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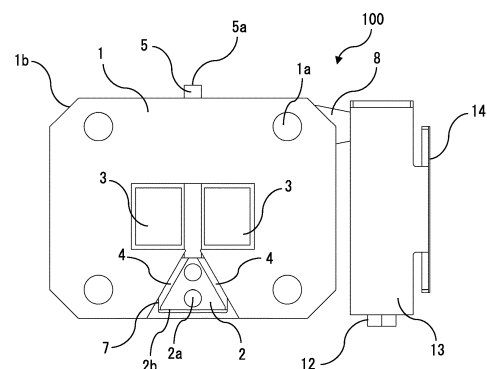
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(54) **OVERCURRENT TRIPPING DEVICE, AND CIRCUIT BREAKER IN WHICH OVERCURRENT TRIPPING DEVICE IS USED**

(57) An overcurrent tripping device (100) includes: a conductor (3); a fixed core (1) surrounding the conductor (3) and being partially open; a movable core (2) having a magnetic gap at a position where the fixed core (1) is open, and movably disposed; a rod (5) penetrating an inside of the fixed core (1), linked to a tripping mechanism at an end projecting to the outside, and fixed to the movable core (2) in a bar shape; and a lever (8) connected at one end thereof to the rod (5), connected at another end thereof to a spring (9) provided outside the fixed core (1), and configured to rotate about a fulcrum and transmit a load force of the spring (9) to the movable core (2). The fixed core (1) has a gap perpendicular to a direction in which the conductor (3) extends, and, in the gap, a plate-shaped fixed core guide (6) having a groove (6c) is fixed and the lever (8) is disposed. The movable core (2) has a gap perpendicular to the direction in which the conductor (3) extends, and a plate-shaped movable core guide (7) which is partially interposed in the groove (6c) and slides is fixed in the gap.

FIG. 1



Description

TECHNICAL FIELD

[0001] The present disclosure relates to an overcurrent tripping device and a circuit breaker using the same.

BACKGROUND ART

[0002] An overcurrent tripping device is a device that is incorporated into a circuit breaker and that detects an overcurrent flowing through a main circuit of the circuit breaker and actuates a tripping mechanism of the circuit breaker in a closed state. A specific overcurrent tripping device includes, for example, an electromagnet for detecting a fault current flowing through the main circuit, an output shaft for transmitting a drive force outputted from the electromagnet, to the tripping mechanism of the circuit breaker, a return spring for setting a current scale value (current prescribed value to start tripping operation) of the tripping device, and a scale device for adjusting the current scale value by manipulating the compression amount of the return spring to change the spring load. As operation of the overcurrent tripping device, it is indicated that when an overcurrent flows through a conductor penetrating the center of the electromagnet, a magnetic flux is generated in the electromagnet, a movable core forming the electromagnet is attracted upward, and a shaft connected to the movable core moves upward to drive a retention latch to separate the holding force that brings the circuit breaker into a closed state, from a movable contact (see, for example, Patent Document 1). Due to this separation, the circuit breaker shifts to an opened state.

[0003] Moreover, in the case where a fault occurs on an electric circuit including a circuit breaker and an overcurrent flows through the electric circuit, in order to reduce damage due to the overcurrent, it is effective to shorten, as much as possible, a time taken until completion of tripping operation from the time when the overcurrent occurs. In order to shorten the time taken until completion of tripping operation, in an overcurrent tripping device, a tripping drive force due to the overcurrent needs to greatly exceed a drive force at a current scale value, which can be achieved by reducing magnetic saturation of the electromagnet included in the overcurrent tripping device. Since the fault current of the circuit breaker increases transitionally within an extremely short time, a magnetomotive force of the overcurrent tripping device also increases transitionally during occurrence of the fault current, but when the electromagnet included in the overcurrent tripping device is magnetically saturated, the amount of increase in the tripping drive force reduces. Therefore, in order to shorten the tripping operation time, a core structure in which magnetic saturation is less likely to occur by the fault current may be adopted.

CITATION LIST

PATENT DOCUMENT

5 **[0004]** Patent Document 1: European Patent Publication No. 2431992

SUMMARY OF THE INVENTION

10 PROBLEMS TO BE SOLVED BY THE INVENTION

[0005] In Patent Document 1 above, it is possible to detect an overcurrent flowing through the main circuit of the circuit breaker, and actuate the tripping mechanism of the circuit breaker in a closed state. However, since the mechanism included in the overcurrent tripping device in order to actuate the tripping mechanism is provided outside the electromagnet, there is a problem that the size of the overcurrent tripping device is increased. In addition, no study has been made to shorten the time until taken completion of tripping operation. In order to shorten the time, for example, in this configuration, magnetic saturation can be reduced by increasing the volume of the core, which is the electromagnet, but there is a problem that the outer shape and mass of the overcurrent tripping device increase when the size of the core is increased.

[0006] The present disclosure has been made to solve the above problems, and an object of the present disclosure is to obtain an overcurrent tripping device that shortens a tripping operation time for a fault current and that has a reduced size, and a circuit breaker using the same.

SOLUTION TO THE PROBLEMS

35 **[0007]** An overcurrent tripping device according to the present disclosure is an overcurrent tripping device which detects an overcurrent flowing through a main circuit of a circuit breaker and actuates a tripping mechanism of the circuit breaker in a closed state, the overcurrent tripping device including: a conductor connected to the main circuit; a fixed core surrounding the conductor along a magnetic field generated around the conductor by a current flowing through the conductor, the fixed core being partially open so as to obliquely cut the magnetic field; a movable core having a magnetic gap between the fixed core and the movable core at a position where the fixed core is open, the movable core being disposed such that the movable core is movable in a direction in which the magnetic gap is reduced by an electromagnetic force generated when an overcurrent flows through the conductor; a rod penetrating an inside of the fixed core through a location where the fixed core is open and a portion of the fixed core facing the location where the fixed core is open, the rod being linked to the tripping mechanism at an end projecting to the outside of the fixed core, the rod being fixed to the movable core in a bar shape; and a lever connected at one end thereof to the

rod, connected at another end thereof to a spring provided outside the fixed core, and configured to rotate about a fulcrum provided between respective connection portions and transmit a load force of the spring to the movable core. The fixed core has a gap perpendicular to a direction in which the conductor extends, and, in the gap, a plate-shaped fixed core guide provided with a groove along a direction in which the rod extends is fixed and the lever is disposed. The movable core has a gap perpendicular to the direction in which the conductor extends, and a plate-shaped movable core guide which is partially interposed in the groove and slides in the direction in which the rod extends is fixed in the gap.

EFFECT OF THE INVENTION

[0008] In the overcurrent tripping device according to the present disclosure and the circuit breaker using the same, a tripping operation time for a fault current can be shortened, and size reduction can be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

[FIG. 1] FIG. 1 is a front view of an overcurrent tripping device according to Embodiment 1.

[FIG. 2] FIG. 2 is a plan view of the overcurrent tripping device according to Embodiment 1.

[FIG. 3] FIG. 3 is a perspective view showing a part of the overcurrent tripping device according to Embodiment 1.

[FIG. 4] FIG. 4 is a perspective view of the overcurrent tripping device according to Embodiment 1.

[FIG. 5] FIG. 5 is a front partial cross-sectional view showing a state before tripping operation of the overcurrent tripping device according to Embodiment 1.

