in the second embodiment.

[0114] The high-speed switching device 201 during an input operation is different from the high-speed switching device 101 of the second embodiment in that the counter side spring receiver 222 of the counter side movable portion 272 is decelerated and stopped just by receiving the counter side return force from the counter side return spring 55 when the state of FIG. 11 changes to the state of FIG. 12.

[0115] As described above, according to the high-speed switching device 201 of this embodiment, since the drive electrode 11 and the counter electrode 12 are operated as in the first embodiment, the same operation and effect as those of the first embodiment can be obtained.

[0116] Further, in this embodiment, the impact buffer portion 204 is accommodated in the vacuum container 212. According to this configuration, the counter side movable portion 272 can be lighter than the counter side movable portion 72 of the other embodiments since the insulating operating rod 24 and the counter shaft 51 are not provided. Thus, it is possible to further reduce the impact force generated when the counter side movable portion 272 contacts the drive side movable portion 71 during an input operation. Thus, it is possible to provide the high-speed input device 201 capable of suppressing the damage to the device due to the impact force when the drive electrode 11 and the counter electrode 12 contact each other and operating many times.

[0117] Further, according to this embodiment, since the entire counter electrode 12 is accommodated in

the vacuum container 212, the second bellows 117 connected to the counter electrode 12 in the second embodiment is not necessary. Since the counter electrode 12 of the second embodiment is rapidly accelerated after contacting the drive electrode 11, there is a possibility that a large mechanical load occurs in the second bellows 117 connected to the counter electrode 12 and the large mechanical load causes damage. Thus, in this embodiment, it is possible to provide the high-speed input device 201 capable of avoiding the vacuum leakage of the vacuum container 212 due to damage and operating many times by removing the second bellows 117.

(Fourth embodiment)

[0118] FIG. 13 is a cross-sectional view showing a high-speed switching device of a fourth embodiment. FIG. 13 shows a high-speed switching device 301 in a steady state which is a non-energized interruption state.

[0119] The fourth embodiment shown in FIG. 13 is different from the third embodiment in that an impact buffer portion 304 is accommodated in the pressure container 211 outside the vacuum container 112. Additionally, configurations other than those described below are the same as those of the third embodiment.

[0120] As shown in FIG. 13, the high-speed switching device 301 includes a contact point portion 302 and an impact buffer portion 304 instead of the contact point portion 202 and the impact buffer portion 204 of the third embodiment.

[0121] The contact point portion 302 will be described.

[0122] The contact point portion 302 is connected to the drive mechanism portion 3 and the impact buffer portion 304. The contact point portion 302 includes the vacuum container 112 of the second embodiment instead of the vacuum container 212 of the third embodiment. The vacuum container 112 is fixed to the pressure container 211 in such a manner that the second end plate 115 is connected to the second lid 213 of the pressure container 211 through the support portion 118. The second end plate 115 is electrically connected to the second lid 213.

[0123] The impact buffer portion 304 will be described.

[0124] The configuration of the impact buffer portion 304 is basically the same as that of the impact buffer portion 204 of the third embodiment. The impact buffer portion 304 is accommodated in the pressure container 211 outside the vacuum container 112. The impact buffer portion 304 is disposed between the second end plate 115 of the vacuum container 112 and the second lid 213 of the pressure container 211. The impact buffer portion 304 is fixed to the pressure container 211 in such a manner that the base 223 is fixed adjacent to the second lid 213. The impact buffer portion 304 is electrically connected to the second lid 213.

[0125] The high-speed switching device 301 of this embodiment is connected to an external circuit by using the first lid 15 and the second lid 213 of the pressure

container 211 of the contact point portion 302 as terminals. The drive electrode 11, the insulating operating rod 23, the drive shaft 31, the ring 36, and the drive side spring receiver 39 form the drive side movable portion 71 which is integrally operated. The counter electrode 12 and the counter side spring receiver 56 form the counter side movable portion 272 which is integrally operated. Additionally, since the operation of the high-speed input device 301 is the same as the operation of the high-speed switching device 201 of the third embodiment, the description thereof will be omitted.

[0126] As described above, according to the high-speed switching device 301 of this embodiment, since the drive electrode 11 and the counter electrode 12 are operated as in the first embodiment, the same operation and effect as those of the first embodiment can be obtained.

[0127] Further, in this embodiment, the impact buffer portion 304 is accommodated in the pressure container 211. According to this configuration, the counter side movable portion 272 can be lighter than the counter side movable portion 72 of the first embodiment and the second embodiment since the insulating operating rod 24 and the counter shaft 51 are not provided. Thus, the same operation and effect as those of the third embodiment can be obtained.

[0128] Further, since the sliding portion of the counter side movable portion 272 can be removed from the vacuum container 112, it is possible to suppress the generation of foreign matter in the vacuum container 112. Thus, it is possible to improve workability such as maintenance work of the high-speed input device 301 by reducing the maintenance work of the contact point portion 302.

[0129] Additionally, in the above-described embodiments, the electromagnetic repulsion operation mechanism has been described as an example of the driving portion 33 of the drive mechanism portion 3, but the present invention is not limited to this configuration. For example, as the driving portion, a hydraulic operating mechanism that uses the pressure difference of the accumulated hydraulic pressure as the driving force or a spring operating mechanism that uses the force of the accumulated coil spring as the driving force may be applied. However, an electromagnetic repulsion mechanism is advantageous as the driving portion in that it takes time to release the driving force or it is difficult to rapidly reduce the driving force after the drive electrode 11 and the counter electrode 12 contact each other.

[0130] Further, in the above-described embodiments, the drive electrode 11 and the counter electrode 12 are connected to the drive mechanism portion 3 and the impact buffer portion 4 through the insulating operating rods 23 and 24 which are insulators, but the present invention is not limited to this configuration. The drive electrode and the counter electrode may be directly connected to the drive mechanism portion and the impact buffer portion to be electrically connected thereto.

[0131] Further, in the above-described embodiments, the drive mechanism portion 3 and the impact buffer portion 4 are provided with the drive side braking portion 35 and the counter side braking portion 54, but the present invention is not limited to this configuration. The drive mechanism portion and the impact buffer portion may be provided with a position holding portion which holds the positions of the drive electrode and the counter electrode in a steady state and outputs a force of returning to the steady state during an input operation.

[0132] Further, in the above-described embodiments, the drive side return spring 38 and the counter side return spring 55 are the coil springs, but the present invention is not limited to this configuration. A disk spring, an air spring, or the like may be used as the drive side return spring and the counter side return spring.

[0133] Further, in the above-described embodiments, the drive side braking portion 35 and the counter side braking portion 54 are the shock absorbers that output an attenuation force by using the viscous resistance of hydraulic oil, but the present invention is not limited to this configuration. The drive side braking portion and the counter side braking portion may be air dampers that use the viscous resistance of air or rubber dampers that use a rubber attenuation mechanism. However, a shock absorber that uses the viscous resistance of hydraulic oil is advantageous as the braking portion when considering the rising characteristics of the attenuation force with respect to the pressing amount.

[0134] Further, in the above-described embodiments, the counter side braking portion 54 is provided with the stopper 61 that limits the amount of pressing into the shock absorber, but the present invention is not limited to this configuration. If the counter side movable portion is decelerated and stopped by at least one of the counter side return force of the counter side return spring and the attenuation force of the shock absorber, the stopper may not be provided.

[0135] According to at least one embodiment described above, since there are provided the driving portion which applies a driving force in a direction approaching the counter electrode with respect to the drive electrode during an input operation, the drive side urging portion which always applies a return force in a direction separating from the counter electrode with respect to the drive electrode, the drive side stopper which regulates the displacement of the drive electrode while the drive electrode and the counter electrode are separated from each other in a steady state, the counter side urging portion which always applies a return force in a direction contacting the drive electrode with respect to the counter electrode, and the counter side stopper which regulates the displacement of the counter electrode while the drive electrode and the counter electrode are separated from each other in a steady state, it is possible to suppress deterioration of withstand voltage performance due to the protrusions caused by welding between the electrodes.

Claims

1. A high-speed switching device (1) comprising:

a contact point portion (2) that includes a drive electrode (11) and a counter electrode (12) which are coaxially arranged to face each other in a separated state and in which a voltage is applied between the drive electrode (11) and the counter electrode (12) from the outside;
 a drive mechanism portion (3) that includes a driving portion (33) which is connected to the drive electrode (11) and is configured to apply a driving force in a first direction approaching the counter electrode (12) with respect to the drive electrode (11) during an input operation; and
 an impact buffer portion (4) that includes a counter side urging portion (55) which is connected to the counter electrode (12) and is configured to always apply a return force in the second direction contacting the drive electrode (11) with respect to the counter electrode (12) and a counter side stopper (57) which is configured to regulate the displacement of the counter electrode (12) in the second direction while the drive electrode (11) and the counter electrode (12) are separated from each other in a steady state,
characterized in that
 the drive mechanism portion (3) further includes:

a drive side urging portion (38) which is configured to always apply a return force in a direction separating from the counter electrode (12) with respect to the drive electrode (11), and
 a drive side stopper (40) which is configured to regulate the displacement of the drive electrode (11) in the second direction while the drive electrode (11) and the counter electrode (12) are separated from each other in a steady state, and
 the input operation includes:

an approaching step in which the drive electrode (11) approaches the counter electrode (12) by a driving force of the driving portion (33),
 a contacting step in which the drive electrode (11) contacts the counter electrode (12) to be displaced in the first direction together with the counter electrode (12) and a displacement direction is reversed to the second direction together with the counter electrode (12) by a return force of the drive side urging portion (38) and a return force of the counter side urging portion (55), and

a separating step in which the displacement of the counter electrode (12) in the second direction is regulated by the counter side stopper (57) and the drive electrode (11) is separated from the counter electrode (12).

