



(11)

EP 3 998 622 A1

(12)

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

(43) Date of publication:

18.05.2022 Bulletin 2022/20

(21) Application number: **20836242.6**

(22) Date of filing: **19.05.2020**

(51) International Patent Classification (IPC):

H01H 73/06 ^(2006.01) **H01H 73/18** ^(2006.01)
H01H 33/20 ^(2006.01)

(52) Cooperative Patent Classification (CPC):

H01H 33/20; H01H 73/06; H01H 73/18

(86) International application number:

PCT/JP2020/019716

(87) International publication number:

WO 2021/005889 (14.01.2021 Gazette 2021/02)

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA ME

Designated Validation States:

KH MA MD TN

(30) Priority: **11.07.2019 JP 2019128879**

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Patentanwälte mbB

Postfach 10 54 62

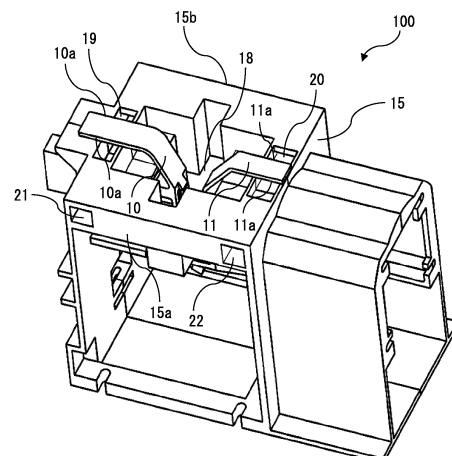
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(54) **AIR CIRCUIT BREAKER**

(57) The present disclosure includes: a fixed element (2) having a fixed contactor (1); a movable element (4) having a movable contactor (3) contactable with and separable from the fixed contactor (1); an arc extinguishing chamber (14) in which an arc (16) is extinguished; a fixed-side arc runner (10) having an end portion extending in a direction opposite to a direction toward the movable element (4), from an interval between the fixed element (2) and the arc extinguishing chamber (14); a movable-side arc runner (11) having an end portion extending in a direction opposite to a direction toward the fixed element (2), from an interval between the movable element (4) and the arc extinguishing chamber (14); and a mold frame (15) enclosing the fixed element (2) and the movable element (4) and supporting the fixed element (2), the movable element (4), the fixed-side arc runner (10), and the movable-side arc runner (11). The mold frame (15) includes: a fixed-side gas discharge passage (21) through which a port provided in a side surface of the mold frame (15) and a fixed-side gas discharge port (19) are in communication with each other and which is separated from the fixed element (2) side by a fixed-side blocking wall (23); and a movable-side gas discharge

passage (22) through which a port provided in a side surface of the mold frame (15) and a movable-side gas discharge port (20) are in communication with each other and which is separated from the movable element (4) side by a movable-side blocking wall (24).

FIG. 3



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Description

TECHNICAL FIELD

[0001] The present disclosure relates to an air circuit breaker.

BACKGROUND ART

[0002] Air circuit breakers are used as protective breakers for electrical systems or the like. Such an air circuit breaker includes: a fixed element having a fixed contactor; a movable element having a movable contactor which is disposed so as to be contactable with and separable from the fixed contactor; an arc extinguishing chamber which is disposed upward of the fixed element and the movable element and in which an arc generated upon opening between the fixed contactor and the movable contactor is divided and extinguished; a pair of arc runners, i.e., fixed-side and movable-side arc runners, which guide the arc to the arc extinguishing chamber; and a mold frame supporting the fixed element, the movable element, the fixed-side arc runner, and the movable-side arc runner and formed of an insulating material. When fault current is generated, the movable element is driven so that the circuit is disconnected. At this time, an arc is generated between the fixed contactor and the movable contactor, between which opening has occurred. The arc is transferred to the fixed-side arc runner and the movable-side arc runner which are respectively disposed upward of the fixed element and the movable element. Then, the arc is driven on the fixed-side and movable-side arc runners. The driven arc enters the arc extinguishing chamber, and an arc voltage equal to or higher than a power supply voltage is generated in the arc extinguishing chamber. Consequently, current is limited and interrupted, whereby the arc is extinguished.

[0003] An arc having a very high temperature generates hot gas having a high electrical conductivity. If the hot gas flows back to the interval between the fixed contactor and the movable contactor during a time taken until the arc is extinguished, an electrical conduction rate between the fixed contactor and the movable contactor becomes high, resulting in occurrence of a restrike in which an arc emerges again. If a restrike occurs, the arc voltage having been increased to be equal to or higher than the power supply voltage sharply drops to around 100 V. Consequently, the limitation is stopped, whereby interruption performance decreases. In addition, arc short circuit may continue to occur between the contactors, resulting in failure of the interruption. In particular, if interruption current increases, the generation amount of hot gas increases, whereby the probability that a restrike occurs increases. In this manner, backflow of hot gas causes: a problem that the interruption performance decreases, and an interrupt time is elongated; and a problem that the backflow leads to failure of interruption.

[0004] To solve these problems, a configuration in

which the cross-sectional area of an arc flow path inside an arc extinguishing chamber is increased toward a gas discharge port, has been disclosed (see, for example, Patent Document 1). This configuration makes it easy for hot gas to flow to an upper side of the arc extinguishing chamber, whereby hot gas discharge performance can be improved. The improvement in the gas discharge performance leads to inhibition of a restrike between a fixed contactor and a movable contactor, whereby high interruption performance can be obtained.

CITATION LIST

PATENT DOCUMENT

[0005] Patent Document 1: WO2016/088561

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] In the above Patent Document 1, hot gas easily flows to the upper side of the arc extinguishing chamber, whereby the hot gas discharge performance in the arc extinguishing chamber is improved. However, an arc needs to be retained at end positions of arc runners during a time taken until extinction of the arc in the arc extinguishing chamber is completed after the arc is driven to the end positions of the arc runners. This leads to occurrence of hot-gas backflow in which hot gas generated during the retaining heads for the interval between the fixed contactor and the movable contactor from the end positions of the arc runners. To prevent this backflow, each contactor and the end position of the corresponding arc runner need to be sufficiently separated from each other by lengthening an insulation distance. Consequently, a problem arises in that the sizes of the arc runners and the arc extinguishing chamber disposed upward of the arc runners, and furthermore, the size of the air circuit breaker, increase.

[0007] The present disclosure has been made to solve the aforementioned problem, and an object of the present disclosure is to obtain an air circuit breaker that allows inhibition of backflow of hot gas without increasing the size of the air circuit breaker.

SOLUTION TO THE PROBLEMS

[0008] An air circuit breaker according to the present disclosure includes: a fixed element having a fixed contactor; a movable element having a movable contactor which is disposed so as to be contactable with and separable from the fixed contactor; an arc extinguishing chamber which is disposed upward of the fixed element and the movable element so as to be apart from the fixed element and the movable element and in which an arc generated upon opening between the fixed contactor and the movable contactor is divided and extinguished; a

fixed-side arc runner which guides the arc to the arc extinguishing chamber and which has an end portion extending in a direction opposite to a direction toward the movable element, from the fixed element side between the fixed element and the arc extinguishing chamber; a movable-side arc runner which guides the arc to the arc extinguishing chamber and which has an end portion extending in a direction opposite to a direction toward the fixed element, from the movable element side between the movable element and the arc extinguishing chamber; and a mold frame enclosing the fixed element and the movable element beneath the arc extinguishing chamber and supporting the fixed element, the movable element, the fixed-side arc runner, and the movable-side arc runner. The mold frame includes: a fixed-side gas discharge passage through which a port provided in a side surface of the mold frame and a fixed-side gas discharge port provided in the mold frame so as to oppose the end portion of the fixed-side arc runner are in communication with each other and which is separated from the fixed element side by a fixed-side blocking wall which is a part of a wall enclosing the fixed element and the movable element; and a movable-side gas discharge passage through which a port provided in a side surface of the mold frame and a movable-side gas discharge port provided in the mold frame so as to oppose the end portion of the movable-side arc runner are in communication with each other and which is separated from the movable element side by a movable-side blocking wall which is a part of the wall enclosing the fixed element and the movable element.

EFFECT OF THE INVENTION

[0009] The air circuit breaker according to the present disclosure allows inhibition of backflow of hot gas without increasing the size of the air circuit breaker.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

[FIG. 1] FIG. 1 is a cross-sectional view showing a schematic configuration of an air circuit breaker according to embodiment 1 in a closed state.

[FIG. 2] FIG. 2 is a cross-sectional view showing a schematic configuration of the air circuit breaker according to embodiment 1 in an opened state, and movement of an arc.

[FIG. 3] FIG. 3 is a perspective view showing a schematic configuration of a part of the air circuit breaker according to embodiment 1.

[FIG. 4] FIG. 4 is a perspective cross-sectional view showing the schematic configuration of the part of the air circuit breaker according to embodiment 1.

[FIG. 5] FIG. 5 is a perspective view showing a schematic configuration of a mold frame of the air circuit breaker according to embodiment 1.

[FIG. 6] FIG. 6 is a cross-sectional view of the air circuit breaker according to embodiment 1, showing the flows of hot gases.

[FIG. 7] FIG. 7 is a cross-sectional view at an alternate long and short dash line A-A in FIG. 6.

[FIG. 8] FIG. 8 is a perspective view showing a schematic configuration of a part of an air circuit breaker according to embodiment 1.

[FIG. 9] FIG. 9 is a cross-sectional view of the air circuit breaker according to embodiment 1, showing the flows of hot gases.

[FIG. 10] FIG. 10 is a perspective view showing a schematic configuration of a part of an air circuit breaker according to embodiment 2.

[FIG. 11] FIG. 11 is a perspective view showing a schematic configuration of a mold frame of the air circuit breaker according to embodiment 2.

[FIG. 12] FIG. 12 is a cross-sectional view of the air circuit breaker according to embodiment 2, showing the flows of hot gases.

[FIG. 13] FIG. 13 is a cross-sectional view at an alternate long and short dash line B-B in FIG. 12.

[FIG. 14] FIG. 14 is a perspective view showing a schematic configuration of a part of an air circuit breaker according to embodiment 3.

[FIG. 15] FIG. 15 is a perspective cross-sectional view showing the schematic configuration of the part of the air circuit breaker according to embodiment 3.

[FIG. 16] FIG. 16 is a cross-sectional view of the air circuit breaker according to embodiment 3, showing the flows of hot gases.

[FIG. 17] FIG. 17 is a perspective view showing a schematic configuration of a part of an air circuit breaker according to embodiment 3.

[FIG. 18] FIG. 18 is a perspective view showing a schematic configuration of a divided mold frame of an air circuit breaker according to embodiment 4.

DESCRIPTION OF EMBODIMENTS

[0011] Hereinafter, air circuit breakers according to embodiments of the present disclosure will be described with reference to the drawings. Description will be given while the same or corresponding members and portions in the drawings are denoted by the same reference characters.