[FIG. 6] FIG. 6 is a front partial cross-sectional view showing a state after tripping operation of the overcurrent tripping device according to Embodiment 1.

[FIG. 7] FIG. 7 is a perspective view showing a part of the overcurrent tripping device according to Embodiment 1.

[FIG. 8] FIG. 8 is a front partial cross-sectional view of an overcurrent tripping device according to Embodiment 2.

[FIG. 9] FIG. 9 is a front cross-sectional view showing a schematic configuration of a circuit breaker according to Embodiment 3 using the overcurrent tripping device.

DESCRIPTION OF EMBODIMENTS

[0010] Hereinafter, an overcurrent tripping device according to each of embodiments of the present disclosure and a circuit breaker using the same will be described with reference to the drawings. In the drawings, the same or corresponding members and parts are denoted by the

same reference characters to give description.

Embodiment 1

[0011] FIG. 1 is a front view of an overcurrent tripping device 100, FIG. 2 is a plan view of the overcurrent tripping device 100, FIG. 3 is a perspective view showing a part of the overcurrent tripping device 100, and FIG. 4 is a perspective view of the overcurrent tripping device 100. The overcurrent tripping device 100 is a device that is incorporated into a circuit breaker 200 described later and that moves a rod 5, which is fixed to a movable core 2, to actuate a tripping mechanism of the circuit breaker 200 in a closed state when an overcurrent flows through a main circuit of the circuit breaker 200. Hereinafter, the configuration of the overcurrent tripping device 100 will be described.

[0012] The overcurrent tripping device 100 includes: two conductors 3 which are connected to the main circuit (not shown) of the circuit breaker 200; a fixed core 1 which surrounds the conductors 3 along a magnetic field generated around the conductors 3 by a current flowing through the conductors 3 and which is partially open so as to obliquely cut the magnetic field; and the movable core 2 which has a magnetic gap 4 between the fixed core 1 and the movable core 2 at the position where the fixed core 1 is open and which is disposed such that the movable core 2 is movable in the direction in which the magnetic gap 4 is reduced, by an electromagnetic force generated when an overcurrent flows through the conductors 3. A magnetic circuit is formed by the fixed core 1 and the movable core 2. The fixed core 1 is a stacked core and includes stacked magnetic steel sheets 1b. Four fixed core pins 1a penetrate the magnetic steel sheets 1b in the direction in which the magnetic steel sheets 1b are stacked, to fix the magnetic steel sheets 1b together. The movable core 2 is also a stacked core and includes stacked magnetic steel sheets 2b, and two movable core pins 2a penetrate the magnetic steel sheets 2b in the direction in which the magnetic steel sheets 2b are stacked, to fix the magnetic steel sheets 2b together. The number of fixed core pins 1a and the number of movable core pins 2a are not limited to these numbers as long as the magnetic steel sheets 1b and the magnetic steel sheets 2b can be fixed. The fixed core 1 and the movable core 2 are preferably composed of stacked cores in order to suppress eddy currents, but the configurations thereof are not limited to the stacked configurations, and the fixed core 1 and the movable core 2 may each be composed of a block made of a ferromagnetic material such as iron-based materials. Each conductor 3 is made of, for example, copper. A main circuit current of the circuit breaker 200 flows through each conductor 3 to induce an electromagnetic force in the magnetic circuit. FIG. 1 shows an example in which the two conductors 3 are disposed and the rod 5 described later is moveable therebetween, but the present disclosure is not limited thereto, and the rod 5 may be disposed next to one conductor 3.

[0013] The rod 5 is provided so as to extend in a bar shape, be movable in an axial direction thereof, and penetrate the inside of the fixed core 1 through the location where the fixed core 1 is open and a portion of the fixed core 1 facing the location where the fixed core 1 is open. The rod 5 is linked to a retention latch (not shown) connected to a tripping mechanism included in the circuit breaker 200, at an end projecting to the outside of the fixed core 1. For example, the rod 5 is fitted with the movable core 2 to be fixed to the movable core 2. The rod 5 is made of a non-ferromagnetic material such as stainless steel, brass, and aluminum. This is because such a material does not affect the magnetic circuit included in the overcurrent tripping device 100.

[0014] As shown in FIG. 2, the fixed core 1 has gaps perpendicular to the direction in which the conductors 3 extend, and a plate-shaped fixed core guide 6 is fixed in each of the gaps. The fixed core guide 6 is interposed between the magnetic steel sheets 1b to be fixed therebetween. The fixed core guide 6 includes a plurality of plates and is stacked. The fixed core guide 6 includes two outer layers 6a and one inner layer 6b. The fixed core guide 6 is fixed by the fixed core pins 1a together with the magnetic steel sheets 1b. The rod 5 is disposed in a space provided between the right and left fixed core guides 6. As shown in FIG. 3, a groove 6c is provided on each fixed core guide 6 along the direction in which the rod 5 extends. The side walls of the groove 6c are formed by the outer layers 6a, and the bottom of the groove 6c is formed by the inner layer 6b.

[0015] As shown in FIG. 3, the movable core 2 has a gap perpendicular to the direction in which the conductors 3 extend, and a plate-shaped movable core guide 7 which is partially interposed in the groove 6c and which slides in the direction in which the rod 5 extends is fixed in this gap. The direction in which the movable core 2 is movable is limited by the groove 6c. The movable core guide 7 is fixed by the movable core pins 2a together with the magnetic steel sheets 2b. The fixed core guides 6 and the movable core guide 7 are each preferably made of a non-ferromagnetic paramagnetic or diamagnetic material such as stainless steel, brass, and aluminum. This is because such a material does not affect the magnetic circuit included in the overcurrent tripping device 100.

[0016] A lever 8 is connected at one end thereof to the rod 5 and connected at another end thereof to a spring 9 provided outside the fixed core 1. The lever 8 rotates about a fulcrum provided between the respective connection portions, and transmits the load force of the spring 9 to the movable core 2 via the rod 5. The lever 8 is provided inside the fixed core guide 6 in the direction in which the conductors 3 extend, in the gap of the fixed core 1, so as to be interposed between the two outer layers 6a. The lever 8 is fixed by the fixed core pin 1a, which penetrates the fixed core 1, together with the fixed core 1. The lever 8 rotates about the portion fixed by the fixed core pin 1a as a fulcrum. The lever 8 is fixed to the spring 9 by a spring seat 10. Since the lever 8 is provided

so as to be interposed between the fixed core guides 6, scratching of the magnetic steel sheets 1b due to rotation of the lever 8 is suppressed. The lever 8 is made of a non-ferromagnetic material such as stainless steel, brass, and aluminum.

[0017] In addition to the spring 9, the overcurrent tripping device 100 includes a stage 11 and a spring adjusting screw 12 outside the fixed core 1. The stage 11 is in contact with the spring 9 on one side, and is fitted with a screw hole provided such that the spring adjusting screw 12 disposed on the other side penetrates a center portion thereof. Inside a spring guide 13 shown in FIG. 4, a side surface 11a of the stage 11 faces wall surfaces of the spring guide 13, so that rotation of the stage 11 about the axis of the screw hole is suppressed. When the spring adjusting screw 12 is rotated, the stage 11 moves in the axial direction of the screw hole along the wall surfaces of the spring guide 13. As the stage 11 moves, the spring 9 expands and contracts, so that the load force of the spring 9 changes. The movable core 2 is biased by the spring 9 in the direction away from the fixed core 1, and the strength of the biasing of the movable core 2 changes as the stage 11 moves. The strength of the biasing of the movable core 2 is to set a current scale value (predetermined current prescribed value to start tripping operation) of the overcurrent tripping device 100, and it is made possible to set a plurality of current scale values by making the strength of the biasing of the movable core 2 adjustable. The initial load of the spring 9 is set so as to be equal to an electromagnetic drive force at the current scale value of the overcurrent tripping device 100.