2. The high-speed switching device (1) according to claim 1,

wherein in the input operation,
 the drive electrode (11) approaches the counter electrode (12) to start energization by a driving force of the driving portion (33) in the approaching step,
 the drive electrode (11) continues the energization with the counter electrode (12) in the contacting step, and
 the drive electrode (11) is separated from the counter electrode (12) in the separating step.

3. The high-speed switching device (1) according to claim 1 or 2,

wherein the driving portion (33) includes a repulsion body (36) of a good conductor connected to the drive electrode (11) and a coil (37) disposed to face the repulsion body (36), and
 wherein a driving force applied from the driving portion (33) to the drive electrode (11) is an induced repulsive force generated in the repulsion body (36) when a current is applied to the coil (37).

4. The high-speed switching device (1) according to any one of claims 1 to 3, wherein at least one of the drive side urging portion (38) and the counter side urging portion (55) is a coil spring.

5. The high-speed switching device (1) according to any one of claims 1 to 4, further comprising: a drive side braking portion (35) configured to decelerate the drive electrode (11) by contacting the drive electrode (11) displaced in the second direction by a return force of the counter side urging portion (55) during the input operation.

6. The high-speed switching device (1) according to any one of claims 1 to 5, further comprising: a counter side braking portion (54) configured to decelerate the counter electrode (12) by contacting the counter electrode (12) contacting the drive electrode (11) and displaced in the first direction together with the drive electrode (11) by a driving force of the driving portion (33) during the input operation.

7. The high-speed switching device (1) according to any one of claims 1 to 6, further comprising:
- a pressure container (13) that accommodates a contact portion between the drive electrode (11) and the counter electrode (12) and encloses an insulating gas, wherein a part of each of the drive electrode (11) and the counter electrode (12) extends to the outside of the pressure container (13) while maintaining the airtightness of the pressure container (13).
8. The high-speed switching device (1) according to claim 7, wherein the insulating gas is composed of at least one of the group consisting of a sulfur hexafluoride gas, nitrogen, carbon dioxide, oxygen, and air.
9. The high-speed switching device (1) according to claim 7 or 8, wherein the impact buffer portion (4) is accommodated in the pressure container (13).
10. The high-speed switching device (1) according to any one of claims 1 to 9, further comprising:
- a vacuum container (112) that accommodates a contact portion between the drive electrode (11) and the counter electrode (12), wherein a part of the drive electrode (11) extends to the outside of the vacuum container (112) while maintaining the vacuum container (112) airtight.
11. The high-speed switching device (1) according to claim 10, wherein the impact buffer portion (4) is accommodated in the vacuum container (112).
12. The high-speed switching device (1) according to any one of claims 1 to 11,
- wherein at least a part of the drive electrode (11) and the counter electrode (12) is made of a metal material having arc resistance, and wherein the metal material is a copper-chromium alloy.

Patentansprüche

1. Eine Hochgeschwindigkeits-Schaltvorrichtung (1), umfassend:
- einen Kontaktpunktabschnitt (2), der eine Antriebselektrode (11) und eine Gegenelektrode (12) enthält, die koaxial angeordnet sind, um

einander in einem getrennten Zustand gegenüberzuliegen, und bei dem eine Spannung von außen zwischen der Antriebselektrode (11) und der Gegenelektrode (12) angelegt wird;

einen Antriebsmechanismusabschnitt (3), der einen Antriebsabschnitt (33) enthält, der mit der Antriebselektrode (11) verbunden ist und konfiguriert ist, um während eines Eingabevorgangs eine Antriebskraft in einer ersten Richtung, die sich der Gegenelektrode (12) annähert, in Bezug auf die Antriebselektrode (11) anzulegen; und

einen Stoßpufferabschnitt (4), der einen gegenseitigen Drängabschnitt (55) enthält, der mit der Gegenelektrode (12) verbunden ist und konfiguriert ist, um immer eine Rückstellkraft in der zweiten Richtung, die die Antriebselektrode (11) kontaktiert, in Bezug auf die Gegenelektrode (12) anzulegen, und einen gegenseitigen Anschlag (57), der konfiguriert ist, um die Verschiebung der Gegenelektrode (12) in der zweiten Richtung zu regulieren, während die Antriebselektrode (11) und die Gegenelektrode (12) in einem stationären Zustand voneinander getrennt sind,

dadurch gekennzeichnet, dass

der Antriebsmechanismusabschnitt (3) ferner umfasst: einen antriebsseitigen Drängabschnitt (38), der konfiguriert ist, um immer eine Rückstellkraft in einer Richtung, die von der Gegenelektrode (12) trennt, in Bezug auf die Antriebselektrode (11) anzulegen, und

einen antriebsseitigen Anschlag (40), der konfiguriert ist, um die Verschiebung der Antriebselektrode (11) in der zweiten Richtung zu regulieren, während die Antriebselektrode (11) und die Gegenelektrode (12) in einem stationären Zustand voneinander getrennt sind, und der Eingabevorgang umfasst:

einen Annäherungsschritt, in dem sich die Antriebselektrode (11) durch eine Antriebskraft des Antriebsabschnitts (33) der Gegenelektrode (12) annähert,

einen Kontaktschritt, in dem die Antriebselektrode (11) die Gegenelektrode (12) kontaktiert, um in der ersten Richtung zusammen mit der Gegenelektrode (12) verschoben zu werden, und eine Verschiebungsrichtung in die zweite Richtung zusammen mit der Gegenelektrode (12) durch eine Rückstellkraft des antriebsseitigen Drängabschnitts (38) und eine Rückstellkraft des gegenseitigen Drängabschnitts (55) umgekehrt wird, und

einen Trennschritt, in dem die Verschiebung der Gegenelektrode (12) in der zweiten Richtung durch den gegenseitigen An-

- schlag (57) reguliert wird und die Antriebselektrode (11) von der Gegenelektrode (12) getrennt wird.
2. Die Hochgeschwindigkeits-Schaltvorrichtung (1) nach Anspruch 1, wobei bei dem Eingabevorgang, sich die Antriebselektrode (11) der Gegenelektrode (12) annähert, um die Erregung durch eine Antriebskraft des Antriebsabschnitts (33) in dem Annäherungsschritt zu starten, die Antriebselektrode (11) die Erregung mit der Gegenelektrode (12) im Kontaktschritt fortsetzt, und die Antriebselektrode (11) von der Gegenelektrode (12) im Trennschritt getrennt wird.
3. Die Hochgeschwindigkeits-Schaltvorrichtung (1) nach Anspruch 1 oder 2, wobei der Antriebsabschnitt (33) einen Abstoßungskörper (36) aus einem guten Leiter, der mit der Antriebselektrode (11) verbunden ist, und eine Spule (37), die angeordnet ist, um dem Abstoßungskörper (36) gegenüberzuliegen, enthält, und wobei eine vom Antriebsabschnitt (33) auf die Antriebselektrode (11) angelegte Antriebskraft eine induzierte abstoßende Kraft ist, die im Abstoßungskörper (36) erzeugt wird, wenn ein Strom an die Spule (37) angelegt wird.
4. Die Hochgeschwindigkeits-Schaltvorrichtung (1) nach einem der Ansprüche 1 bis 3, wobei mindestens einer von dem antriebsseitigen Drängabschnitt (38) und dem gegenseitigen Drängabschnitt (55) eine Schraubenfeder ist.
5. Die Hochgeschwindigkeits-Schaltvorrichtung (1) nach einem der Ansprüche 1 bis 4, ferner umfassend: einen antriebsseitigen Bremsabschnitt (35), der konfiguriert ist, um die Antriebselektrode (11) zu verlangsamen, indem er die Antriebselektrode (11) kontaktiert, die in der zweiten Richtung durch eine Rückstellkraft des gegenseitigen Drängabschnitts (55) während des Eingabevorgangs verschoben wird.
6. Die Hochgeschwindigkeits-Schaltvorrichtung (1) nach einem der Ansprüche 1 bis 5, ferner umfassend: einen gegenseitigen Bremsabschnitt (54), der konfiguriert ist, um die Gegenelektrode (12) zu verlangsamen, indem er die Gegenelektrode (12) kontaktiert, die die Antriebselektrode (11) kontaktiert und in der ersten Richtung zusammen mit der Antriebselektrode (11) durch eine Antriebskraft des Antriebsabschnitts (33) während des Eingabevorgangs verschoben wird.
7. Die Hochgeschwindigkeits-Schaltvorrichtung (1) nach einem der Ansprüche 1 bis 6, ferner umfassend: einen Druckbehälter (13), der einen Kontaktabschnitt zwischen der Antriebselektrode (11) und der Gegenelektrode (12) aufnimmt und ein Isoliergas umschließt, wobei ein Teil jeder der Antriebselektrode (11) und der Gegenelektrode (12) sich zur Außenseite des Druckbehälters (13) erstreckt, während die Luftdichtheit des Druckbehälters (13) aufrechterhalten wird.
8. Die Hochgeschwindigkeits-Schaltvorrichtung (1) nach Anspruch 7, wobei das Isoliergas aus mindestens einem aus der Gruppe bestehend aus Schwefelhexafluoridgas, Stickstoff, Kohlendioxid, Sauerstoff und Luft zusammengesetzt ist.
9. Die Hochgeschwindigkeits-Schaltvorrichtung (1) nach Anspruch 7 oder 8, wobei der Stoßpufferabschnitt (4) in dem Druckbehälter (13) untergebracht ist.
10. Die Hochgeschwindigkeits-Schaltvorrichtung (1) nach einem der Ansprüche 1 bis 9, ferner umfassend: einen Vakuumbehälter (112), der einen Kontaktabschnitt zwischen der Antriebselektrode (11) und der Gegenelektrode (12) aufnimmt, wobei sich ein Teil der Antriebselektrode (11) zur Außenseite des Vakuumbehälters (112) erstreckt, während die Luftdichtheit des Vakuumbehälters (112) aufrechterhalten wird.
11. Die Hochgeschwindigkeits-Schaltvorrichtung (1) nach Anspruch 10, wobei der Stoßpufferabschnitt (4) in dem Vakuumbehälter (112) untergebracht ist.
12. Die Hochgeschwindigkeits-Schaltvorrichtung (1) nach einem der Ansprüche 1 bis 11, wobei mindestens ein Teil der Antriebselektrode (11) und der Gegenelektrode (12) aus einem Metallmaterial mit Lichtbogenbeständigkeit hergestellt ist, und wobei das Metallmaterial eine Kupfer-Chrom-Legierung ist.