Embodiment 1

[0012] FIG. 1 is a cross-sectional view showing a schematic configuration of an air circuit breaker 100 in a closed state. FIG. 2 is a cross-sectional view showing a schematic configuration of the air circuit breaker 100 in an opened state, and movement of an arc. FIG. 3 is a perspective view showing a schematic configuration of a part of the air circuit breaker 100. FIG. 4 is a perspective cross-sectional view showing the schematic configuration of the part of the air circuit breaker 100. FIG. 5 is a

perspective view showing a schematic configuration of a mold frame 15 of the air circuit breaker 100. FIG. 3 and FIG. 4 do not show any arc extinguishing chamber 14 provided on an upper side of the air circuit breaker 100. The air circuit breaker 100 is used as a protective breaker for an electrical system or the like. When fault current flows during current conduction, the air circuit breaker 100 interrupts the current. Hereinafter, a configuration of the air circuit breaker 100 will be described.

[0013] The air circuit breaker 100 includes: a fixed element 2 having a fixed contactor 1; a movable element 4 having a movable contactor 3 which is disposed so as to be contactable with and separable from the fixed contactor 1; an arc extinguishing chamber 14 which is disposed upward of the fixed element 2 and the movable element 4 so as to be apart from the fixed element 2 and the movable element 4 and in which an arc 16 generated upon opening between the fixed contactor 1 and the movable contactor 3 is divided and extinguished; a fixed-side arc runner 10 which guides the arc 16 to the arc extinguishing chamber 14 and which has an end portion extending in a direction opposite to a direction toward the movable element 4, from the fixed element 2 side between the fixed element 2 and the arc extinguishing chamber 14; a movable-side arc runner 11 which guides the arc 16 to the arc extinguishing chamber 14 and which has an end portion extending in a direction opposite to a direction toward the fixed element 2, from the movable element 4 side between the movable element 4 and the arc extinguishing chamber 14; and the mold frame 15 supporting the fixed element 2, the movable element 4, the fixed-side arc runner 10, and the movable-side arc runner 11. The mold frame 15 is provided with: a closing actuator 5 joined to the movable element 4; an upper conductor 6 connected to the fixed element 2; a lower conductor 7 connected to the movable element 4; a detector 8 disposed on the lower conductor 7; and a latch 9 joined to the detector 8. Grids 12 having thin plate shapes and formed of a magnetic material, and insulating plates 13 supporting and insulating the grids 12, are stacked inside the arc extinguishing chamber 14. The grids 12 and the insulating plates 13 which are stacked, are disposed above each of the fixed-side arc runner 10 and the movable-side arc runner 11. The mold frame 15 is formed from, for example, a fiber-reinforced plastic (FRP) which is an unsaturated polyester resin reinforced with glass fiber. The mold frame 15 has therein a contactors-disposed space 18 and encloses the fixed element 2 and the movable element 4 beneath the arc extinguishing chamber 14.

[0014] The movable element 4 is movable in the lateral direction in FIG. 1 in conjunction with an operation of the closing actuator 5. The movable contactor 3 moved along with the movable element 4 comes into contact with the fixed contactor 1, to cause closing therebetween. Consequently, current is conducted through the upper conductor 6 and the lower conductor 7. When fault current flows during current conduction, the detector 8 detects

the fault current and is operated, and the latch 9 holding the movable element 4 is released. When the latch 9 is released, the fixed contactor 1 and the movable contactor 3 becomes apart from each other, and opening therebetween occurs. If opening occurs during current conduction, an arc 16 having a very high temperature is generated between the fixed contactor 1 and the movable contactor 3. FIG. 2 shows the generated arc 16 as an arc 16a having emerged. An arc voltage which is a voltage reverse to a power supply voltage of a circuit (not shown) connected to the air circuit breaker 100, is generated at the arc 16.

[0015] The arc 16 generates hot gas 17 having a high electrical conductivity. The hot gas 17 is diffused around the arc 16 and flows also to the arc extinguishing chamber 14. An example of the flows of hot gases 17 is indicated by broken-line arrows in FIG. 2. Then, the arc 16 jumps to the fixed-side arc runner 10 and the movable-side arc runner 11, to turn into a transferred arc 16b. Owing to the flows of the hot gases 17 and electromagnetic forces caused by currents flowing to the fixed-side arc runner 10 and the movable-side arc runner 11, the transferred arc 16b runs on the fixed-side arc runner 10 and the movable-side arc runner 11 in a direction toward the arc extinguishing chamber 14, to turn into a driven arc 16c. The arc 16 guided to the arc extinguishing chamber 14 moves in directions toward the grids 12 since electromagnetic forces are generated owing to biased magnetic fluxes of the grids 12. The arcs 16 having moved toward the grids 12 located upward are divided by the grids 12 provided separately on the left and right sides, to turn into divided arcs 16d. The arc voltage of each arc 16 kept in the divided state increases to be equal to or higher than the power supply voltage of the circuit. Thus, current is limited and interrupted, and the arc 16 is extinguished.

[0016] Gas discharge passages and blocking walls which are major parts of the present disclosure will be described. As shown in FIG. 5, the mold frame 15 includes a fixed-side gas discharge passage 21 and a movable-side gas discharge passage 22 as gas discharge passages through which hot gases 17 are discharged from a side surface 15a and a side surface 15b to the outside of the mold frame 15. In addition, the mold frame 15 further includes a fixed-side blocking wall 23 and a movable-side blocking wall 24 as blocking walls for inhibiting hot gases 17 from flowing back from the fixed-side gas discharge passage 21 and the movable-side gas discharge passage 22 in directions toward the contactors-disposed space 18.

[0017] Arrangement of the gas discharge passages and the blocking walls will be described. As shown in FIG. 3, the mold frame 15 further includes: a fixed-side gas discharge port 19 provided so as to oppose the end portion of the fixed-side arc runner 10; and a movable-side gas discharge port 20 provided so as to oppose the end portion of the movable-side arc runner 11. The distance between end side surfaces 10a of the fixed-side arc runner 10 is the width of the fixed-side arc runner 10.

The distance between end side surfaces 11a of the movable-side arc runner 11 is the width of the movable-side arc runner 11. The width of the fixed-side gas discharge port 19 opened in a direction of the width of the fixed-side arc runner 10 is larger than the width of the fixed-side arc runner 10. Likewise, the width of the movable-side gas discharge port 20 opened in a direction of the width of the movable-side arc runner 11 is larger than the width of the movable-side arc runner 11. The widths of the gas discharge ports are set to be larger than the widths of the respective arc runners in order to cause hot gases 17 generated from the divided arcs 16d to be efficiently discharged via these gas discharge ports to the outside. As shown in FIG. 5, the fixed-side gas discharge passage 21 allows two ports 15g respectively provided in the side surfaces 15a and 15b of the mold frame 15 and the fixed-side gas discharge port 19 to be in communication with each other, and is provided so as to be separated from the fixed element 2 side by the fixed-side blocking wall 23 which is a part of a wall enclosing the fixed element 2 and the movable element 4. The fixed-side gas discharge passage 21 penetrates both side surfaces (the side surface 15a and the side surface 15b), of the mold frame 15, which are parallel to a direction in which the movable contactor 3 is brought into contact with and separated from the fixed contactor 1. As shown in FIG. 5, the movable-side gas discharge passage 22 allows two ports 15g respectively provided in the side surfaces 15a and 15b of the mold frame 15 and the movable-side gas discharge port 20 to be in communication with each other, and is provided so as to be separated from the movable element 4 side by the movable-side blocking wall 24 which is a part of the wall enclosing the fixed element 2 and the movable element 4. The movable-side gas discharge passage 22 penetrates both side surfaces (the side surface 15a and the side surface 15b), of the mold frame 15, which are parallel to the direction in which the movable contactor 3 is brought into contact with and separated from the fixed contactor 1.

[0018] The flows of hot gases 17 will be described. FIG. 6 is a cross-sectional view of the air circuit breaker 100, showing the flows of hot gases 17. FIG. 7 is a cross-sectional view at an alternate long and short dash line A-A in FIG. 6. FIG. 6 shows the flows of hot gases 17 when the arc 16 is retained at the position of each divided arc 16d, and shows a cross section of the air circuit breaker 100, excluding the arc extinguishing chamber 14. In FIG. 6, the flows of hot gases 17 inside the fixed-side gas discharge passage 21 and the movable-side gas discharge passage 22 are indicated by broken-line arrows 17a, and the flows of the other hot gases 17 are indicated by solid-line arrows 17b. In addition, the flows of hot gases 17 that would be generated if neither the fixed-side gas discharge port 19 nor the movable-side gas discharge port 20 were present, are indicated by broken-line arrows 17c as a comparative example. The hot gases 17 are generated from the divided arcs 16d and diffused around the arcs. If neither the fixed-side gas discharge

port 19 nor the movable-side gas discharge port 20 were present, the hot gases 17 could not enter either of the fixed-side gas discharge passage 21 and the movable-side gas discharge passage 22. Consequently, as indicated by the solid-line arrows 17b and the broken-line arrows 17c, the hot gases 17 would be diffused around the arcs, whereby a large amount of the hot gases 17 would head for the contactors-disposed space 18. Thus, a part of the hot gases 17 would flow back to the interval between the fixed contactor 1 and the movable contactor 3.

[0019] Meanwhile, hot gases 17 generated in directions toward the end side surfaces 10a of the fixed-side arc runner 10 from the corresponding divided arc 16d, enter the fixed-side gas discharge passage 21 from the fixed-side gas discharge port 19 and are, as indicated by the broken-line arrows 17a, discharged from the side surface 15a and the side surface 15b of the mold frame 15. Likewise, hot gases 17 generated in directions toward the end side surfaces 11a of the movable-side arc runner 11 from the corresponding divided arc 16d, enter the movable-side gas discharge passage 22 from the movable-side gas discharge port 20 and are discharged from the side surface 15a and the side surface 15b of the mold frame 15. As shown in FIG. 7, the fixed-side blocking wall 23 and the movable-side blocking wall 24 are included, and thus the hot gases 17 having entered the fixed-side gas discharge passage 21 and the movable-side gas discharge passage 22 are prevented from flowing back to the interval between the fixed contactor 1 and the movable contactor 3.

[0020] It is noted that, although the fixed-side gas discharge passage 21 and the movable-side gas discharge passage 22 are provided so as to penetrate the side surface 15a and the side surface 15b, the present disclosure is not limited thereto. For example, as shown in FIG. 8 and FIG. 9, ports 15g leading to the outside of the fixed-side gas discharge passage 21 and the movable-side gas discharge passage 22 may be provided in a side surface 15c and a side surface 15d. Since there is also a case where the places at which hot gases 17 are discharged are restricted according to the external environment of the place at which the air circuit breaker 100 has been installed, the places at which hot gases 17 are discharged may be arbitrarily set on side surfaces of the mold frame 15. In addition, although the two ports 15g are provided so as to be in communication with the fixed-side gas discharge port 19 or the movable-side gas discharge port 20 in the present embodiment, the present disclosure is not limited thereto, and the number of the ports 15g may be any number equal to or more than one.