[0018] The spring guide 13 is provided so as to surround the spring 9 and the side surface of the stage 11. The spring guide 13 suppresses bending of the spring 9 in a direction other than the movement direction of the stage 11 and suppresses rotation of the stage 11. The spring guide 13 includes a scale 14 on the outside thereof. Since the scale 14 is provided, the position of the stage 11 can be quantitatively grasped. Since the position of the stage 11 is quantitatively grasped, the correlation between the position of the stage 11 and the current scale value can be recorded in advance, so that it is possible to change the current scale value on the basis of the recorded current scale value without causing a current to flow through the conductors 3 to operate the overcurrent tripping device 100.

[0019] Next, tripping operation of the overcurrent tripping device 100 will be described. FIG. 5 is a front partial cross-sectional view showing a state before tripping operation of the overcurrent tripping device 100 according to Embodiment 1, and FIG. 6 is a front partial cross-sectional view showing a state after tripping operation of the overcurrent tripping device 100. FIG. 5 and FIG. 6 are each a front partial cross-sectional view taken along an alternate long and short dash line A-A in FIG. 2. A retention latch 51 is connected to the tripping mechanism (not shown) included in the circuit breaker 200, is in contact with another end 5a of the rod 5 on one side, and is

rotatably fixed on the other side. Before tripping operation in which a fault current does not flow through the conductors 3, the load force is given from the spring 9 to the movable core 2, and, as shown in FIG. 5, the movable core 2 is placed at an initial position facing the fixed core 1 with the magnetic gap 4 therebetween. When a fault current flows through the conductors 3 and the electromagnetic drive force acting on the movable core 2 becomes larger than the load force of the spring 9, the movable core 2 moves from the initial position to a tripping position where the magnetic gap 4 is eliminated, as shown in FIG. 6. An arrow shown in the fixed core 1 and the movable core 2 in the drawing indicates a magnetic circuit Φ , and a fault current I is shown in the conductors 3. The rod 5 moves together with the movable core 2, and the other end 5a rotates the retention latch 51 to release the latch. The tripping mechanism of the circuit breaker 200 connected to the retention latch 51 is actuated to bring the circuit breaker 200 into an opened state.

[0020] In the present embodiment, the example in which each fixed core guide 6 includes a plurality of plates as shown in FIG. 3 is illustrated, but the present disclosure is not limited thereto. As shown in FIG. 7, a fixed core guide 6 obtained by processing one plate, for example, by means of cutting may be adopted.

[0021] Moreover, in the present embodiment, the example in which the lever 8 is installed so as to be interposed between the two outer layers 6a as shown in FIG. 2 is illustrated, but the configuration for installing the lever 8 is not limited thereto. The lever 8 that has an increased thickness may be fixed so as to be interposed between the magnetic steel sheets 1b without providing the outer layers 6a at the location where the lever 8 is disposed. The thickness of the lever 8 can be increased to increase the rigidity of the lever 8 for transmitting the load force of the spring 9 to the movable core 2.

[0022] Moreover, in the present embodiment, the example in which the lever 8 is fixed by the fixed core pin 1a at the fulcrum about which the lever 8 is rotationally driven as shown in FIG. 5 is illustrated, but the configuration of the fulcrum for fixing the lever 8 is not limited thereto. Instead of fixing the lever 8 by the fixed core pin 1a, a fulcrum for the lever 8 may be provided outside the fixed core 1 and the load force of the spring 9 may be transmitted to the movable core 2 using the principle of leverage.

[0023] As described above, since the rod 5 and the lever 8 involved in the operation of the tripping mechanism are provided inside the fixed core 1 in the overcurrent tripping device 100, the outer shape of the overcurrent tripping device 100 can be reduced and the size of the overcurrent tripping device 100 can be reduced. In addition, the rod 5 and the lever 8, which are movable parts, are provided inside the fixed core 1, so that the sizes of the movable parts are reduced and the masses of the movable parts are decreased. Thus, the movement speeds of the movable parts when a fault current flows through the conductors 3 can be increased, and the trip-

ping operation time for the fault current can be shortened. Moreover, in the case where the lever 8 is provided so as to be interposed between the two outer layers 6a, the thickness of the lever 8 is set to be equal to the thickness of the inner layer 6b, so that the size of the overcurrent tripping device 100 can be reduced. Moreover, in the case where each fixed core guide 6 is stacked and provided to form the groove 6c, the groove 6c can be easily formed, and the manufacturing process for the overcurrent tripping device 100 can be simplified. Moreover, in the case where the fixed core guides 6 and the movable core guide 7 are each formed from a paramagnetic or diamagnetic material, such a material does not affect the magnetic circuit included in the overcurrent tripping device 100, and the tripping operation time for a fault current can be shortened. Moreover, in the case where the lever 8 is fixed by the fixed core pin 1a, the lever 8 can be fixed inside the fixed core 1 without adding any component, so that the weight of the overcurrent tripping device 100 can be reduced and the manufacturing process for the overcurrent tripping device 100 can be simplified.

Embodiment 2

[0024] An overcurrent tripping device 100 according to Embodiment 2 will be described. FIG. 8 is a front partial cross-sectional view of the overcurrent tripping device 100. An area shown in the cross-section is the same as in FIG. 5. In the overcurrent tripping device 100 according to Embodiment 2, the position of the stage 11 which is provided in the overcurrent tripping device 100 shown in Embodiment 1 is different from that in Embodiment 1, and the stage 11 is provided on the side on which the rod 5 actuates the tripping mechanism.

[0025] The direction in which the rod 5 actuates the tripping mechanism is shown by an arrow in FIG. 8. The movable core 2 is provided so as to face the fixed core 1 on the side on which the rod 5 actuates the tripping mechanism. Therefore, the rod 5 penetrates the movable core 2 and is fixed to the movable core 2. The lever 8 is fixed by the fixed core pin 1a provided at the lower right of the fixed core 1. Thus, the stage 11 is disposed on the side on which the rod 5 actuates the tripping mechanism. In this configuration, the spring 9 generates a load force in the direction in which the rod 5 actuates the tripping mechanism, and transmits the load force to the lever 8. Similar to Embodiment 1, it is possible to change the current scale value by moving the stage 11 using a spring adjusting screw (not shown).

[0026] As described above, in the overcurrent tripping device 100, the position of the stage 11 is on the side on which the tripping mechanism is actuated, and the position where the operator operates the spring adjusting screw is different from that in Embodiment 1. Thus, the number of choices of locations where the overcurrent tripping device 100 can be installed inside a circuit breaker can be increased.