Revendications

1. Un dispositif de commutation à grande vitesse (1), comprenant :

une partie de point de contact (2) qui inclut une électrode d'entraînement (11) et une contre-électrode (12) qui sont agencées coaxialement pour se faire face dans un état séparé et dans lequel une tension est appliquée entre l'électrode d'entraînement (11) et la contre-électrode (12) depuis l'extérieur ;
 une partie de mécanisme d'entraînement (3) qui inclut une partie d'entraînement (33) qui est connectée à l'électrode d'entraînement (11) et est configurée pour appliquer une force d'entraînement dans une première direction s'approchant de la contre-électrode (12) par rapport à l'électrode d'entraînement (11) pendant une opération d'entrée ; et
 une partie de tampon d'impact (4) qui inclut une partie de poussée côté compteur (55) qui est connectée à la contre-électrode (12) et est configurée pour toujours appliquer une force de rappel dans la seconde direction contactant l'électrode d'entraînement (11) par rapport à la contre-électrode (12) et une butée côté compteur (57) qui est configurée pour réguler le déplacement de la contre-électrode (12) dans la seconde direction tandis que l'électrode d'entraînement (11) et la contre-électrode (12) sont séparées l'une de l'autre dans un état stable,
caractérisé en ce que
 la partie de mécanisme d'entraînement (3) inclut en outre :

une partie de poussée côté entraînement (38) qui est configurée pour toujours appliquer une force de rappel dans une direction se séparant de la contre-électrode (12) par rapport à l'électrode d'entraînement (11), et une butée côté entraînement (40) qui est configurée pour réguler le déplacement de l'électrode d'entraînement (11) dans la seconde direction tandis que l'électrode d'entraînement (11) et la contre-électrode (12) sont séparées l'une de l'autre dans un état stable, et
 l'opération d'entrée inclut :

une étape d'approche dans laquelle l'électrode d'entraînement (11) s'approche de la contre-électrode (12) par une force d'entraînement de la partie d'entraînement (33),
 une étape de contact dans laquelle l'électrode d'entraînement (11) contacte la contre-électrode (12) pour

être déplacée dans la première direction conjointement avec la contre-électrode (12) et une direction de déplacement est inversée vers la seconde direction conjointement avec la contre-électrode (12) par une force de rappel de la partie de poussée côté entraînement (38) et une force de rappel de la partie de poussée côté compteur (55), et
 une étape de séparation dans laquelle le déplacement de la contre-électrode (12) dans la seconde direction est régulé par la butée côté compteur (57) et l'électrode d'entraînement (11) est séparée de la contre-électrode (12).

2. Le dispositif de commutation à grande vitesse (1) selon la revendication 1, dans lequel, dans l'opération d'entrée,

l'électrode d'entraînement (11) s'approche de la contre-électrode (12) pour commencer l'énergisation par une force d'entraînement de la partie d'entraînement (33) dans l'étape d'approche, l'électrode d'entraînement (11) continue l'énergisation avec la contre-électrode (12) dans l'étape de contact, et l'électrode d'entraînement (11) est séparée de la contre-électrode (12) dans l'étape de séparation.

3. Le dispositif de commutation à grande vitesse (1) selon la revendication 1 ou 2, dans lequel la partie d'entraînement (33) inclut

un corps de répulsion (36) d'un bon conducteur connecté à l'électrode d'entraînement (11) et une bobine (37) disposée pour faire face au corps de répulsion (36), et dans lequel une force d'entraînement appliquée de la partie d'entraînement (33) à l'électrode d'entraînement (11) est une force répulsive induite générée dans le corps de répulsion (36) lorsqu'un courant est appliqué à la bobine (37).

4. Le dispositif de commutation à grande vitesse (1) selon l'une quelconque des revendications 1 à 3, dans lequel

au moins l'une de la partie de poussée côté entraînement (38) et de la partie de poussée côté compteur (55) est un ressort hélicoïdal.

5. Le dispositif de commutation à grande vitesse (1) selon l'une quelconque des revendications 1 à 4, comprenant en outre :

une partie de freinage côté entraînement (35) configurée pour décélérer l'électrode d'entraînement (11)

en contactant l'électrode d'entraînement (11) déplacée dans la seconde direction par une force de rappel de la partie de poussée côté compteur (55) pendant l'opération d'entrée.

6. Le dispositif de commutation à grande vitesse (1) selon l'une quelconque des revendications 1 à 5, comprenant en outre :
une partie de freinage côté compteur (54) configurée pour décélérer la contre-électrode (12) en contactant la contre-électrode (12) qui contacte l'électrode d'entraînement (11) et est déplacée dans la première direction conjointement avec l'électrode d'entraînement (11) par une force d'entraînement de la partie d'entraînement (33) pendant l'opération d'entrée. 5 10 15
7. Le dispositif de commutation à grande vitesse (1) selon l'une quelconque des revendications 1 à 6, comprenant en outre :
un récipient sous pression (13) qui loge une partie de contact entre l'électrode d'entraînement (11) et la contre-électrode (12) et renferme un gaz isolant,
dans lequel une partie de chacune de l'électrode d'entraînement (11) et de la contre-électrode (12) s'étend vers l'extérieur du récipient sous pression (13) tout en maintenant l'étanchéité à l'air du récipient sous pression (13). 20 25 30
8. Le dispositif de commutation à grande vitesse (1) selon la revendication 7, dans lequel le gaz isolant est composé d'au moins un élément du groupe constitué par l'hexafluorure de soufre gazeux, l'azote, le dioxyde de carbone, l'oxygène et l'air. 35
9. Le dispositif de commutation à grande vitesse (1) selon la revendication 7 ou 8, dans lequel la partie de tampon d'impact (4) est logée dans le récipient sous pression (13). 40
10. Le dispositif de commutation à grande vitesse (1) selon l'une quelconque des revendications 1 à 9, comprenant en outre :
un récipient à vide (112) qui loge une partie de contact entre l'électrode d'entraînement (11) et la contre-électrode (12),
dans lequel une partie de l'électrode d'entraînement (11) s'étend vers l'extérieur du récipient à vide (112) tout en maintenant l'étanchéité à l'air du récipient à vide (112). 45 50
11. Le dispositif de commutation à grande vitesse (1) selon la revendication 10, dans lequel la partie de tampon d'impact (4) est logée dans le récipient à vide (112). 55

12. dispositif de commutation à grande vitesse (1) selon l'une quelconque des revendications 1 à 11, dans lequel

au moins une partie de l'électrode d'entraînement (11) et de la contre-électrode (12) est faite d'un matériau métallique ayant une résistance à l'arc, et dans lequel le matériau métallique est un alliage cuivre-chrome.