[0021] As described above, the air circuit breaker 100 includes: the fixed-side gas discharge passage 21 which is in communication with the fixed-side gas discharge port 19 provided in the mold frame 15 so as to oppose the end portion of the fixed-side arc runner 10, and which penetrates the side surfaces 15a and 15b of the mold frame 15; and the movable-side gas discharge passage

22 which is in communication with the movable-side gas discharge port 20 provided in the mold frame 15 so as to oppose the end portion of the movable-side arc runner 11, and which penetrates the side surfaces 15a and 15b of the mold frame 15. These gas discharge passages allow hot gases 17 to be discharged to the outside of the mold frame 15. Consequently, the hot gases 17 can be inhibited from flowing back to the interval between the fixed contactor 1 and the movable contactor 3 without increasing the size of the air circuit breaker 100. In addition, since the fixed-side blocking wall 23 separating the fixed-side gas discharge passage 21 from the fixed element 2 side and the movable-side blocking wall 24 separating the movable-side gas discharge passage 22 from the movable element 4 side are included, hot gases 17 having entered the fixed-side gas discharge passage 21 and the movable-side gas discharge passage 22 can be prevented from flowing back to the interval between the fixed contactor 1 and the movable contactor 3. In addition, since the backflow of the hot gases 17 can be inhibited, high interruption performance can be obtained. In addition, if the fixed-side gas discharge passage 21 and the movable-side gas discharge passage 22 are provided perpendicularly to the side surface 15a and the side surface 15b so as to penetrate both side surfaces, of the mold frame 15, which are parallel to the direction in which the movable contactor 3 is brought into contact with and separated from the fixed contactor 1, the mold frame 15 can be produced with only a simple mold at the time of production of the mold frame 15 by molding.

Embodiment 2

[0022] An air circuit breaker 100 according to embodiment 2 will be described. FIG. 10 is a perspective view showing a schematic configuration of a part of the air circuit breaker 100. FIG. 11 is a perspective view showing a schematic configuration of a mold frame 15 of the air circuit breaker 100. In the air circuit breaker 100 according to embodiment 2, a fixed-side blocking wall 23 and a movable-side blocking wall 24 have configurations different from those in embodiment 1.

[0023] The fixed-side blocking wall 23 is tilted in a direction toward the end portion of the fixed-side arc runner 10 from the fixed element 2 side and the movable-side blocking wall 24 is tilted in a direction toward the end portion of the movable-side arc runner 11 from the movable element 4 side, such that the gap between the fixed-side blocking wall 23 and the movable-side blocking wall 24 is broadened in the direction toward the arc extinguishing chamber 14. An angle between the fixed-side blocking wall 23 and a bottom surface 21a of the fixed-side gas discharge passage 21 and an angle between the movable-side blocking wall 24 and a bottom surface 22a of the movable-side gas discharge passage 22, are formed as acute angles as shown in FIG. 11. Ports 15g leading to the outside of the fixed-side gas discharge passage 21 and the movable-side gas discharge pas-

sage 22 have trapezoidal shapes, and the area of each port 15g is larger than that in embodiment 1. Thus, hot gases 17 are more easily discharged. As shown in FIG. 10, the fixed-side gas discharge passage 21 and the fixed-side gas discharge port 19 provided in the mold frame 15 so as to oppose the end portion of the fixed-side arc runner 10 are in communication with each other, and the movable-side gas discharge passage 22 and the movable-side gas discharge port 20 provided in the mold frame 15 so as to oppose the end portion of the movable-side arc runner 11 are in communication with each other.

[0024] The flows of hot gases 17 will be described. FIG. 12 is a cross-sectional view of the air circuit breaker 100, showing the flows of hot gases 17. FIG. 13 is a cross-sectional view taken at an alternate long and short dash line B-B in FIG. 12. FIG. 12 shows the flows of hot gases 17 generated from the transferred arc 16b, and shows a cross section of the air circuit breaker 100, excluding the arc extinguishing chamber 14. In addition, in the drawings, the flows of the hot gases 17 are indicated by solid-line arrows 17b. Since the hot gases 17 have very high electrical conductivities, the arc 16 tends to be driven along with the flows of the hot gases 17. If the hot gases 17 smoothly flow from near the fixed contactor 1 and the movable contactor 3 to the end portions of the fixed-side arc runner 10 and the movable-side arc runner 11, the arc 16 is smoothly driven in the direction toward the arc extinguishing chamber 14 without any restrike. If the fixed-side blocking wall 23 and the movable-side blocking wall 24 are provided perpendicularly to a bottom surface for installation, the flows of parts of the hot gases 17 are blocked or pushed back by the fixed-side blocking wall 23 and the movable-side blocking wall 24, whereby the flows of the hot gases 17 toward the arc runners might be restricted. Meanwhile, as shown in FIG. 13, since the fixed-side blocking wall 23 and the movable-side blocking wall 24 are tilted to attain the broadening in the direction toward the arc extinguishing chamber 14, the flows of the hot gases 17 are not restricted by the fixed-side blocking wall 23 or the movable-side blocking wall 24. As shown in FIG. 12, the hot gases 17 flow along the solid-line arrows 17b to the end portions of the fixed-side arc runner 10 and the movable-side arc runner 11. Thus, a restrike of an arc 16 is inhibited, and the arc 16 is smoothly driven in the direction toward the arc extinguishing chamber 14.

[0025] As described above, the fixed-side blocking wall 23 is tilted in the direction toward the end portion of the fixed-side arc runner 10 from the fixed element 2 side, and the movable-side blocking wall 24 is tilted in the direction toward the end portion of the movable-side arc runner 11 from the movable element 4 side. Consequently, hot gases 17 smoothly flow from near the fixed contactor 1 and the movable contactor 3 to the end portions of the fixed-side arc runner 10 and the movable-side arc runner 11. Thus, a restrike of an arc 16 can be inhibited, and the arc 16 can be smoothly driven in the direction toward the arc extinguishing chamber 14. In addition, hot

gases 17 can be inhibited from flowing back to the interval between the fixed contactor 1 and the movable contactor 3.

Embodiment 3

[0026] An air circuit breaker 100 according to embodiment 3 will be described. FIG. 14 is a perspective view showing a schematic configuration of a part of the air circuit breaker 100. FIG. 15 is a perspective cross-sectional view showing the schematic configuration of the part of the air circuit breaker 100. The air circuit breaker 100 according to embodiment 3 has a configuration further including fixed-side hot gas discharge passages 25 and movable-side hot gas discharge passages 26 in addition to the components in embodiment 2.

[0027] The air circuit breaker 100 further includes: the fixed-side hot gas discharge passages 25 penetrating, along a surface of the fixed-side blocking wall 23 formed on the fixed element 2 side, to the respective side surfaces 15a and 15b of the mold frame 15 opposing each other; and the movable-side hot gas discharge passages 26 penetrating, along a surface of the movable-side blocking wall 24 formed on the movable element 4 side, to the respective side surfaces 15a and 15b of the mold frame 15 opposing each other.

[0028] The flows of hot gases 17 will be described. FIG. 16 is a cross-sectional view of the air circuit breaker 100, showing the flows of hot gases 17. FIG. 16 shows a cross section of the air circuit breaker 100, excluding the arc extinguishing chamber 14. FIG. 16 shows the flows of hot gases 17 generated from the transferred arc 16b. In FIG. 16, the flows of hot gases 17 inside the fixed-side hot gas discharge passages 25 and the movable-side hot gas discharge passages 26 are indicated by broken-line arrows 17a, and the flows of the other hot gases 17 are indicated by solid-line arrows 17b. When a high-current arc is generated upon opening between the fixed contactor 1 and the movable contactor 3, a large amount of hot gases 17 are generated so that the contactors-disposed space 18 is filled with the hot gases 17. If the hot gases 17 remain in the contactors-disposed space 18, the inside of the contactors-disposed space 18 is kept in a state where an electrical conduction rate is high. Therefore, the arc 16 is not smoothly driven in the direction toward the arc extinguishing chamber 14, whereby interruption might fail. Meanwhile, as shown in FIG. 16, since the fixed-side hot gas discharge passages 25 and the movable-side hot gas discharge passages 26 leading to the outside of the mold frame 15 from the contactors-disposed space 18 are provided, hot gases 17 are discharged to the outside of the mold frame 15 without remaining in the contactors-disposed space 18. In addition, hot gases 17 flow to the end portions of the fixed-side arc runner 10 and the movable-side arc runner 11, and thus stagnation of the arc 16 in the contactors-disposed space 18 is inhibited, whereby high interruption performance is obtained.

[0029] It is noted that, although a configuration in which the fixed-side hot gas discharge passages 25 and the movable-side hot gas discharge passages 26 are provided in addition to the components in embodiment 2 has been described, the present disclosure is not limited thereto. As shown in FIG. 17, the fixed-side hot gas discharge passages 25 and the movable-side hot gas discharge passages 26 may be provided in addition to the components in embodiment 1. By providing the fixed-side hot gas discharge passages 25 and the movable-side hot gas discharge passages 26, hot gases 17 are discharged from the fixed-side hot gas discharge passages 25 and the movable-side hot gas discharge passages 26. This discharge leads to mitigation of the restriction imposed on the flows of hot gases 17 by the fixed-side blocking wall 23 and the movable-side blocking wall 24 which are perpendicularly disposed.

[0030] As described above, this air circuit breaker 100 further includes the fixed-side hot gas discharge passages 25 and the movable-side hot gas discharge passages 26 penetrating to the respective side surfaces 15a and 15b of the mold frame 15 opposing each other. Thus, hot gases 17 do not remain in the contactors-disposed space 18, and stagnation of the arc 16 in the contactors-disposed space 18 is inhibited, whereby high interruption performance can be obtained. In addition, hot gases 17 can be inhibited from flowing back to the interval between the fixed contactor 1 and the movable contactor 3.

Embodiment 4

[0031] An air circuit breaker 100 according to embodiment 4 will be described. FIG. 18 is a perspective view showing a schematic configuration of a divided mold frame 15 of the air circuit breaker 100. The air circuit breaker 100 according to embodiment 4 has a configuration in which the mold frame 15 is divided into two frames.

[0032] The mold frame 15 is formed by combining a first frame 15e and a second frame 15f. The mold frame 15 is divided into the first frame 15e and the second frame 15f at a center plane, of the mold frame 15, which is a plane parallel to the direction in which the movable contactor 3 is brought into contact with and separated from the fixed contactor 1. Each of the first frame 15e and the second frame 15f is integrally formed of a resin material. The first frame 15e and the second frame 15f are attached to each other by means of fitting, screwing, or the like. Components of the air circuit breaker 100 that are provided in the mold frame 15 such as the fixed element 2 and the fixed-side arc runner 10, are attached to one frame out of the first frame 15e or the second frame 15f. Then, the other frame is attached to the one frame having the components attached thereto, whereby the air circuit breaker 100 is manufactured. This manner of manufacturing allows a working space for the manufacturing to be effectively used, whereby assemblability is improved. It is noted that the plane at which the mold frame 15 is

divided is not limited to the center plane and may be another plane as long as the plane allows the attaching of the components of the air circuit breaker 100.

[0033] As described above, in this air circuit breaker 100, the mold frame 15 is formed of the first frame 15e and the second frame 15f. Thus, the number of components of the mold frame 15 can be reduced. The mold frame 15 is divided at a plane parallel to the direction in which the movable contactor 3 is brought into contact with and separated from the fixed contactor 1, and the air circuit breaker 100 can be manufactured through attaching of the components to one of the frames. This allows a working space for the manufacturing to be effectively used, whereby assemblability is improved.