Embodiment 3

[0027] The circuit breaker 200 according to Embodiment 3 will be described. FIG. 9 is a front cross-sectional view showing a schematic configuration of the circuit breaker 200 using the overcurrent tripping device 100. The overcurrent tripping device 100 shown in Embodiment 1 or Embodiment 2 is incorporated into the circuit breaker 200, and the overcurrent tripping device 100 actuates the tripping mechanism of the circuit breaker 200 in a closed state. FIG. 8 shows the circuit breaker 200 inserted into a fixation framework 70.

[0028] In the circuit breaker 200, an upper conductor 53 and a lower conductor 54 are arranged under an arc-extinguishing chamber 52 in which an arc-extinguishing space is formed when a current flows. A fixed-side main contact 55 is connected to the upper conductor 53. The lower conductor 54 is connected to a movable conductor 57 via a flexible conductor 56, and a movable-side main contact 58 is provided at a position facing the fixed-side main contact 55, at an end of the movable conductor 57. The movable conductor 57 rotates about a rotation shaft 59. An opening operation is performed by an opening spring 60, and a closing operation is performed by an actuator 61. When the fixed-side main contact 55 and the movable-side main contact 58 are brought into contact with each other, a current flows between the upper conductor 53 and the lower conductor 54 via the movable conductor 57 and the flexible conductor 56.

[0029] The overcurrent tripping device 100 is provided at a certain location on the lower conductor 54. The lower conductor 54 is connected to the conductors 3 of the overcurrent tripping device 100, and a main circuit current flows through the conductors 3. The overcurrent tripping device 100 is engaged with a latch 64 via a latch driving link 63. Here, the latch driving link 63 shown by a broken line in FIG. 8 corresponds to a part for transmitting movement of the rod 5 of the overcurrent tripping device 100 described above with reference to FIG. 5, to the retention latch 51, and on the basis of this operation, the latch 64 is driven.

[0030] Next, operation when a fault current flows will be described. When a fault current flows, the overcurrent tripping device 100 provided on the lower conductor 54 detects an overcurrent and performs operation, and the operation is transmitted to the latch 64 via the latch driving link 63. Then, the latch 64 rotates about a latch shaft 65 in the clockwise direction, whereby engagement with the movable conductor 57 is released and the movable conductor 57 rotates about the rotation shaft 59 in the clockwise direction, thereby performing an opening operation.

[0031] The fixed-side main contact 55 and the movable-side main contact 58 are housed inside the arc-extinguishing chamber 52. Above the fixed-side main contact 55 and the movable-side main contact 58, a fixed-side arc contact element 66 and a movable-side arc contact element 67 are disposed, and an arc is generated upon interruption. In an opening operation, the fixed-side

arc contact element 66 and the movable-side arc contact element 67 are opened after the fixed-side main contact 55 and the movable-side main contact 58 are opened. Thus, an arc is prevented from being generated at the fixed-side main contact 55 and the movable-side main contact 58, and erosion of the main contact part is prevented, whereby the main contact part is protected. Above the fixed-side arc contact element 66 and the movable-side arc contact element 67, a fixed-side arc horn 68 and a movable-side arc horn 69 are disposed for transferring the generated arc and leading the arc upward in the arc-extinguishing chamber 52.

[0032] The configuration of the circuit breaker 200 described with reference to FIG. 9 is merely an example, and is not limited thereto. The configuration of the circuit breaker 200 may be any configuration in which a current flowing through the main circuit of the circuit breaker 200 is detected by the overcurrent tripping device 100, and the engagement between the movable conductor 57 and the latch 64 is released by operation of the overcurrent tripping device 100 to bring the circuit breaker 200 into an opened state.

[0033] As described above, since the overcurrent tripping device 100 shown in Embodiment 1 or Embodiment 2 is incorporated into the circuit breaker 200, the movement speeds of the movable parts of the overcurrent tripping device 100 when a fault current flows through the lower conductor 54 can be increased, and the tripping operation time of the circuit breaker 200 for the fault current can be shortened. In addition, since the size of the overcurrent tripping device 100 is reduced, a space in which the overcurrent tripping device 100 is installed in the circuit breaker 200 can be reduced, so that the size of the circuit breaker 200 can be reduced.

[0034] Although the disclosure is described above in terms of various exemplary embodiments and implementations, it should be understood that the various features, aspects, and functionality described in one or more of the individual embodiments are not limited in their applicability to the particular embodiment with which they are described, but instead can be applied, alone or in various combinations to one or more of the embodiments of the disclosure.

[0035] It is therefore understood that numerous modifications which have not been exemplified can be devised without departing from the scope of the present disclosure. For example, at least one of the constituent components may be modified, added, or eliminated. At least one of the constituent components mentioned in at least one of the preferred embodiments may be selected and combined with the constituent components mentioned in another preferred embodiment.

DESCRIPTION OF THE REFERENCE CHARACTERS

[0036]

1 fixed core

1a	fixed core pin	
1b	magnetic steel sheet	
2	movable core	
2a	movable core pin	
2b	magnetic steel sheet	5
3	conductor	
4	magnetic gap	
5	rod	
5a	other end	
6	fixed core guide	10
6a	outer layer	
6b	inner layer	
6c	groove	
7	movable core guide	
8	lever	15
9	spring	
10	spring seat	
11	stage	
11a	side surface	
12	spring adjusting screw	20
13	spring guide	
14	scale	
51	retention latch	
52	arc-extinguishing chamber	
53	upper conductor	25
54	lower conductor	
55	fixed-side main contact	
56	flexible conductor	
57	movable conductor	
58	movable-side main contact	30
59	rotation shaft	
60	opening spring	
61	actuator	
63	latch driving link	
64	latch	35
65	latch shaft	
66	fixed-side arc contact element	
67	movable-side arc contact element	
68	fixed-side arc horn	
69	movable-side arc horn	40
70	fixation framework	
100	overcurrent tripping device	
200	circuit breaker	

Claims

1. An overcurrent tripping device which detects an overcurrent flowing through a main circuit of a circuit breaker and actuates a tripping mechanism of the circuit breaker in a closed state, the overcurrent tripping device comprising:

a conductor connected to the main circuit;
a fixed core surrounding the conductor along a magnetic field generated around the conductor by a current flowing through the conductor, the fixed core being partially open so as to obliquely

cut the magnetic field;

a movable core having a magnetic gap between the fixed core and the movable core at a position where the fixed core is open, the movable core being disposed such that the movable core is movable in a direction in which the magnetic gap is reduced by an electromagnetic force generated when an overcurrent flows through the conductor;

a rod penetrating an inside of the fixed core through a location where the fixed core is open and a portion of the fixed core facing the location where the fixed core is open, the rod being linked to the tripping mechanism at an end projecting to the outside of the fixed core, the rod being fixed to the movable core in a bar shape; and a lever connected at one end thereof to the rod, connected at another end thereof to a spring provided outside the fixed core, and configured to rotate about a fulcrum provided between respective connection portions and transmit a load force of the spring to the movable core, wherein the fixed core has a gap perpendicular to a direction in which the conductor extends, and, in the gap, a plate-shaped fixed core guide provided with a groove along a direction in which the rod extends is fixed and the lever is disposed, and

the movable core has a gap perpendicular to the direction in which the conductor extends, and a plate-shaped movable core guide which is partially interposed in the groove and slides in the direction in which the rod extends is fixed in the gap.

2. The overcurrent tripping device according to claim 1, wherein the lever is provided inside the fixed core guide in the direction in which the conductor extends.