FIG. 1

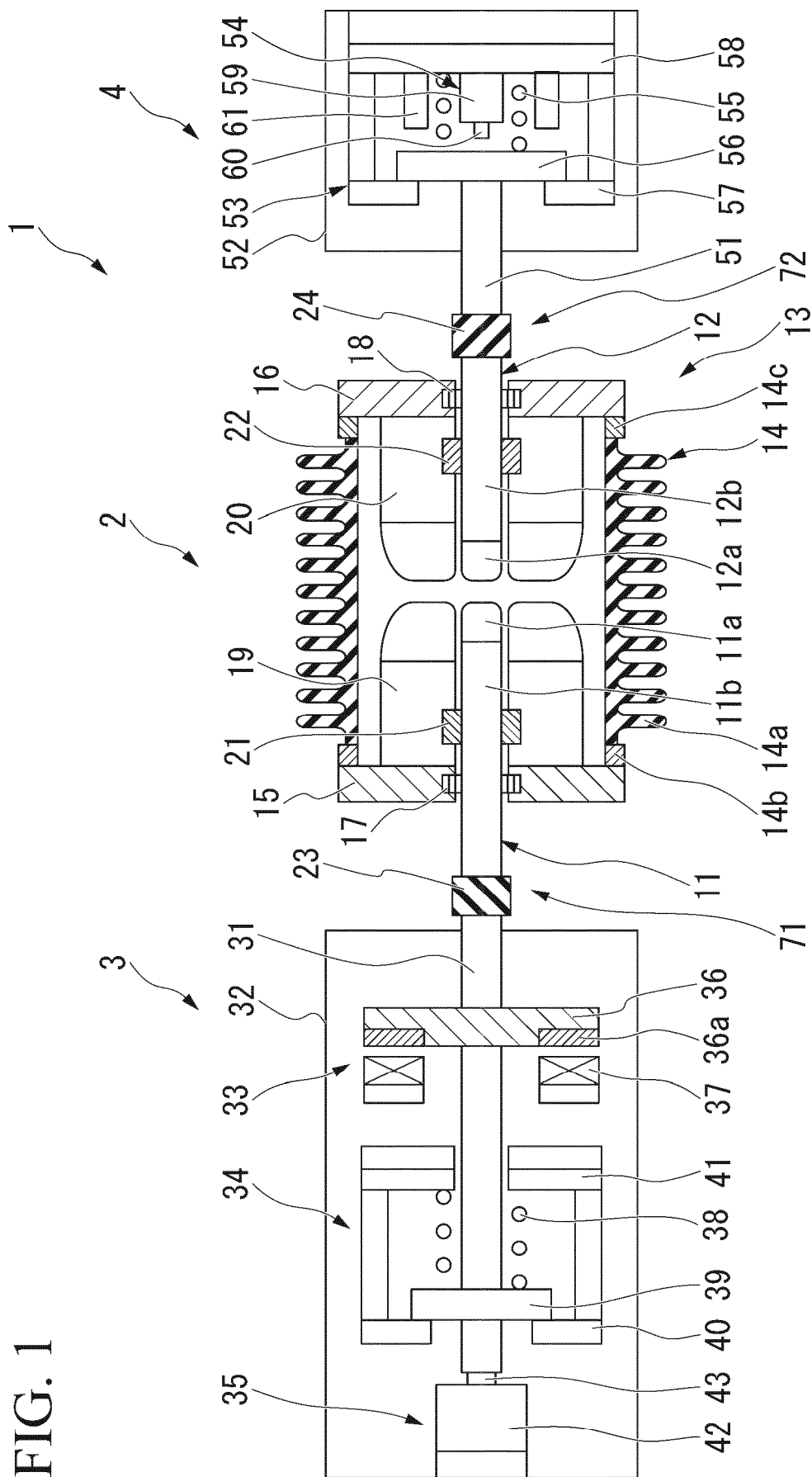


FIG. 2

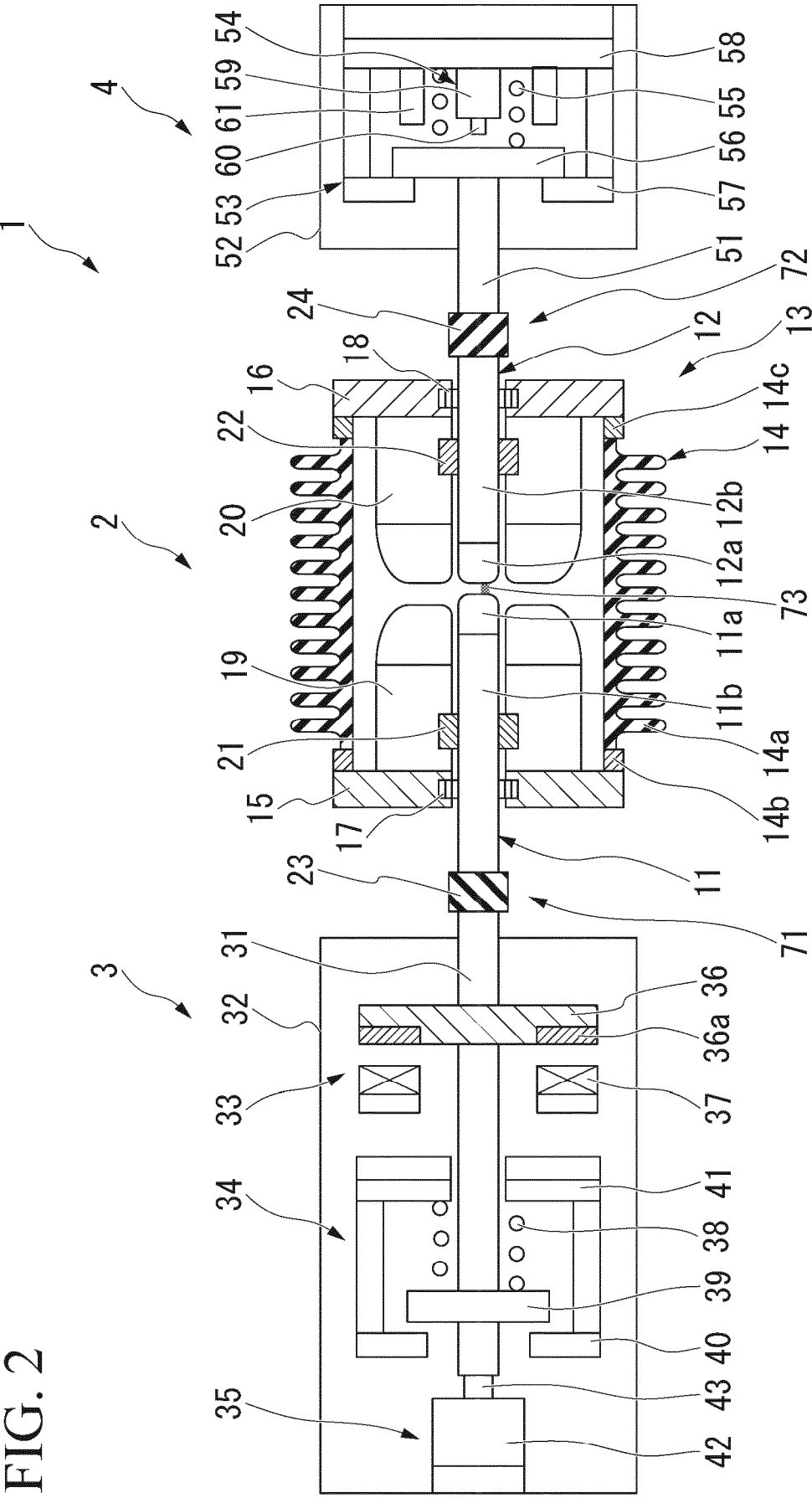


FIG. 3

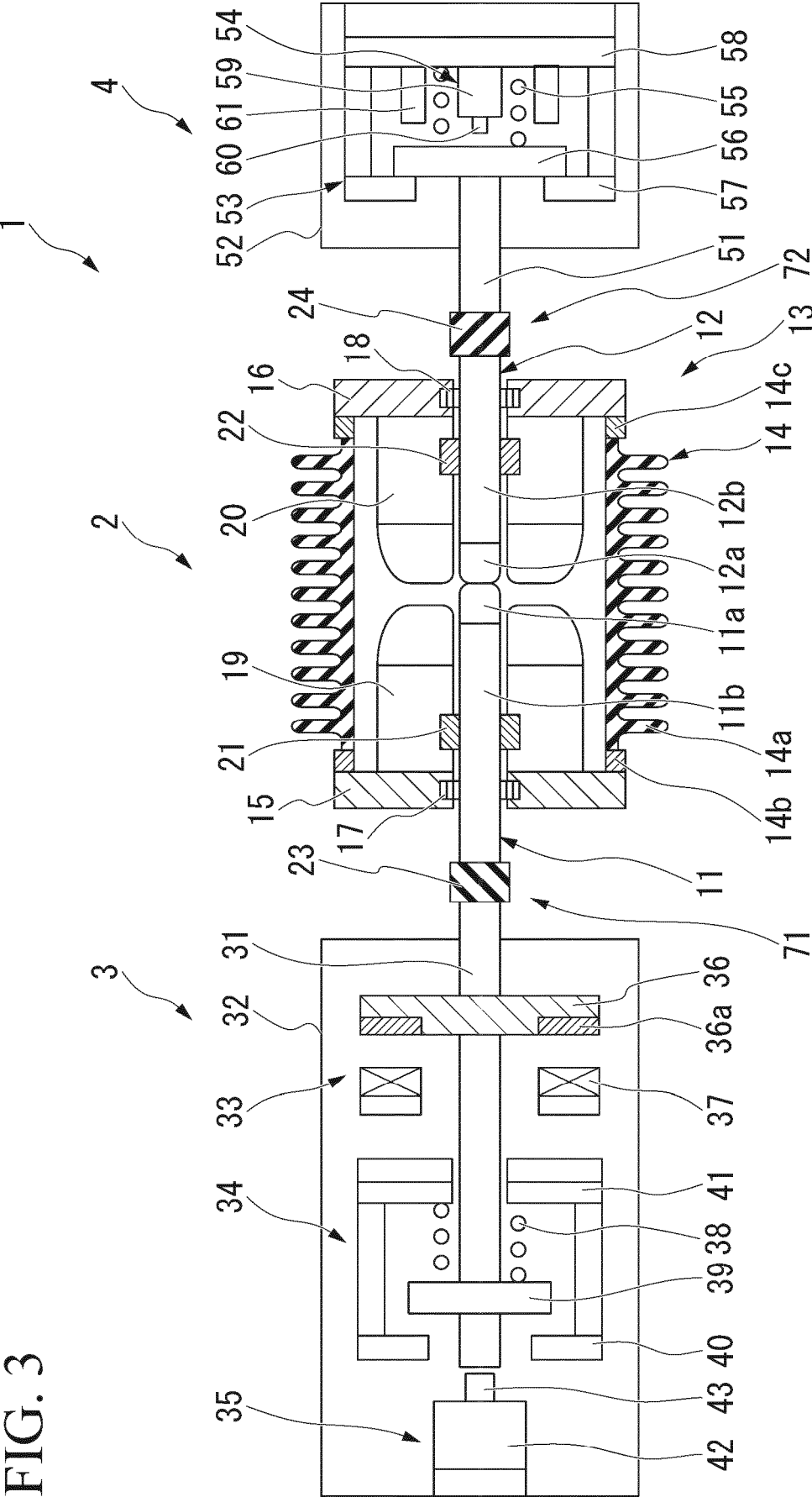