[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 technical scope of the specification 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 contactor	
2	fixed element	40
3	movable contactor	
4	movable element	
5	closing actuator	
6	upper conductor	
7	lower conductor	45
8	detector	
9	latch	
10	fixed-side arc runner	
11	movable-side arc runner	
12	grid	50
13	insulating plate	
14	arc extinguishing chamber	
15	mold frame	
15a	side surface	
15b	side surface	55
15c	side surface	
15d	side surface	
15e	first frame	

15f	second frame
15g	port
16	arc
16a	arc having emerged
5 16b	transferred arc
16c	driven arc
16d	divided arc
17	hot gas
18	contactors-disposed space
10 19	fixed-side gas discharge port
20	movable-side gas discharge port
21	fixed-side gas discharge passage
22	movable-side gas discharge passage
23	fixed-side blocking wall
15 24	movable-side blocking wall
25	fixed-side hot gas discharge passage
26	movable-side hot gas discharge passage
100	air circuit breaker

Claims

1. An air circuit breaker comprising:

25 a fixed element having a fixed contactor;
a movable element having a movable contactor
which is disposed so as to be contactable with
and separable from the fixed contactor;
an arc extinguishing chamber which is disposed
30 upward of the fixed element and the movable
element so as to be apart from the fixed element
and the movable element and in which an arc
generated upon opening between the fixed con-
tactor and the movable contactor is divided and
extinguished;
a fixed-side arc runner which guides the arc to
the arc extinguishing chamber and which has
an end portion extending in a direction opposite
40 to a direction toward the movable element, from
the fixed element side between the fixed ele-
ment and the arc extinguishing chamber;
a movable-side arc runner which guides the arc
to the arc extinguishing chamber and which has
an end portion extending in a direction opposite
45 to a direction toward the fixed element, from the
movable element side between the movable el-
ement and the arc extinguishing chamber; and
a mold frame enclosing the fixed element and
the movable element beneath the arc extin-
guishing chamber and supporting the fixed ele-
ment, the movable element, the fixed-side arc
runner, and the movable-side arc runner, where-
in
50 the mold frame includes

a fixed-side gas discharge passage through
which a port provided in a side surface of
the mold frame and a fixed-side gas dis-

charge port provided in the mold frame so as to oppose the end portion of the fixed-side arc runner are in communication with each other and which is separated from the fixed element side by a fixed-side blocking wall which is a part of a wall enclosing the fixed element and the movable element, and
 a movable-side gas discharge passage through which a port provided in a side surface of the mold frame and a movable-side gas discharge port provided in the mold frame so as to oppose the end portion of the movable-side arc runner are in communication with each other and which is separated from the movable element side by a movable-side blocking wall which is a part of the wall enclosing the fixed element and the movable element.

2. The air circuit breaker according to claim 1, wherein

the fixed-side blocking wall is tilted in a direction toward the end portion of the fixed-side arc runner from the fixed element side, and
 the movable-side blocking wall is tilted in a direction toward the end portion of the movable-side arc runner from the movable element side.

3. The air circuit breaker according to claim 1 or 2, further comprising:

fixed-side hot gas discharge passages penetrating, along a surface of the fixed-side blocking wall formed on the fixed element side, to respective side surfaces of the mold frame opposing each other; and
 movable-side hot gas discharge passages penetrating, along a surface of the movable-side blocking wall formed on the movable element side, to the respective side surfaces of the mold frame opposing each other.

4. The air circuit breaker according to any one of claims 1 to 3, wherein the mold frame is formed by combining a first frame and a second frame, and the mold frame is divided into the first frame and the second frame at a plane parallel to a direction in which the movable contactor is brought into contact with and separated from the fixed contactor.