3. The overcurrent tripping device according to claim 1 or 2, wherein

the fixed core guide includes a plurality of plates and is stacked, and

a side wall of the groove is formed by an outer layer of the fixed core guide, and a bottom of the groove is formed by an inner layer of the fixed core guide.

4. The overcurrent tripping device according to any one of claims 1 to 3, wherein the lever is fixed by a fixed core pin penetrating the fixed core, together with the fixed core.

5. The overcurrent tripping device according to any one of claims 1 to 4, wherein the fixed core guide and the movable core guide are each formed from a paramagnetic or diamagnetic material.

6. A circuit breaker comprising:

an arc-extinguishing chamber in which an arc-extinguishing space is formed;
a fixed-side main contact located under the arc-extinguishing chamber; 5
a movable-side main contact located so as to be contactable with and separable from the fixed-side main contact; and
the overcurrent tripping device according to any one of claims 1 to 5 which detects an overcurrent flowing between the fixed-side main contact and the movable-side main contact and drives the movable-side main contact in a tripping direction. 10 15

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FIG. 1

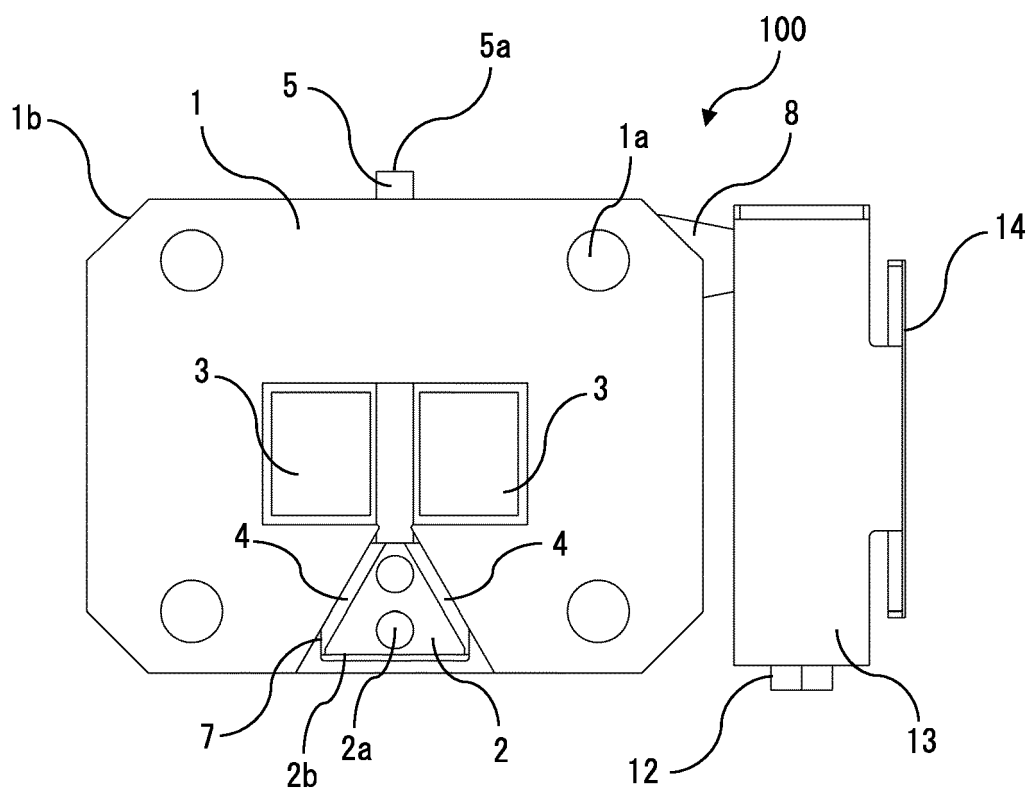


FIG. 2

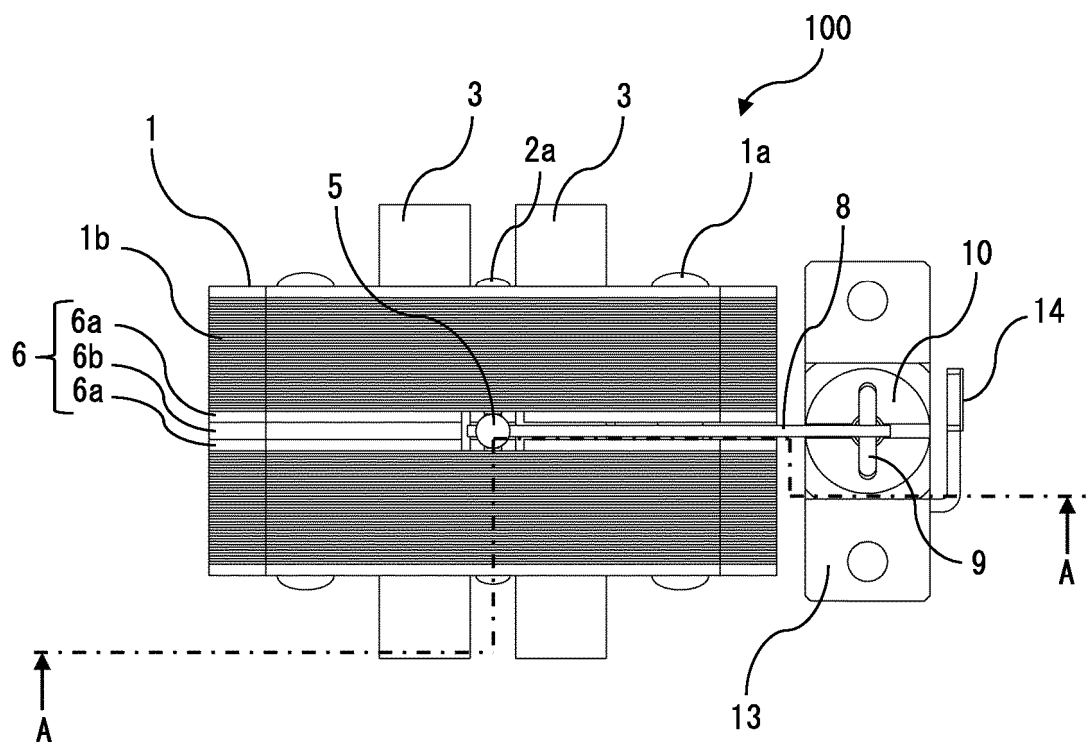


FIG. 3

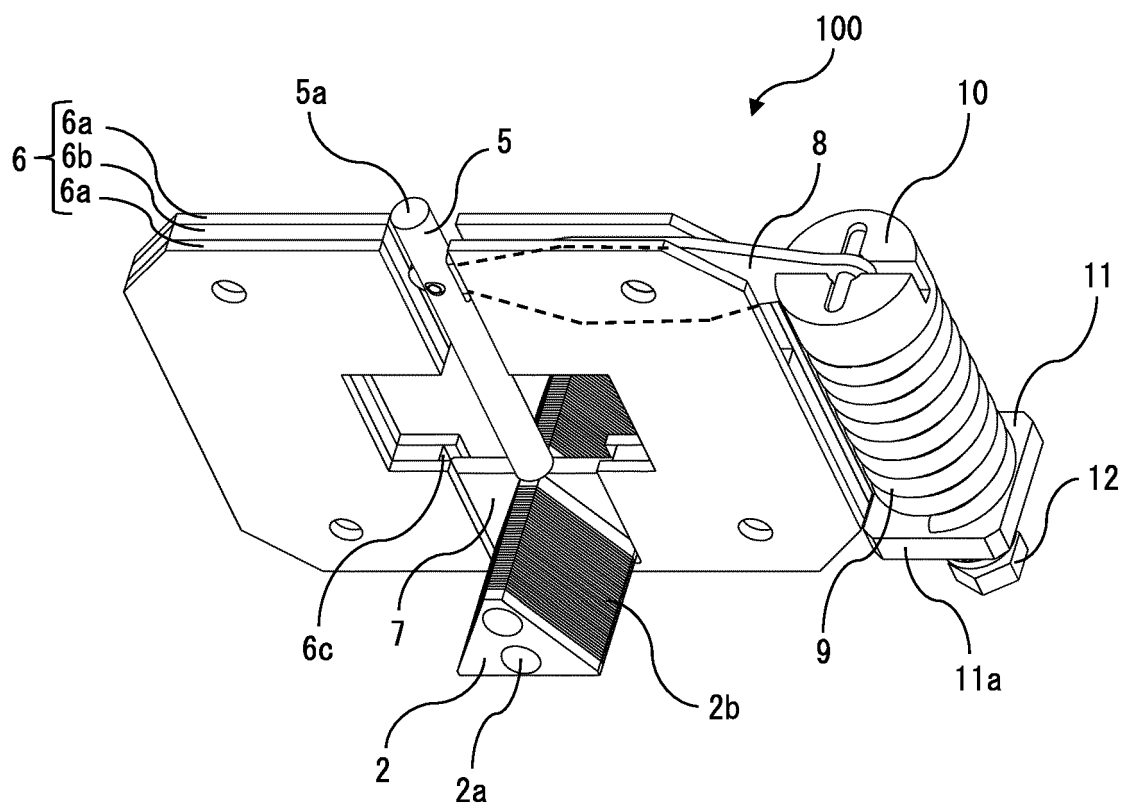


FIG. 4

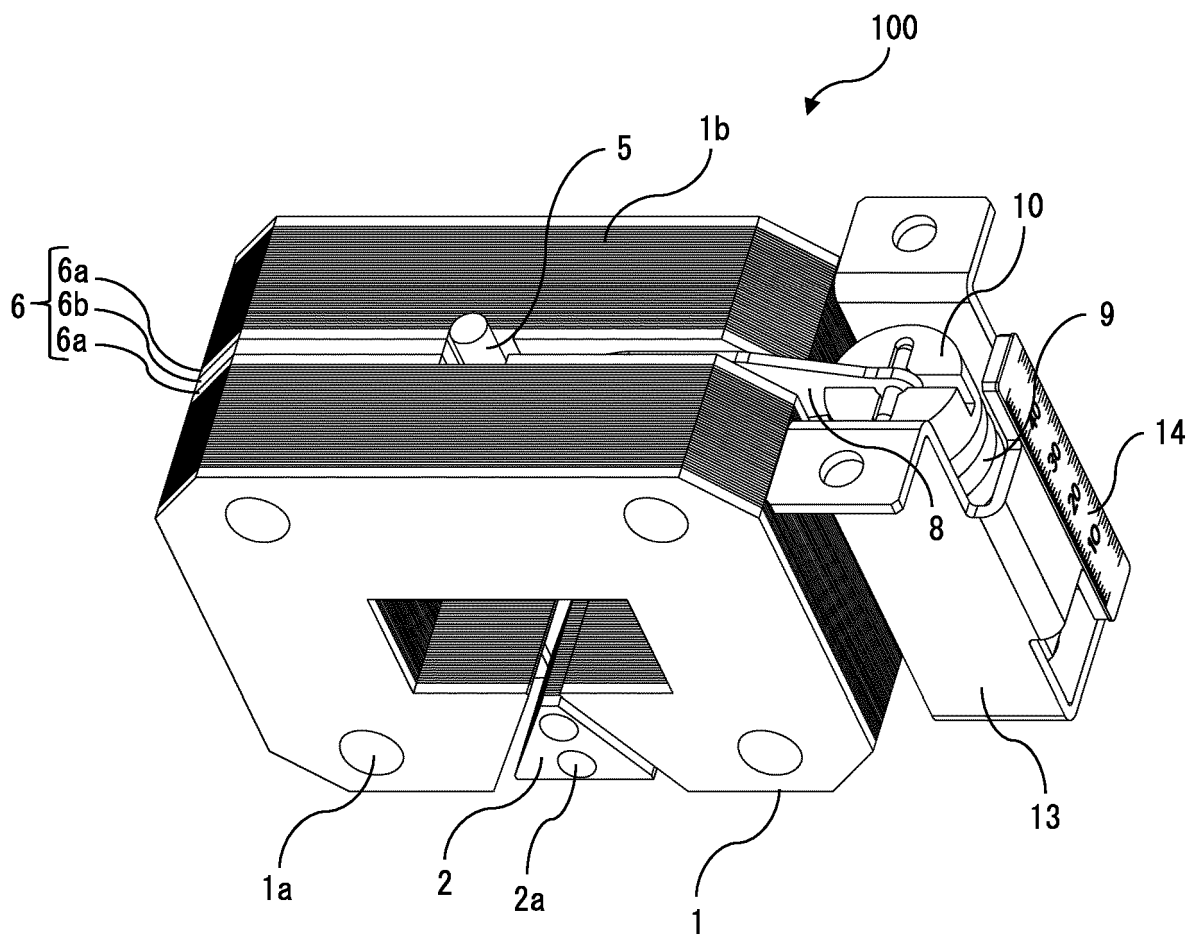


FIG. 5

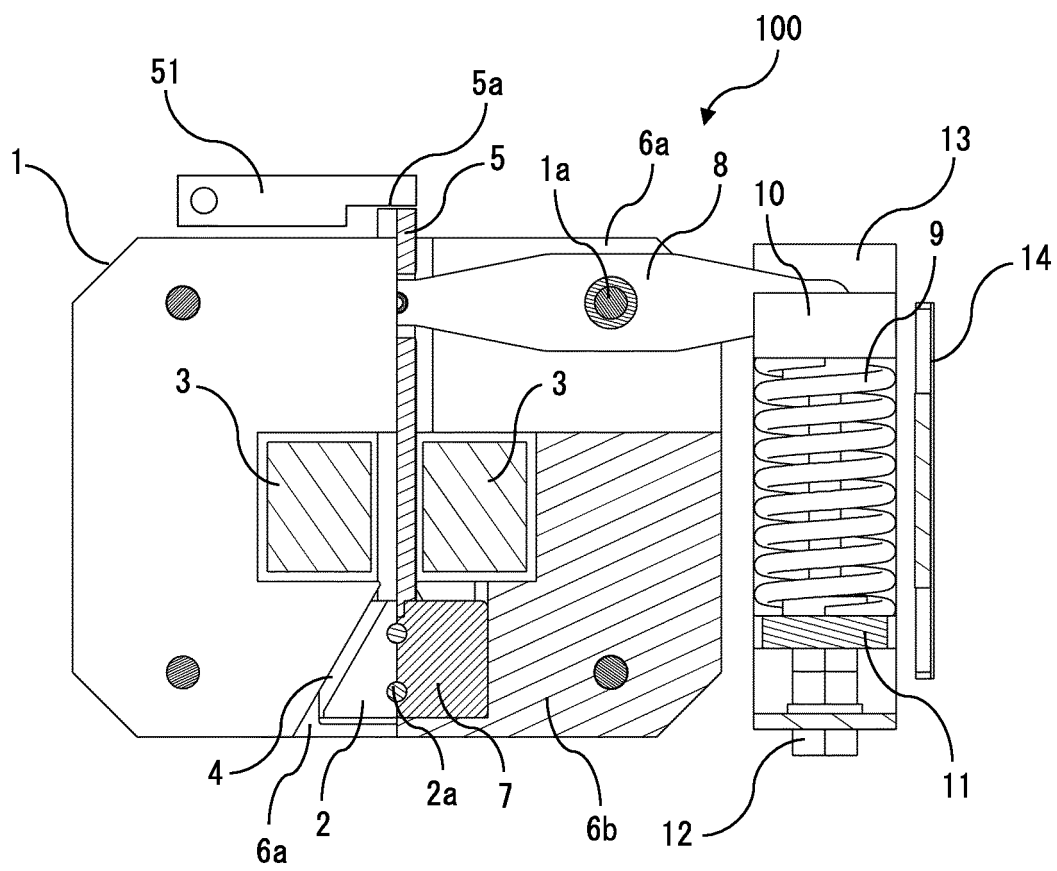


FIG. 6

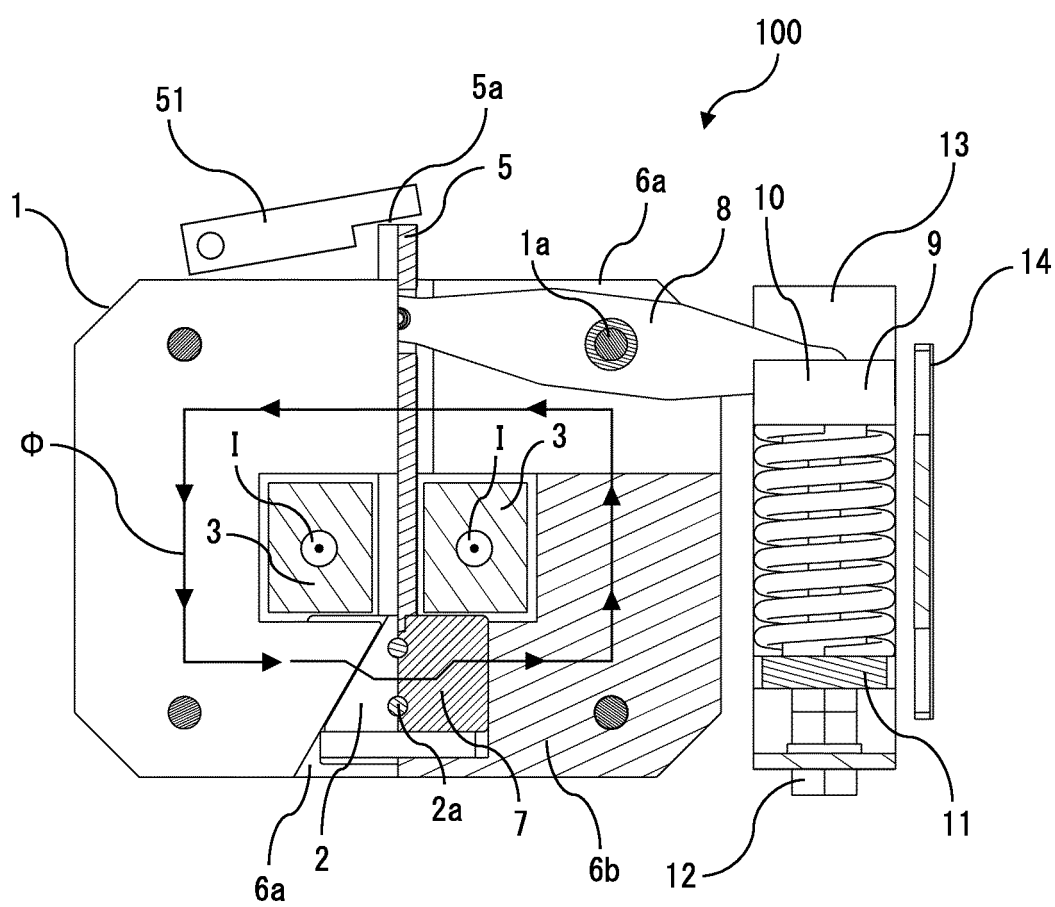


FIG. 7

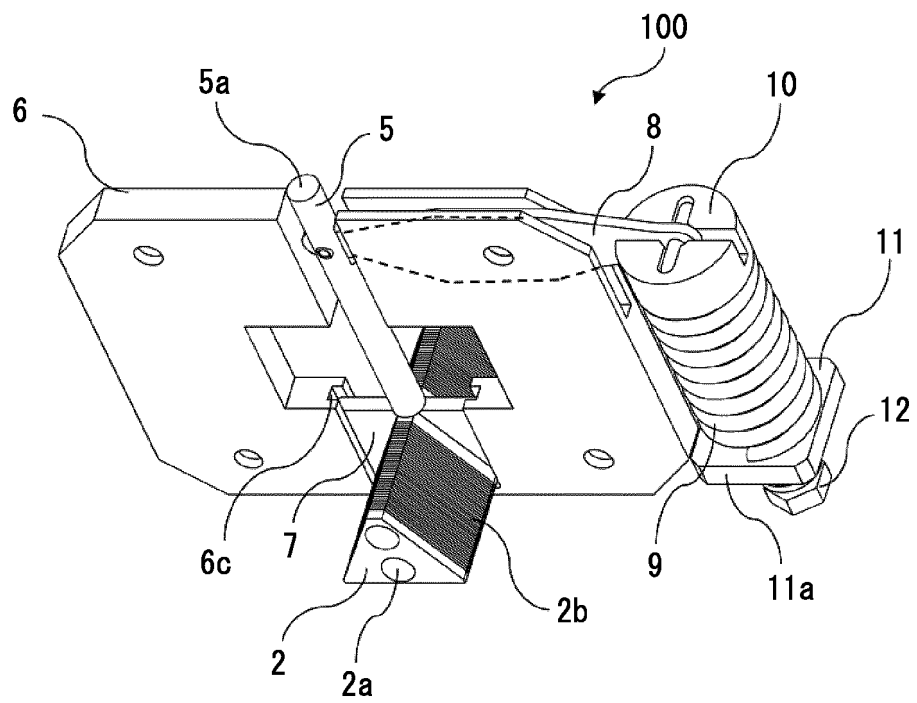


FIG. 8

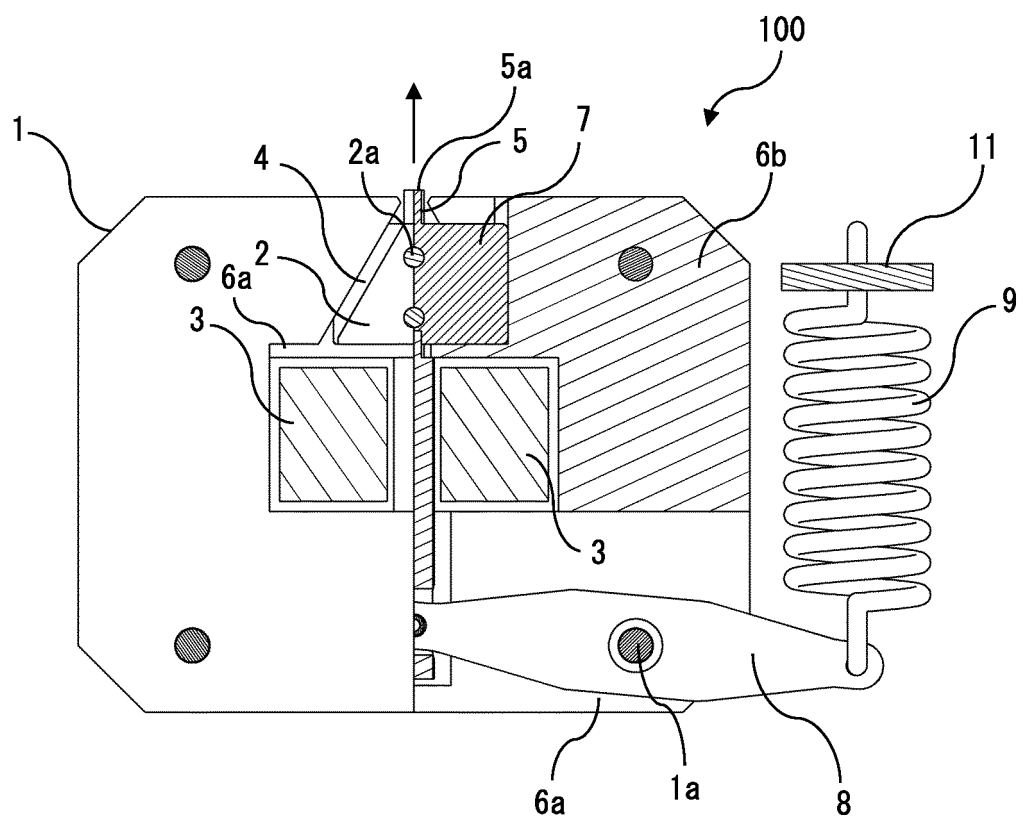