FIG. 4

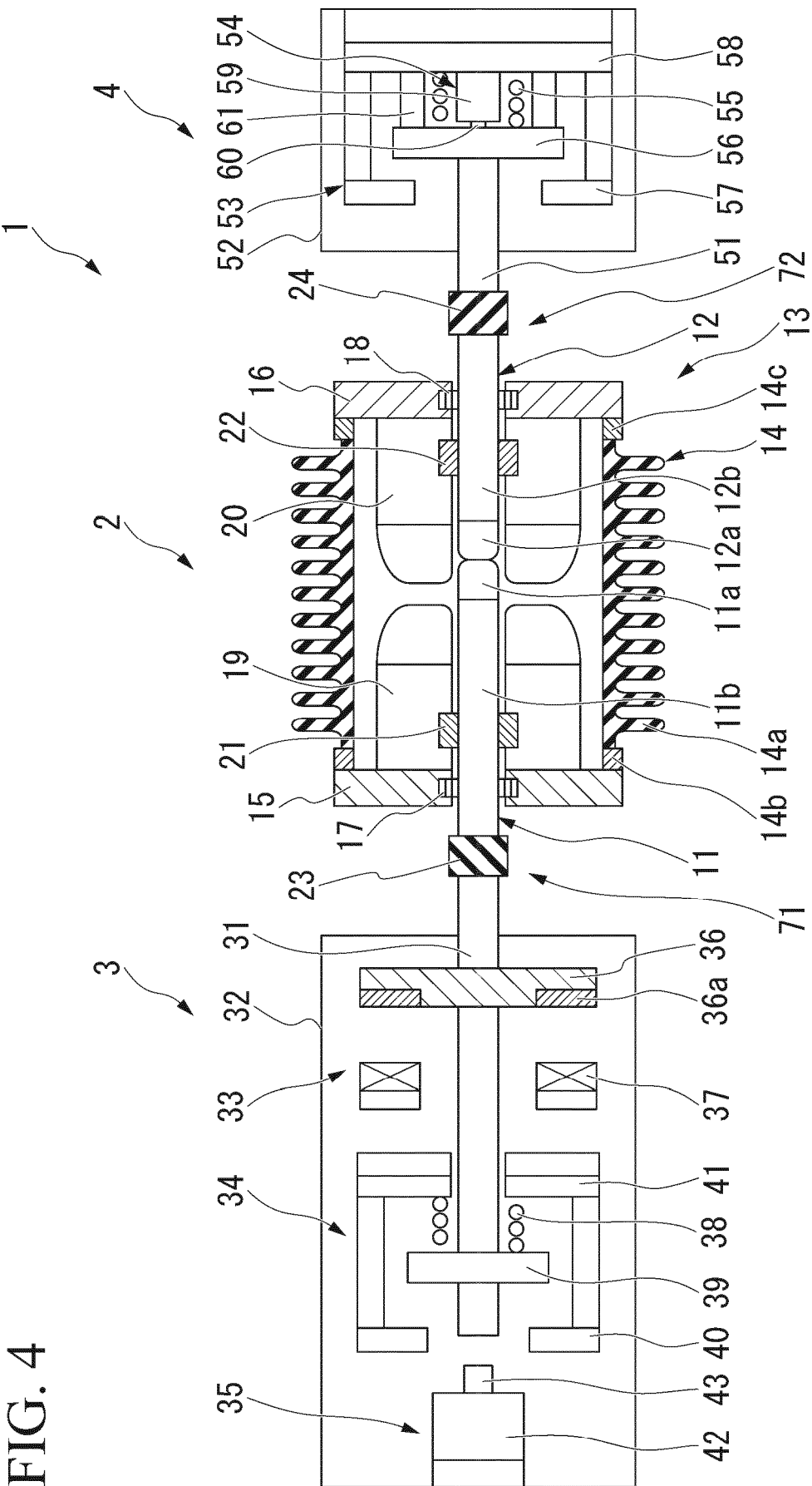


FIG. 5

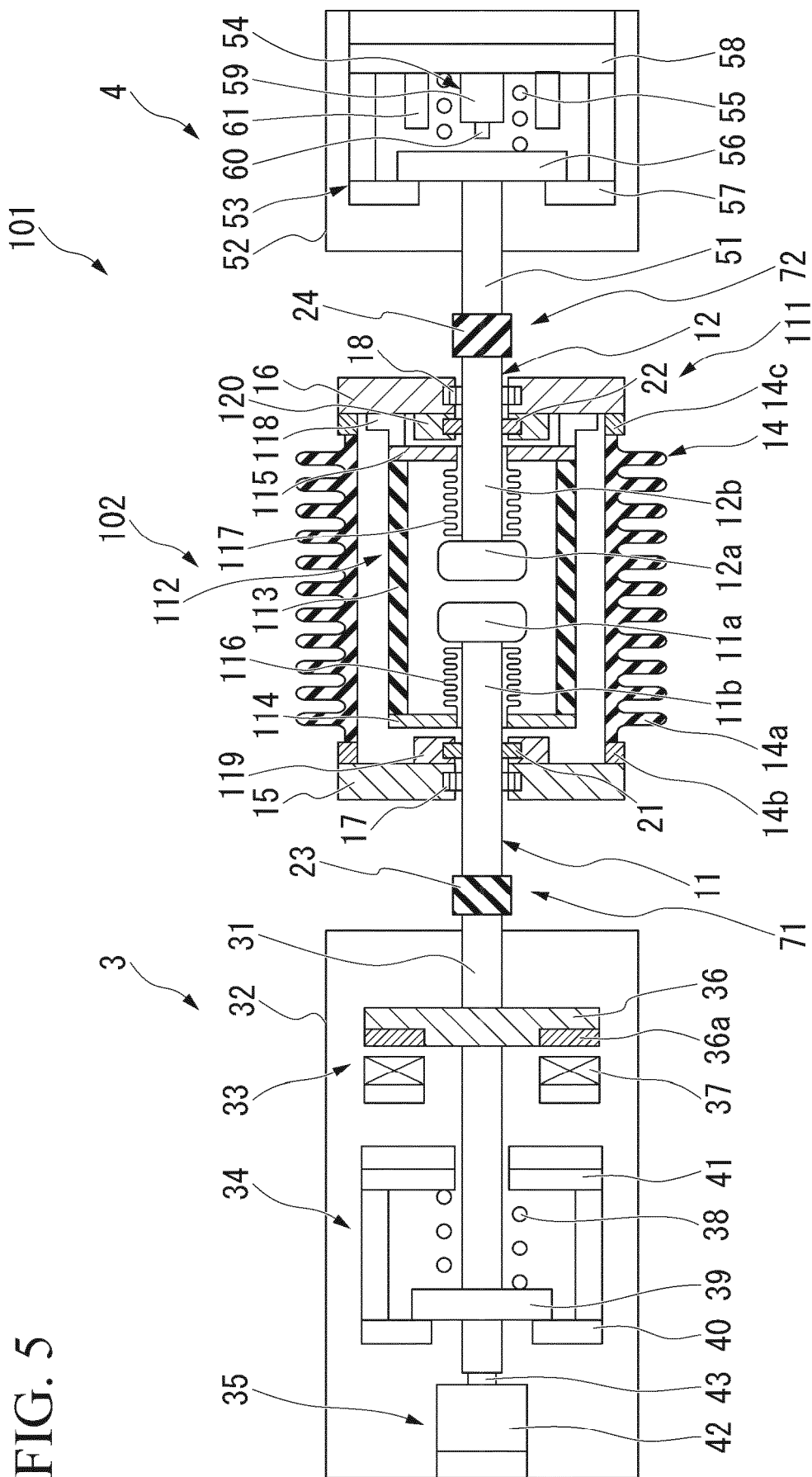


FIG. 6

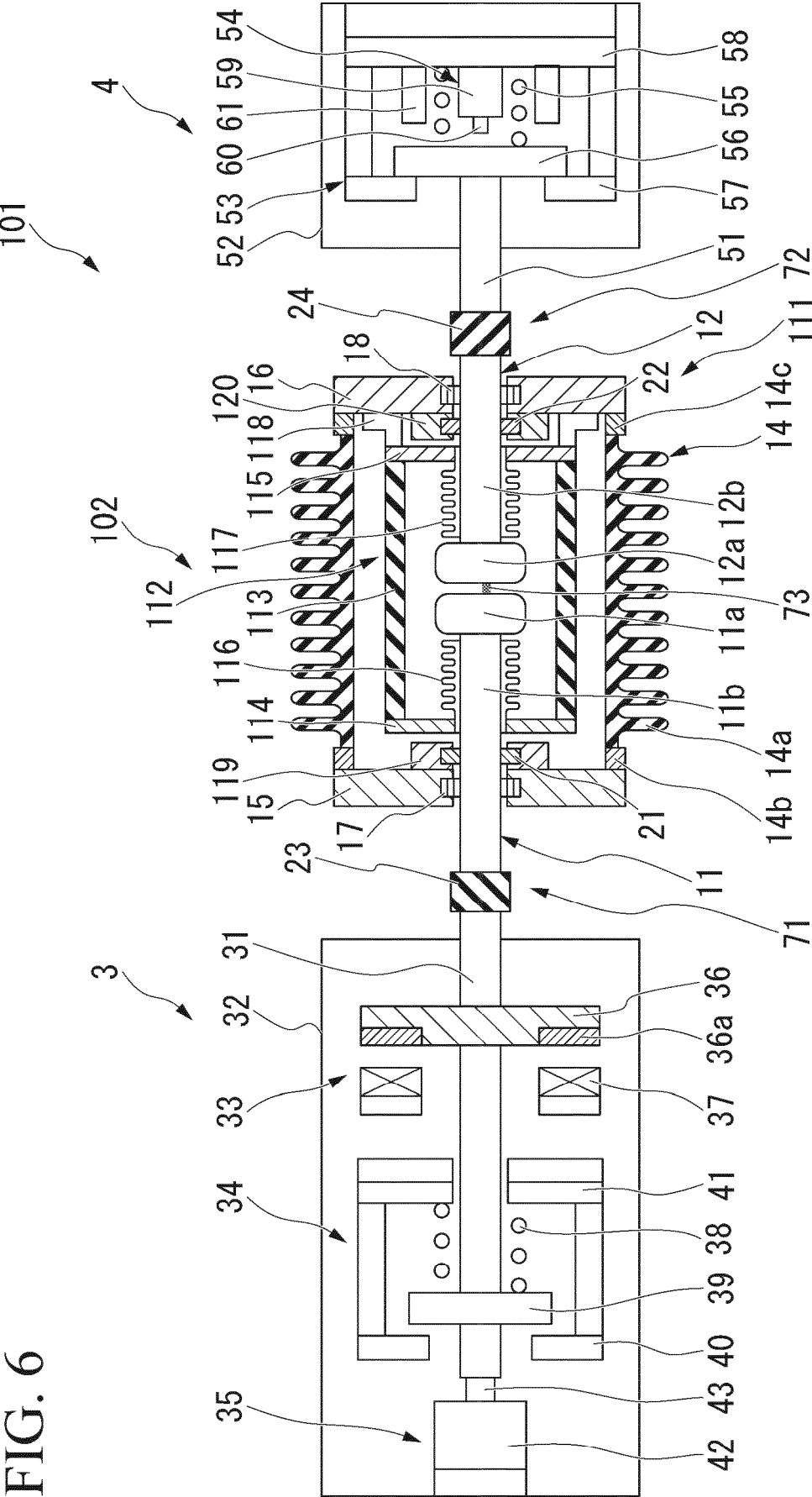