FIG. 1

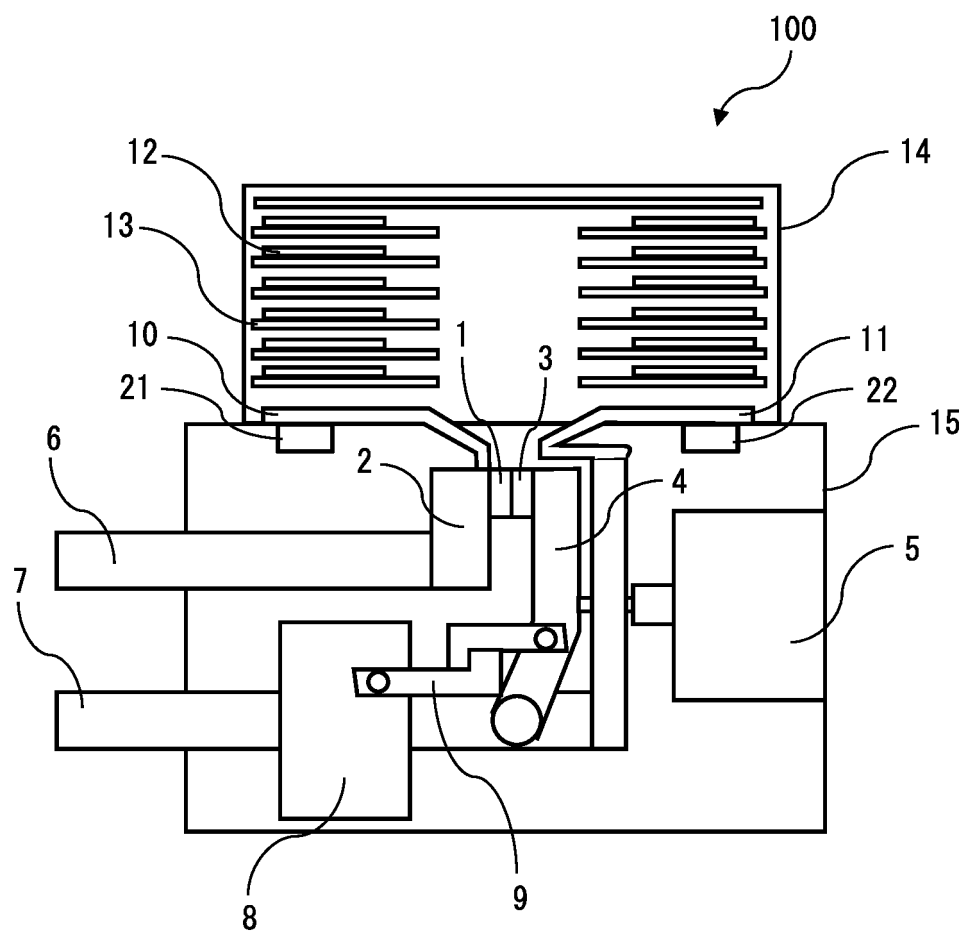


FIG. 2

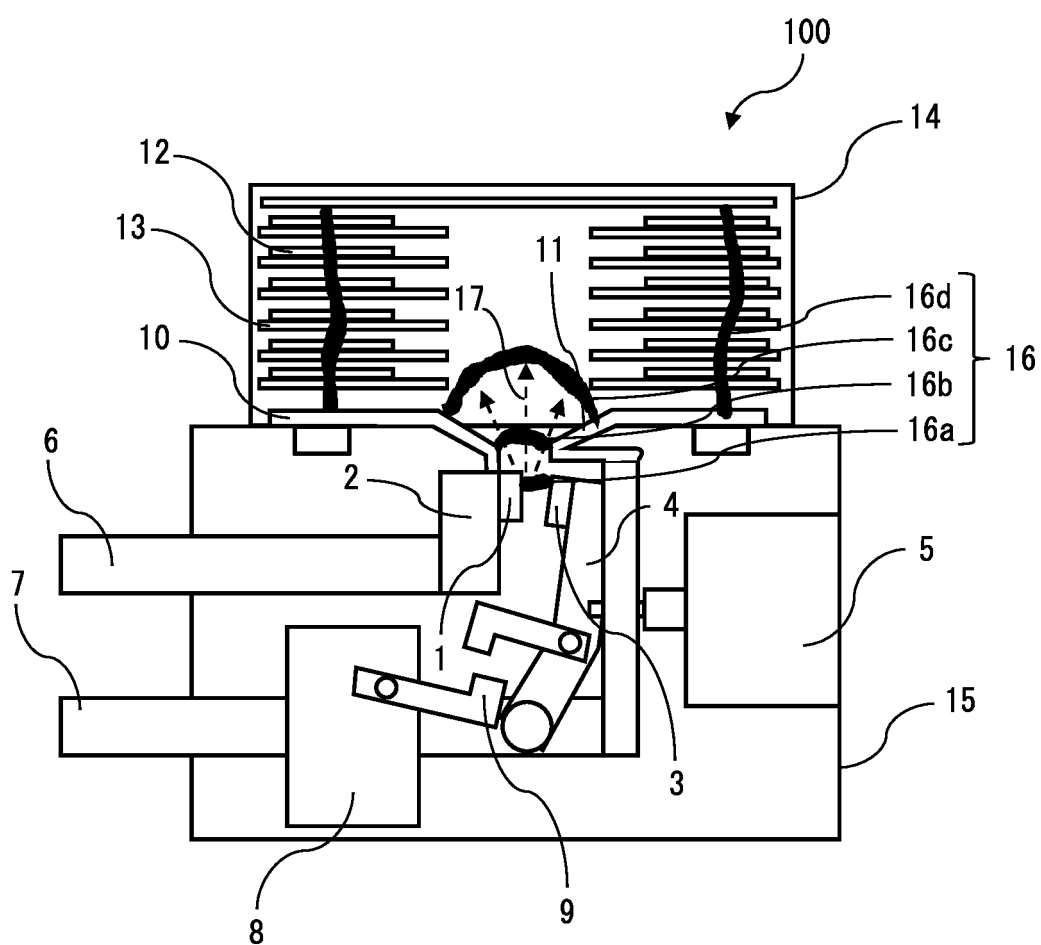


FIG. 3

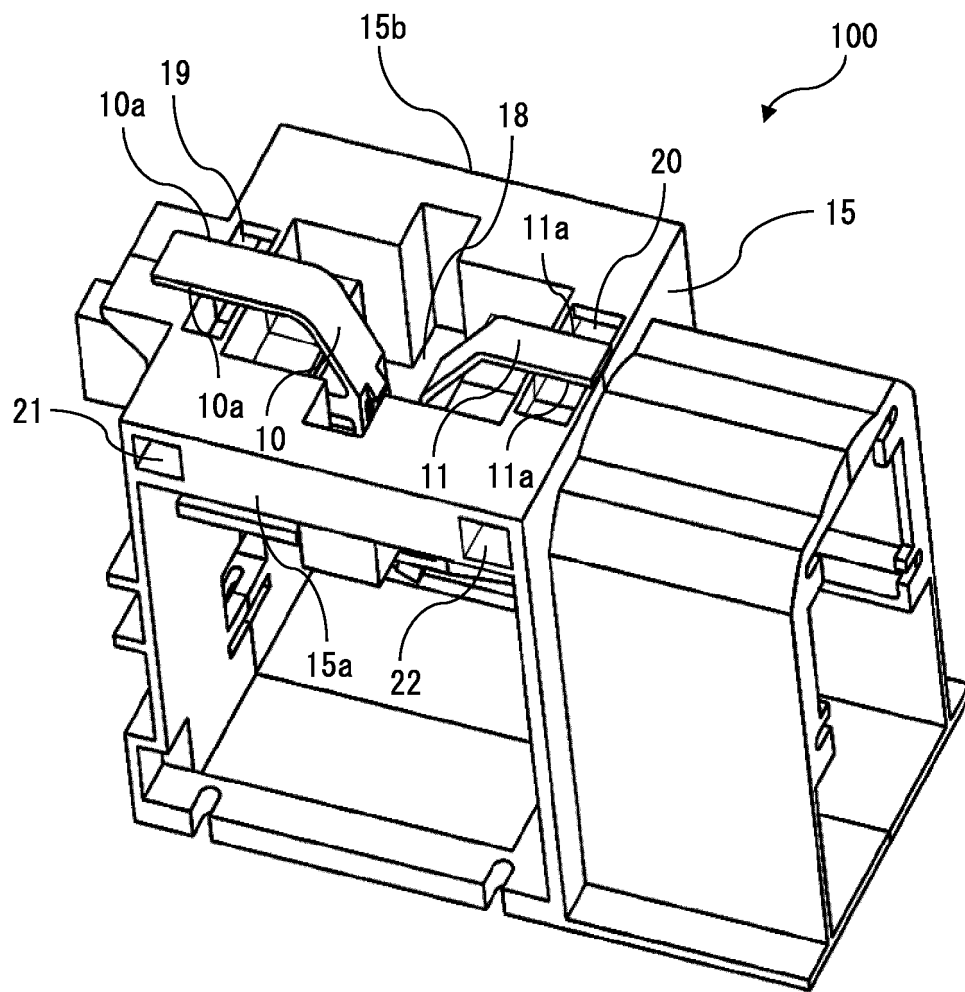


FIG. 4

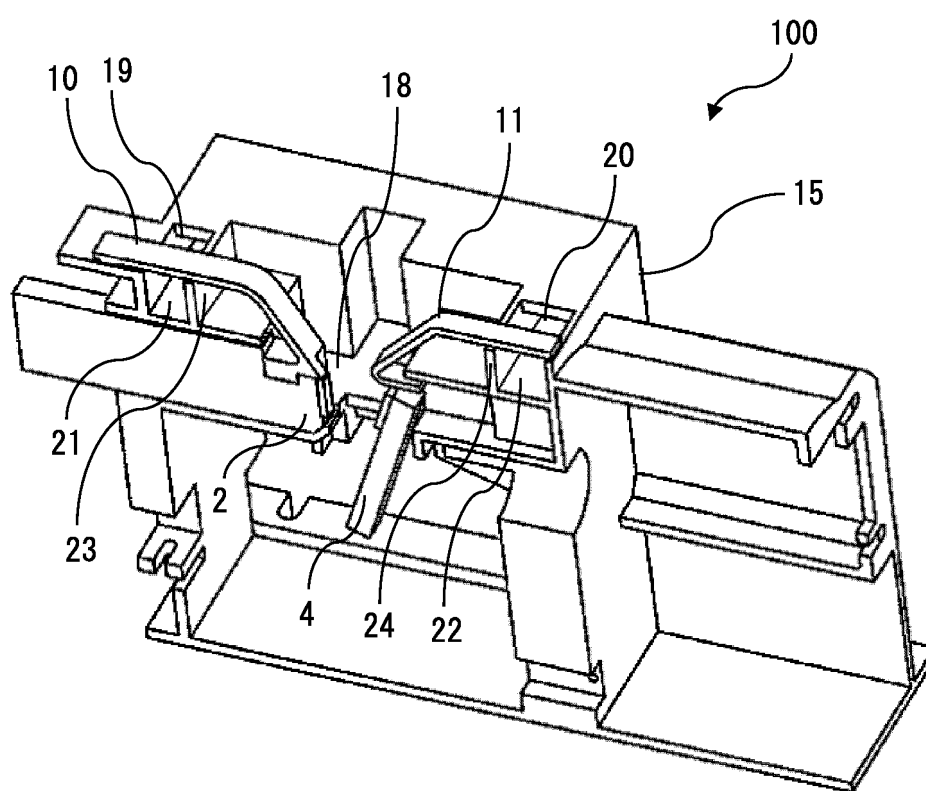


FIG. 5

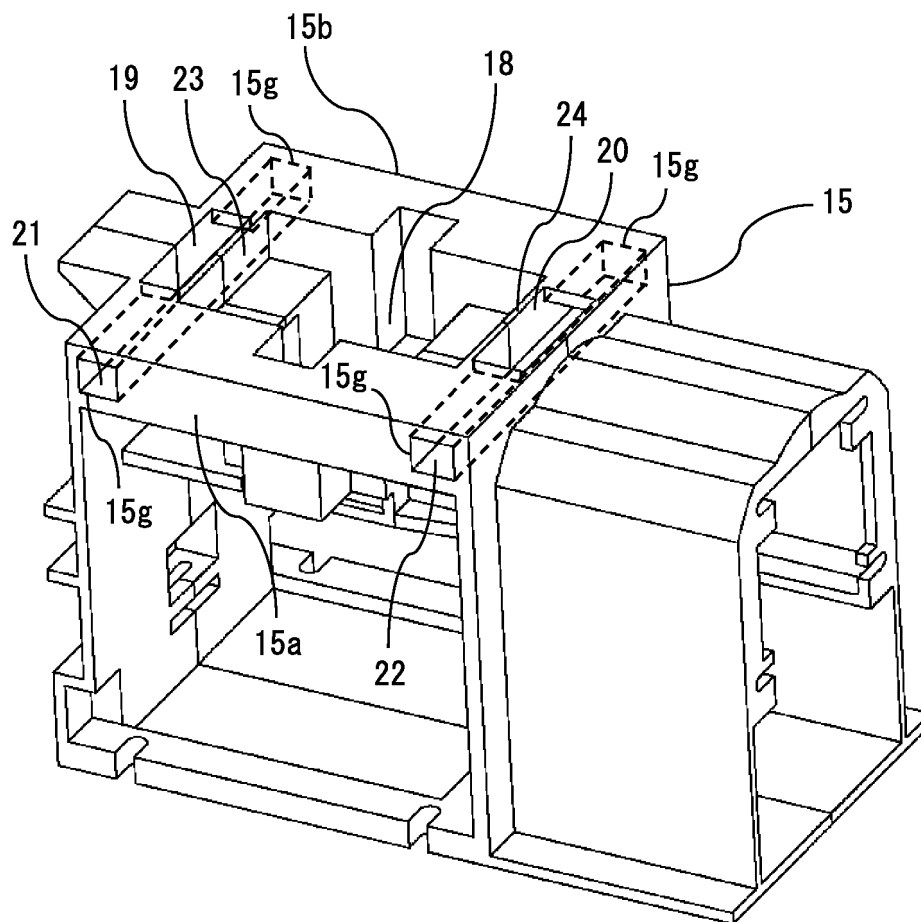


FIG. 6

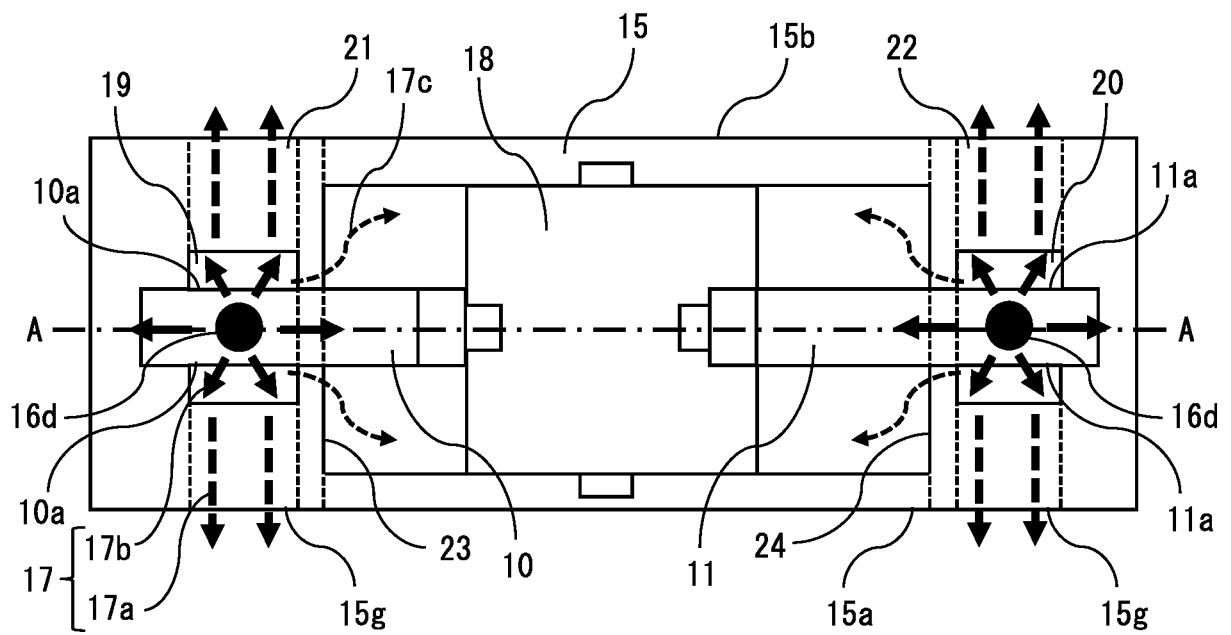


FIG. 7

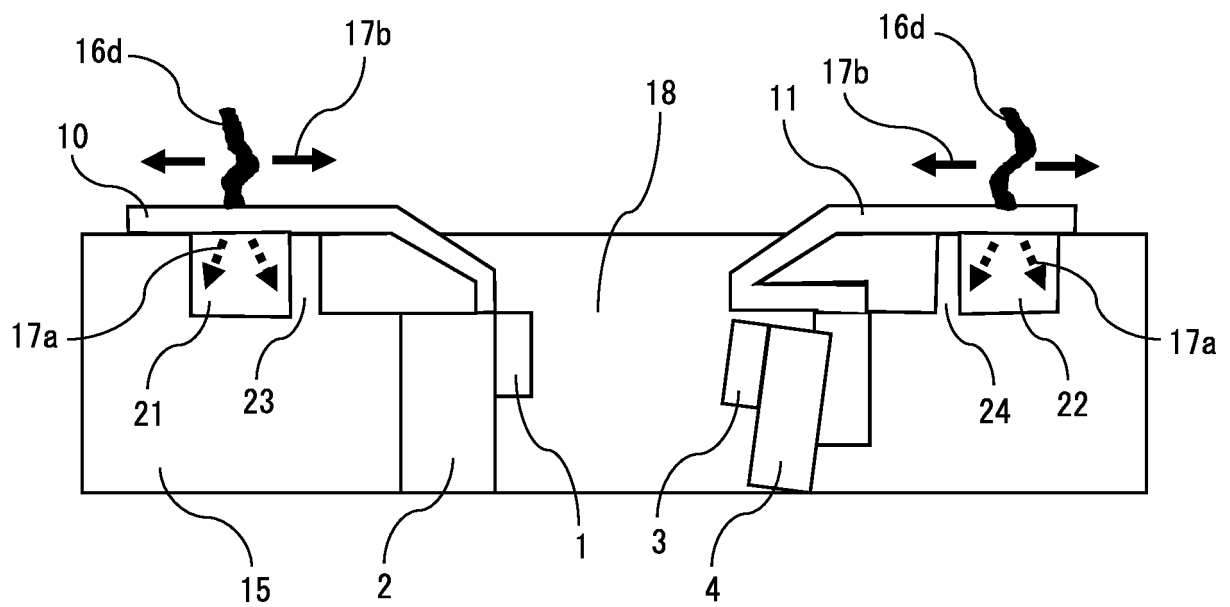


FIG. 8

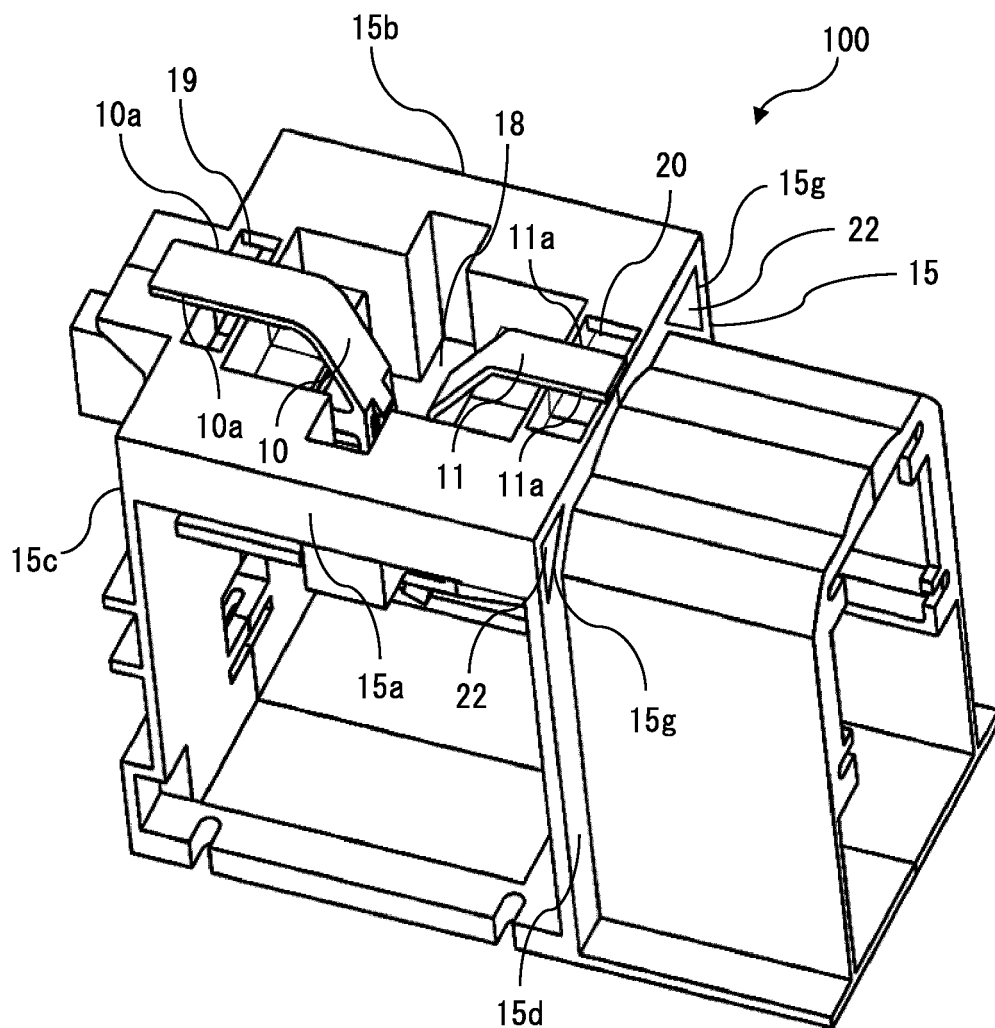


FIG. 9

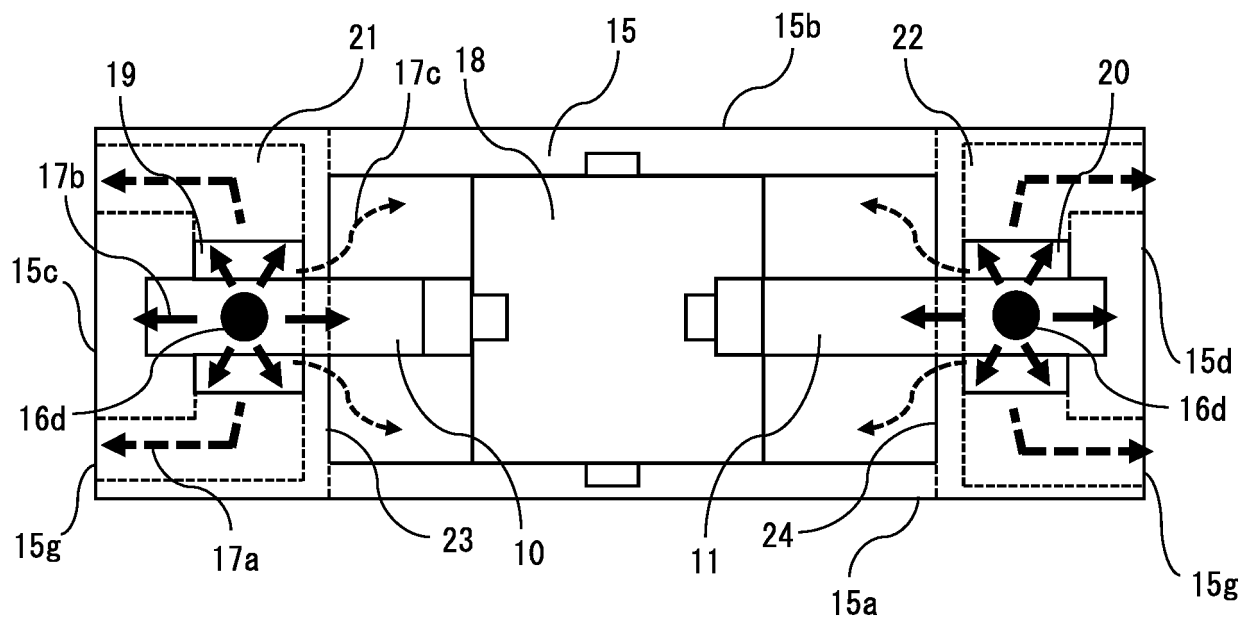


FIG. 10

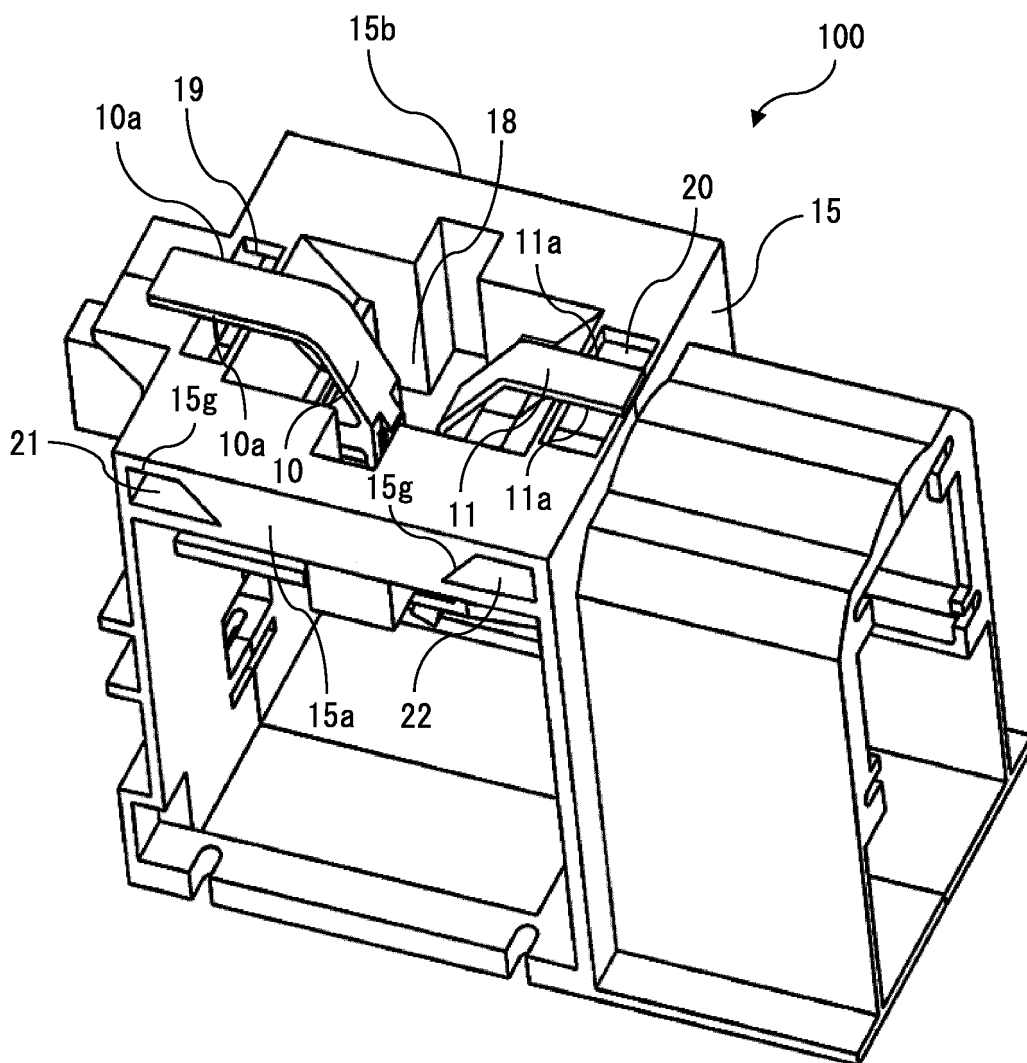


FIG. 11

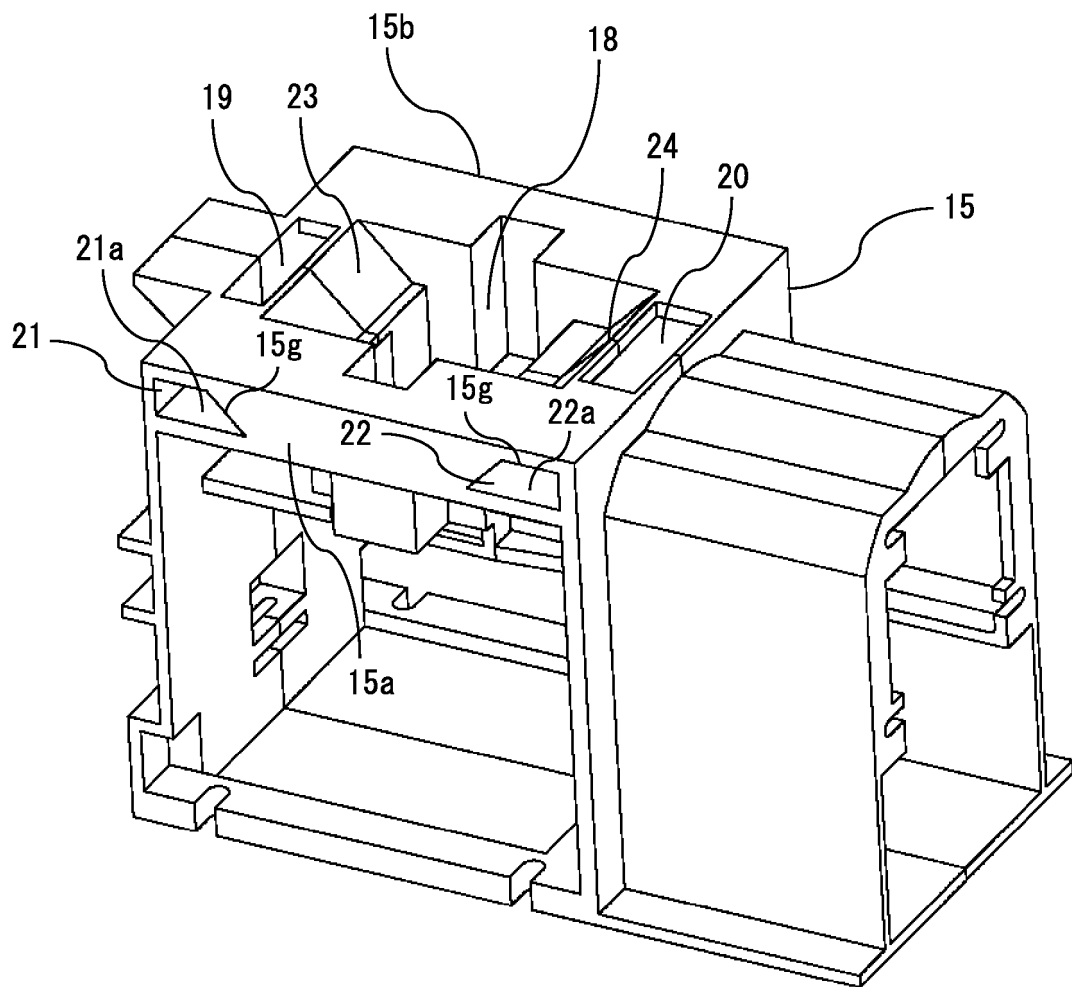