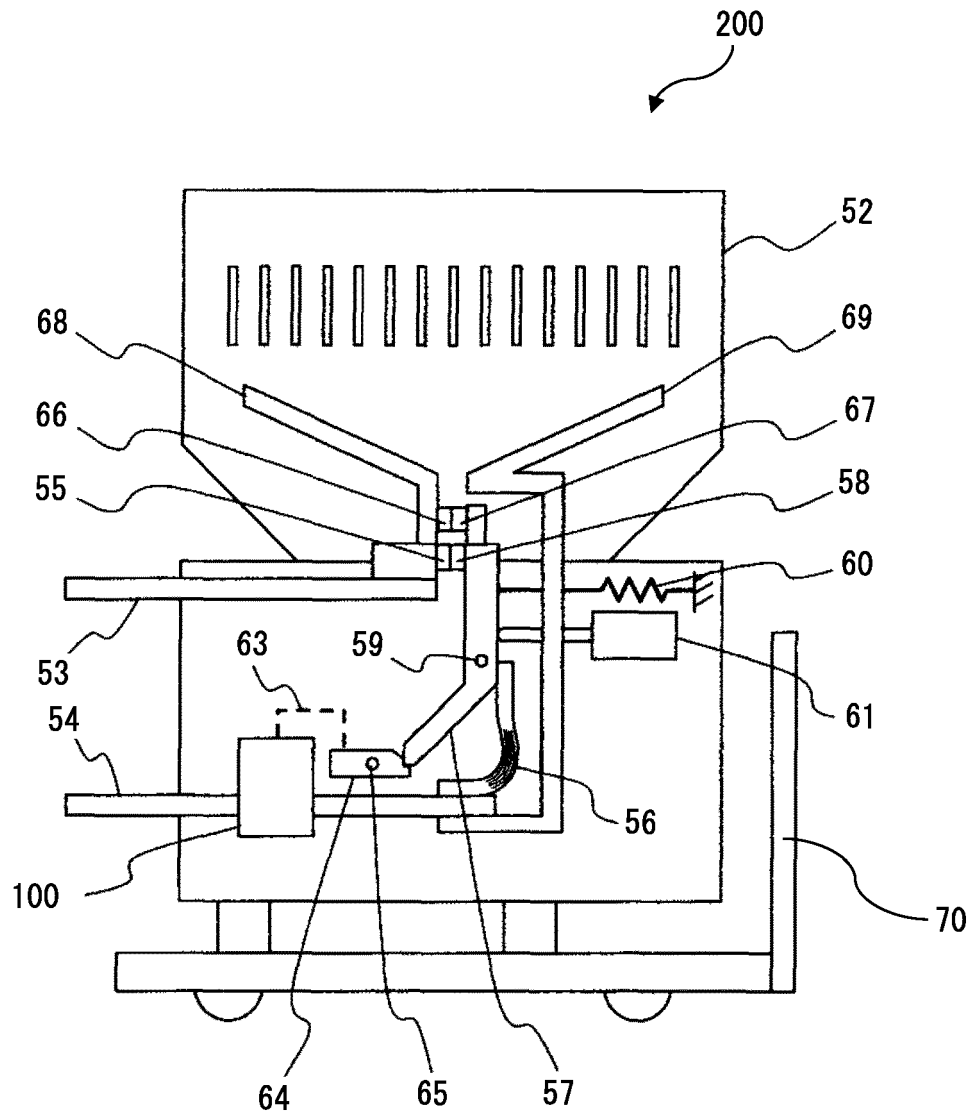


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/018509

A. CLASSIFICATION OF SUBJECT MATTER

H01H 71/24 (2006.01) i

FI: H01H71/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01H69/00-83/22

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2020

Registered utility model specifications of Japan 1996-2020

Published registered utility model applications of Japan 1994-2020

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 2431992 (SECHERON SA) 21.03.2012 (2012-03-21) entire text, all drawings	1-6
A	WO 2016/204104 A1 (MITSUBISHI ELECTRIC CORP.) 22.12.2016 (2016-12-22) entire text, all drawings	1-6
A	WO 2019/038813 A1 (MITSUBISHI ELECTRIC CORP.) 28.02.2019 (2019-02-28) entire text, all drawings	1-6
A	DE 19715114 A1 (AEG NIEDERSPANNUNGSTECHNIK GMBH & CO KG) 22.10.1998 (1998-10-22) entire text, all drawings	1-6



Further documents are listed in the continuation of Box C.



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"&" document member of the same patent family

Date of the actual completion of the international search

21 July 2020 (21.07.2020)

Date of mailing of the international search report

04 August 2020 (04.08.2020)

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2020/018509

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
EP 2431992 A1	21 Mar. 2012	(Family: none)	
WO 2016/204104 A1	22 Dec. 2016	US 2018/0012720 A1	
		entire text, all drawings	
WO 2019/038813 A1	28 Feb. 2019	EP 3312865 A1	
		WO 2019/038946 A1	
		entire text, all drawings	
DE 19715114 A1	22 Oct. 1998	DE 29723307 U1	
		entire text, all drawings	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 2431992 A [0004]