FIG. 7

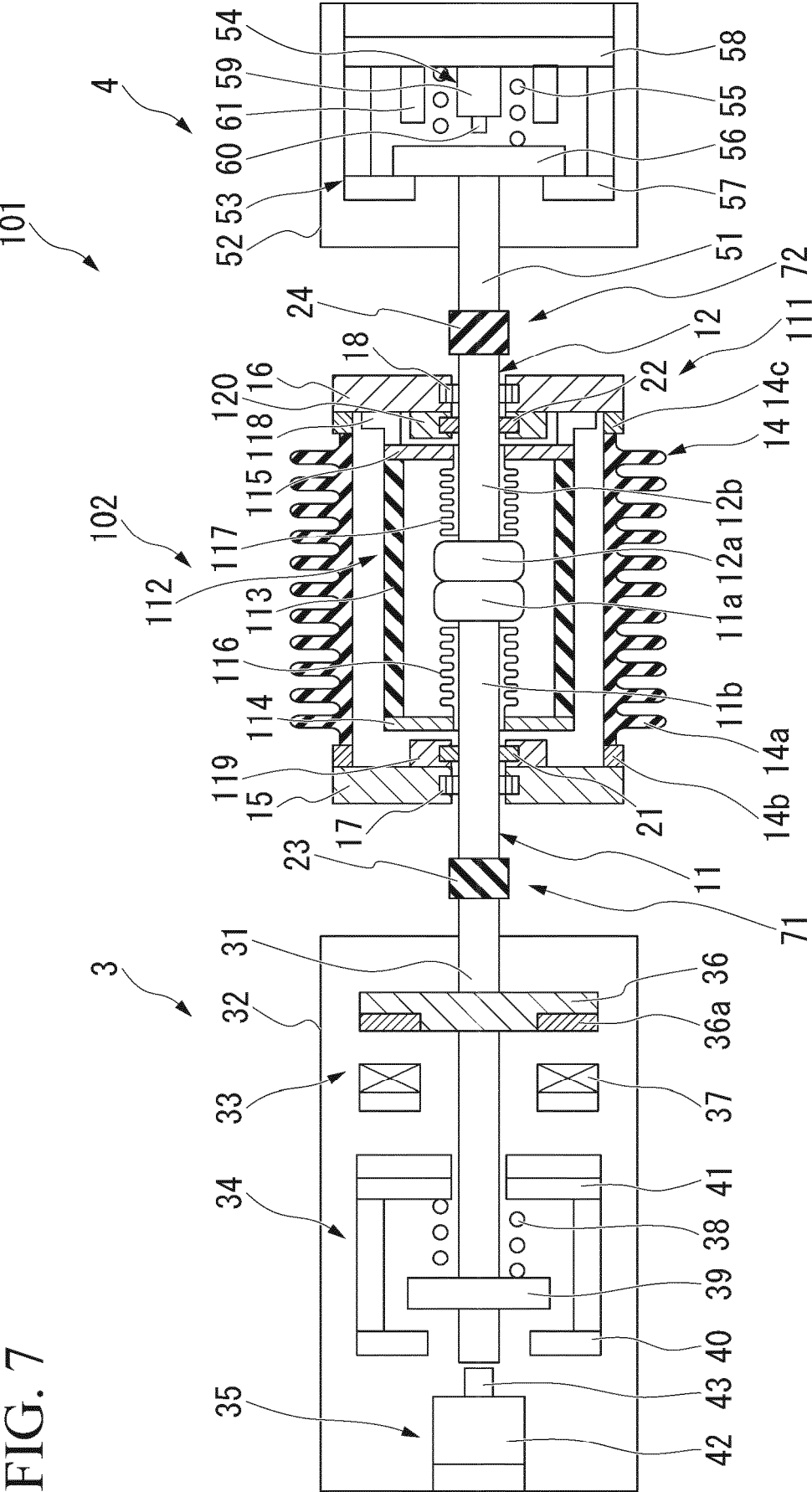


FIG. 8

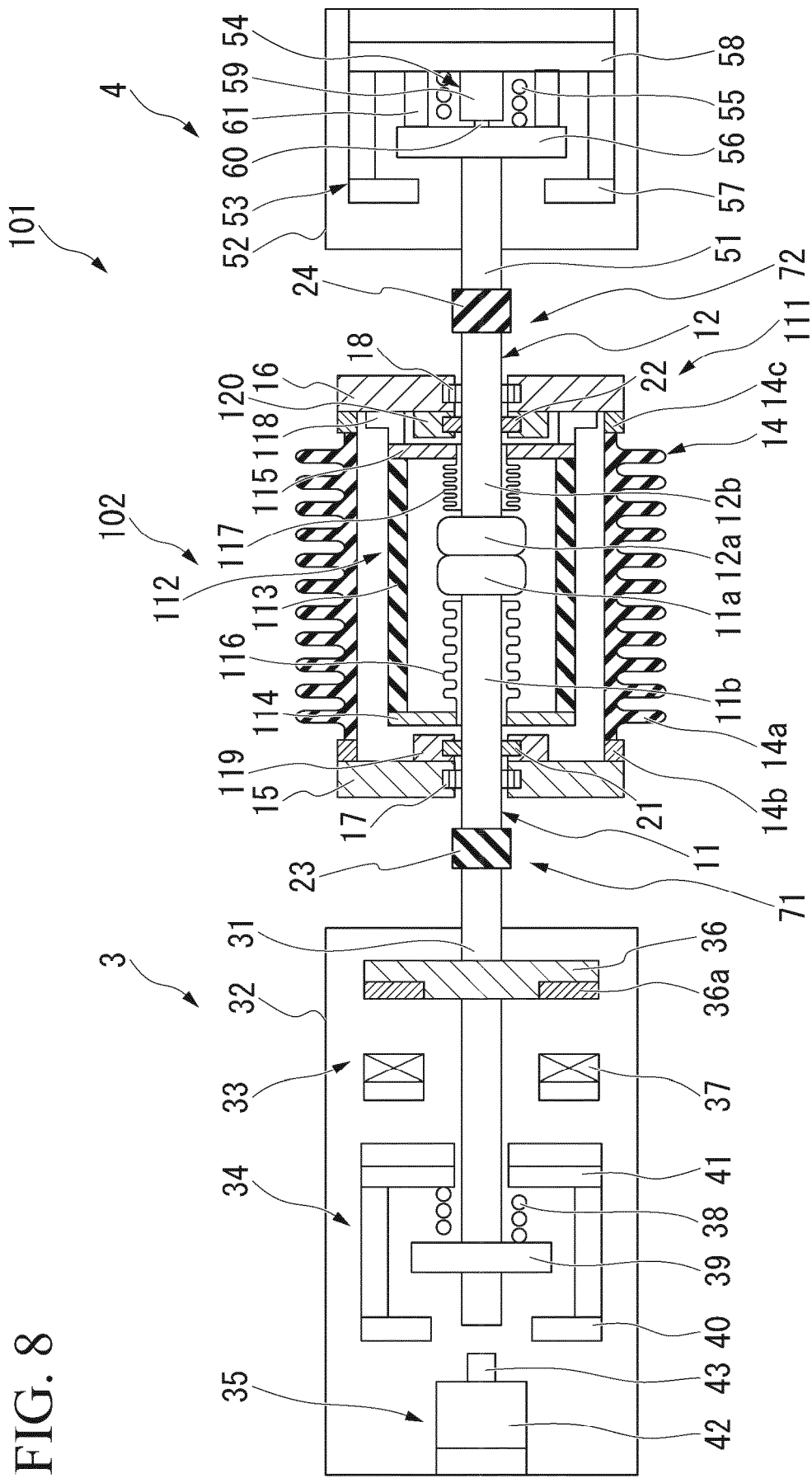


FIG. 9

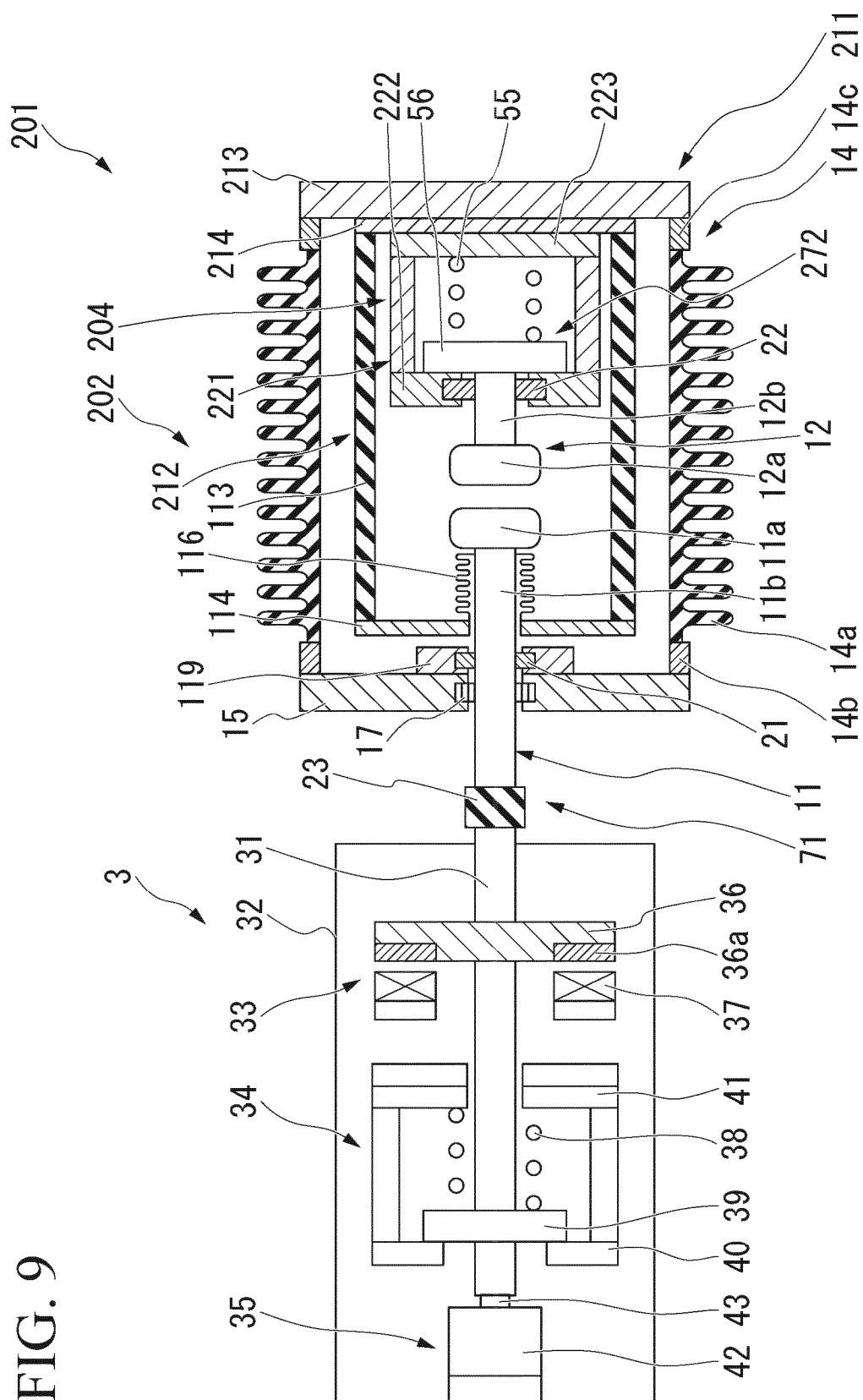


FIG. 10