FIG. 12

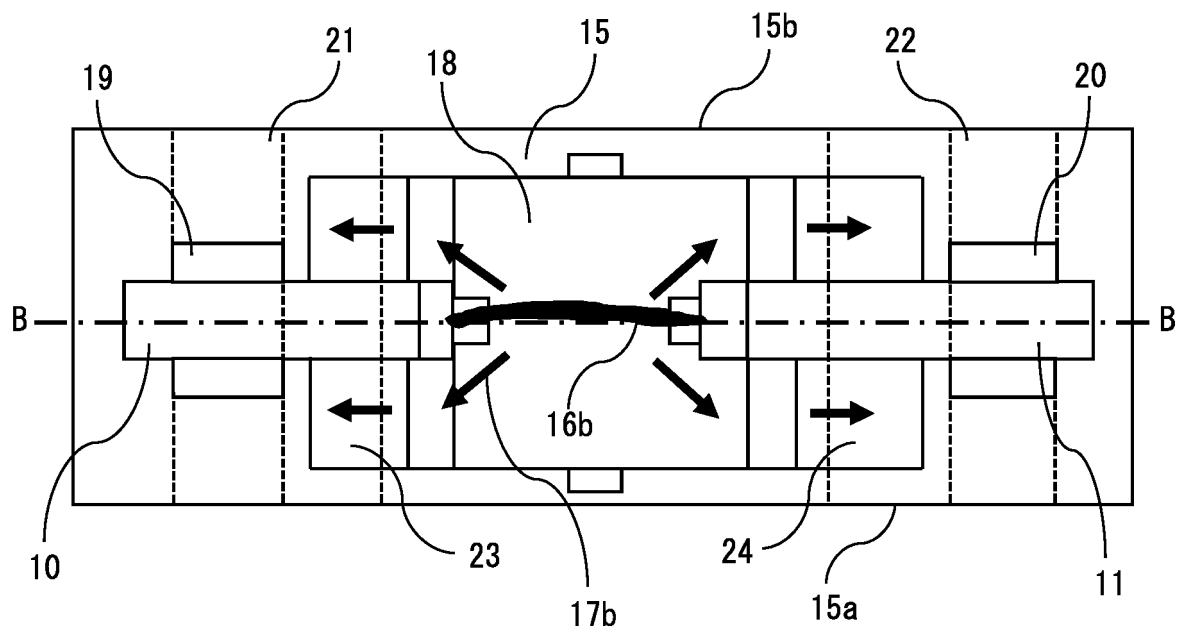


FIG. 13

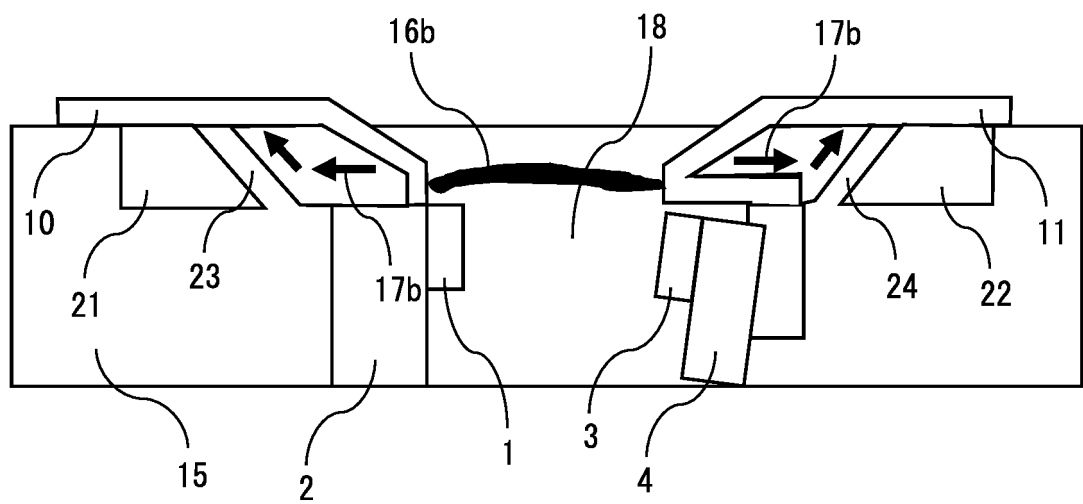


FIG. 14

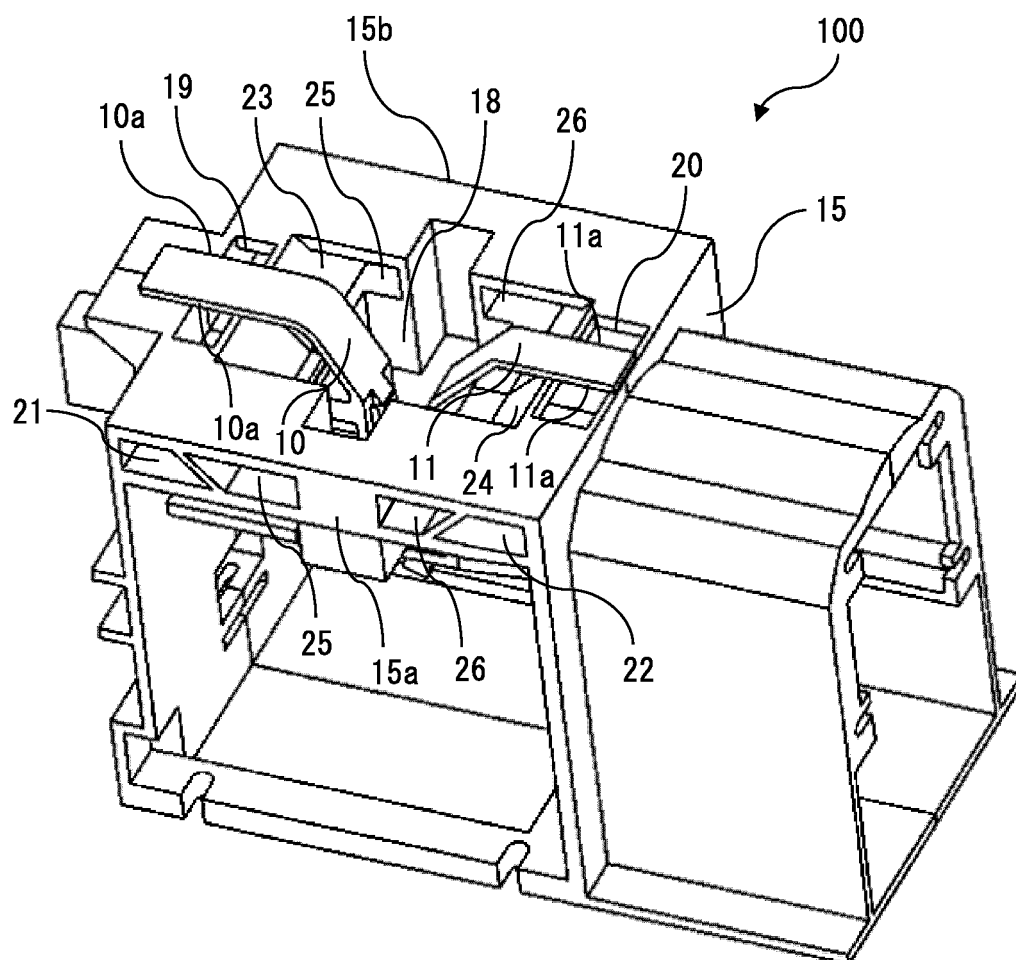


FIG. 15

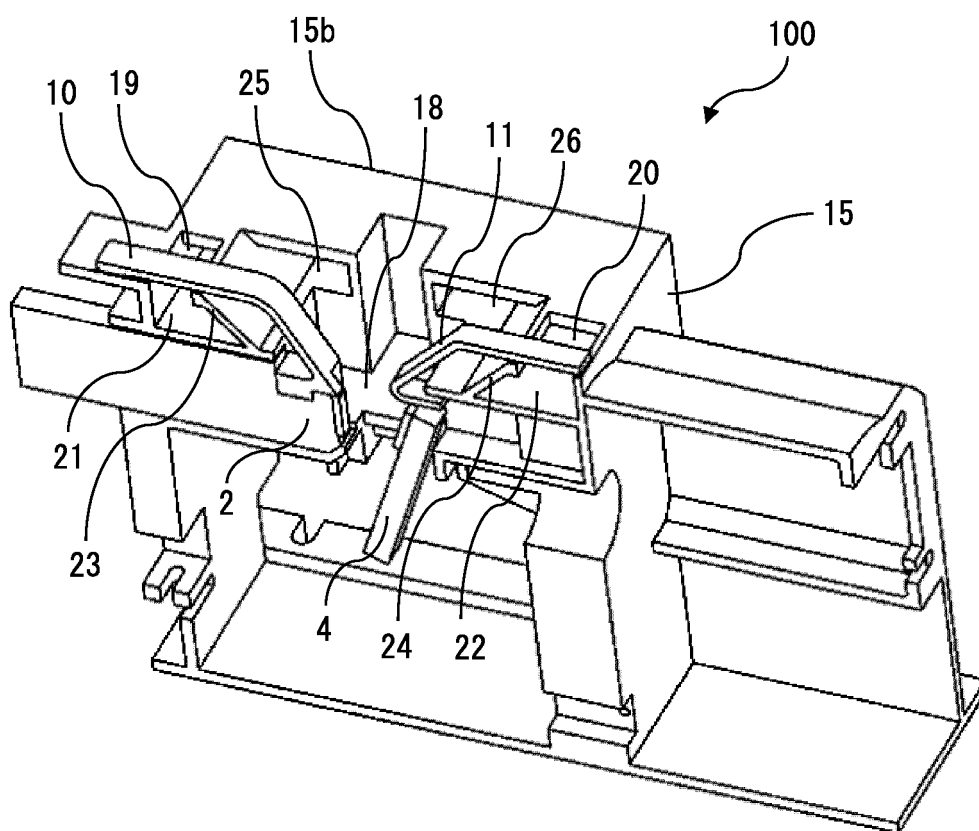


FIG. 16

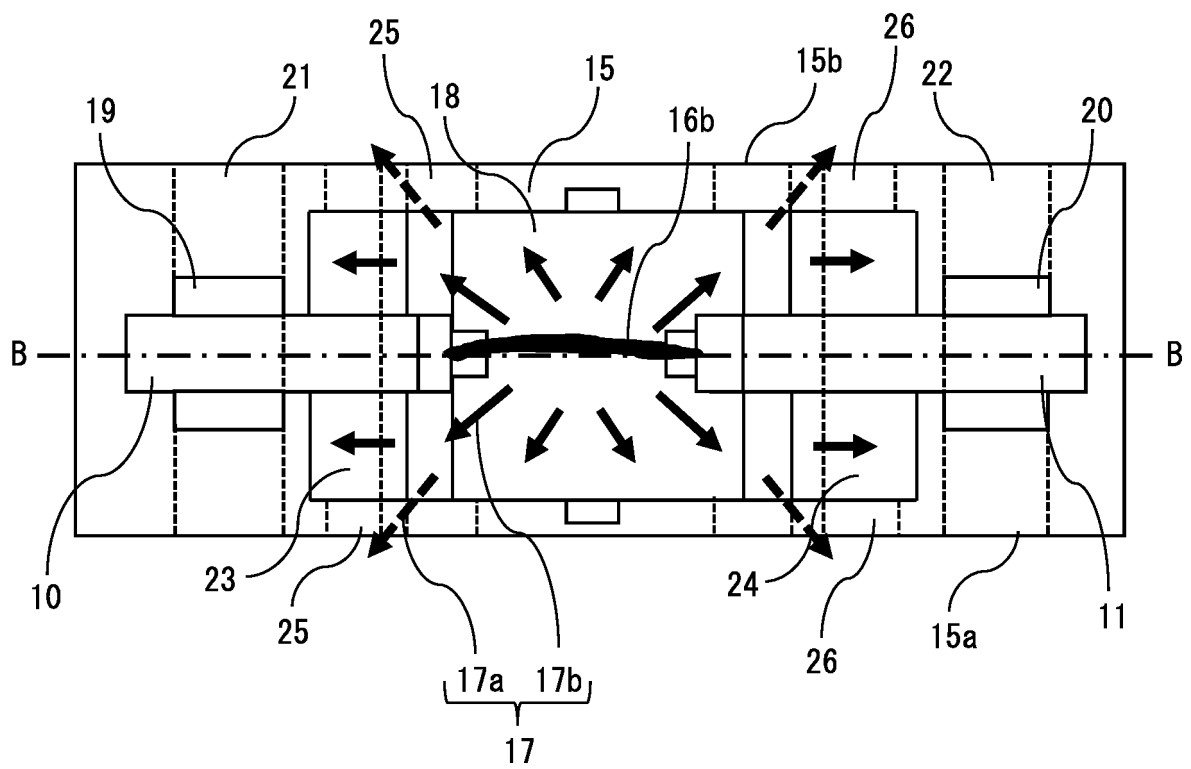


FIG. 17

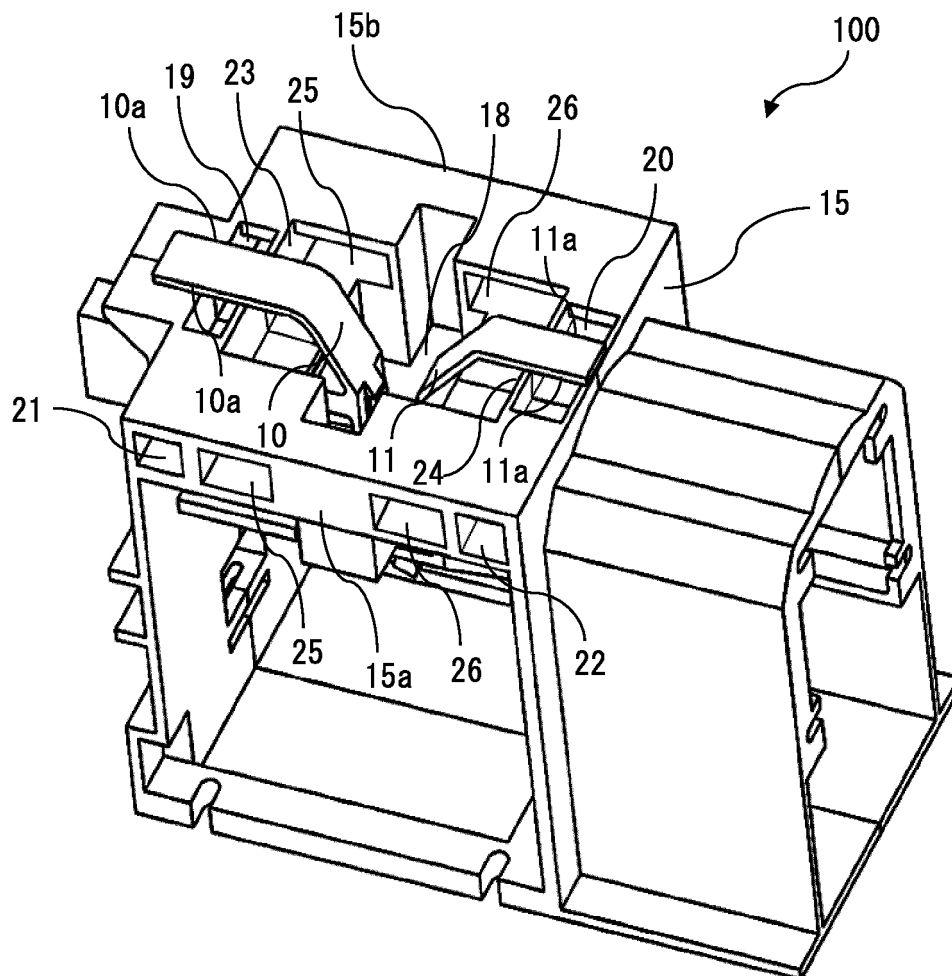
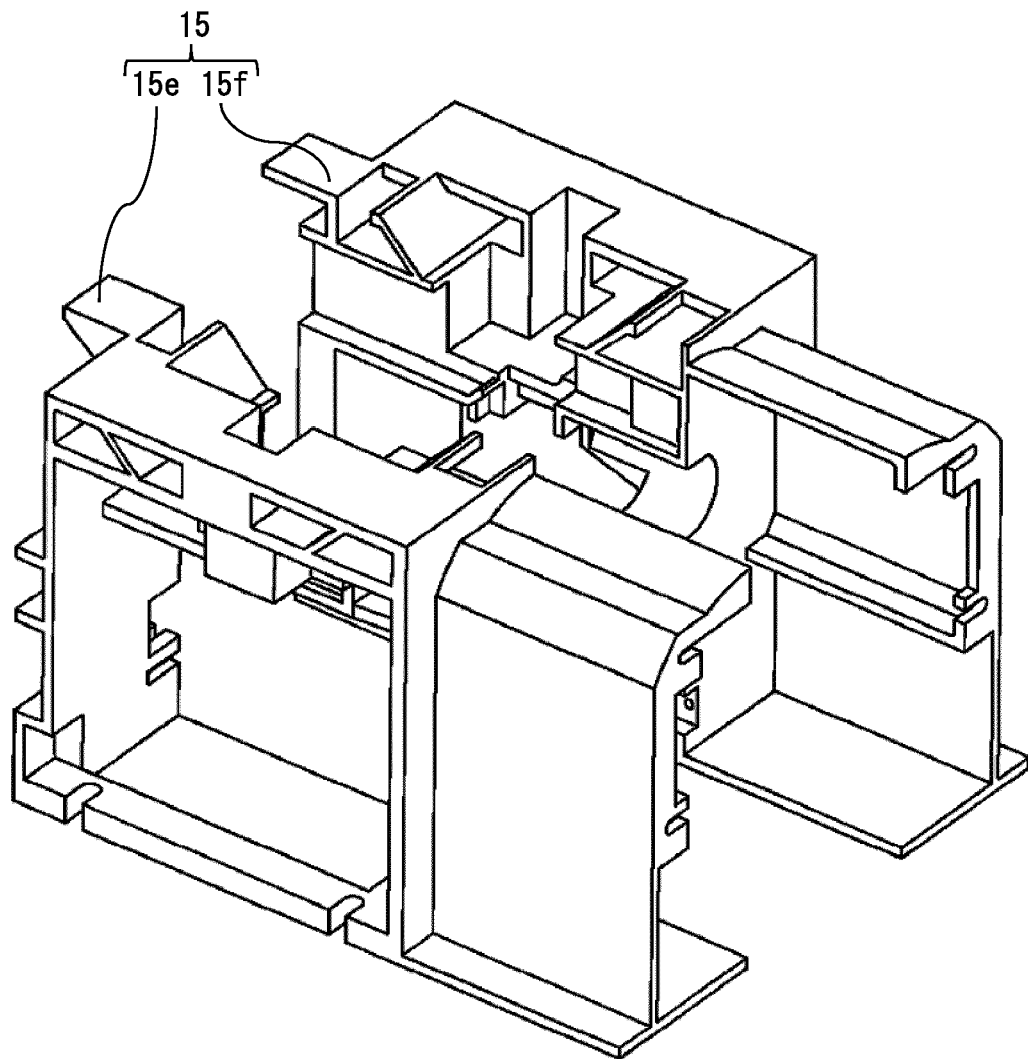


FIG. 18



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/019716

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H01H73/06 (2006.01) i, H01H73/18 (2006.01) i, H01H33/20 (2006.01) i
 FI: H01H73/06B, H01H73/18A, H01H33/20

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. H01H33/18-33/20, H01H71/00-83/22

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	WO 2016/088561 A1 (MITSUBISHI ELECTRIC CORPORATION) 09.06.2016 (2016-06-09), entire text, all drawings	1-4
A	WO 2017/183679 A1 (MITSUBISHI ELECTRIC CORPORATION) 26.10.2017 (2017-10-26), entire text, all drawings	1-4
A	JP 2017-103005 A (FUJI ELECTRIC CO., LTD.) 08.06.2017 (2017-06-08), entire text, all drawings	1-4

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

* Special categories of cited documents:	"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
27.07.2020

Date of mailing of the international search report
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.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No. PCT/JP2020/019716
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WO 2016/088561 A1	09.06.2016	EP 3229250 A1	entire text, all drawings
WO 2017/183679 A1	26.10.2017	EP 3447782 A1	entire text, all drawings
JP 2017-103005 A	08.06.2017	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2016088561 A [0005]