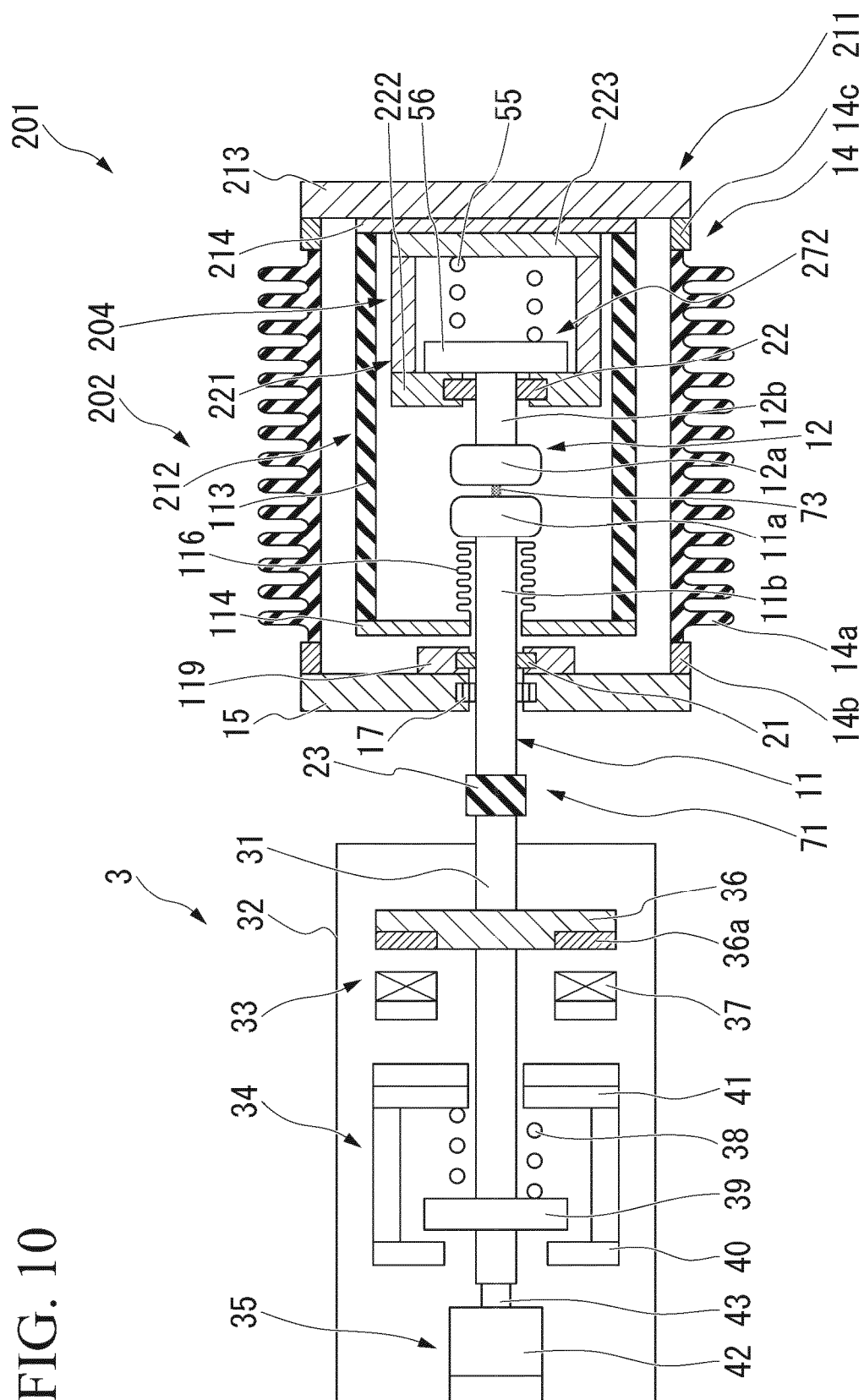


FIG. 11

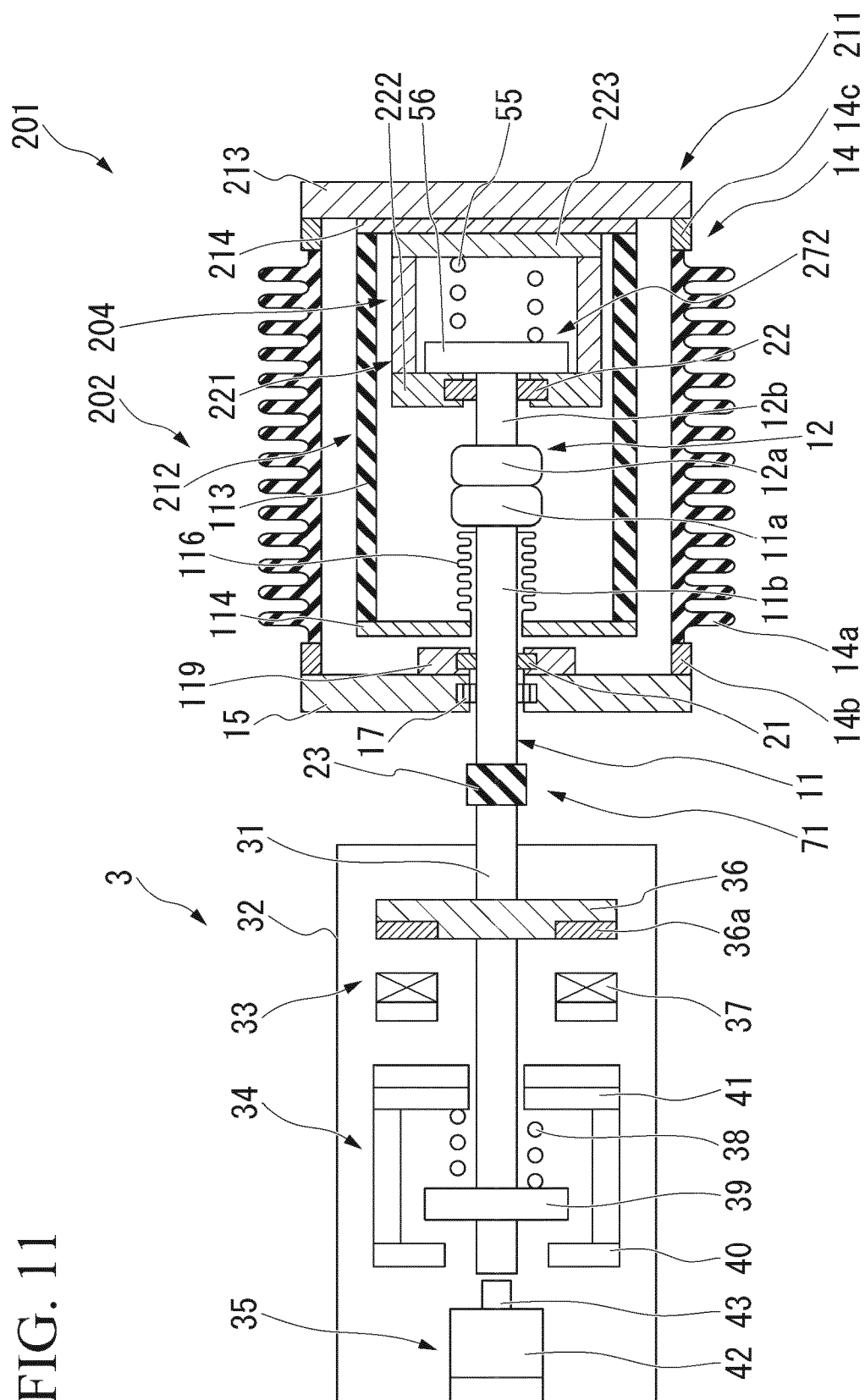


FIG. 12

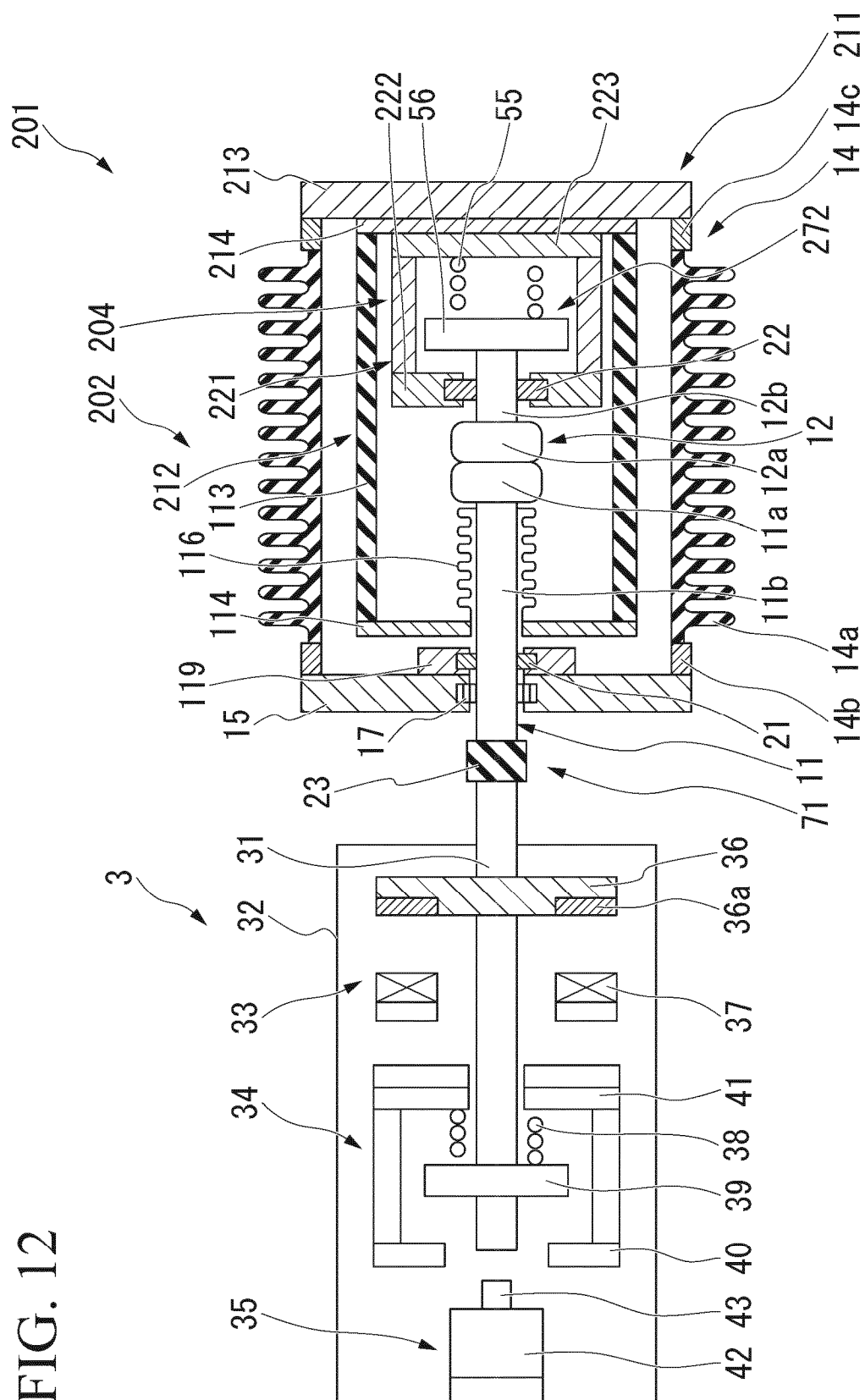
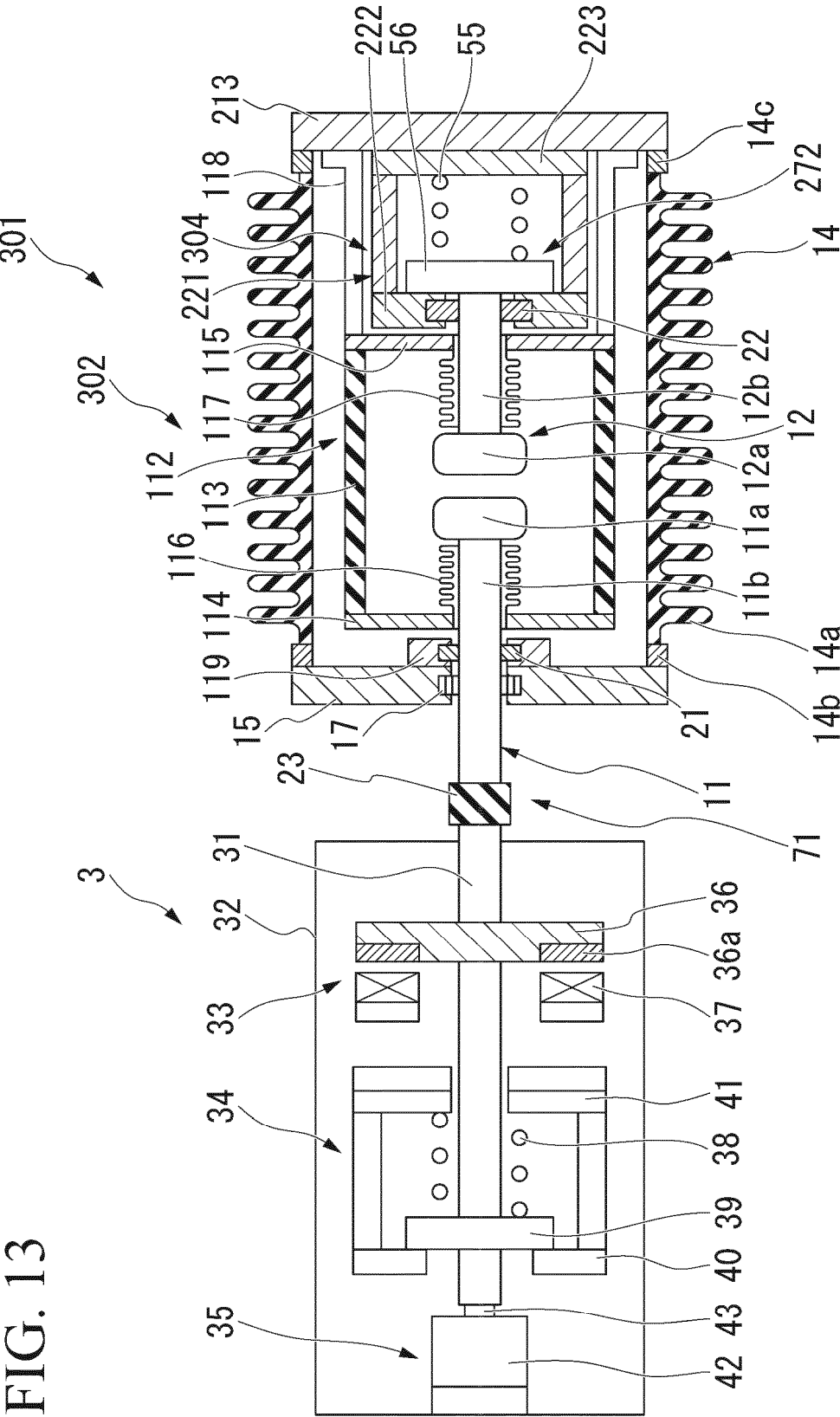


FIG. 13



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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