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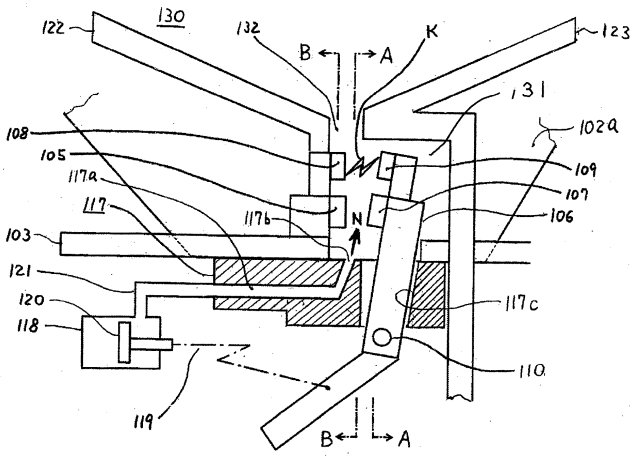
(54) CONTACTOR DEVICE FOR CIRCUIT BREAKER AND CIRCUIT BREAKER USING SAME CONTACTOR DEVICE

(57) A configuration such that there is an advantage in increasing external force working on an arc, and a shortening of commutation time is realized, is obtained with a simple configuration, and without an increase in size of a device.

An arc generating chamber configured of main contactors provided on a fixed side and a movable side, arc contactors provided on the fixed side and the movable side, and a side wall of an arc extinguishing chamber, is such that at least a side face and a bottom face are enclosed by an insulating wall, leaving an opening in a direction facing the arc extinguishing chamber.

FIG. 3



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Description

Technical Field

[0001] The present invention relates to a contactor device of a direct current high-speed circuit breaker used as, for example, a protective circuit breaker for an electric railroad substation, or the like, and in particular, relates to a contactor device such that an interruption time can be shortened by an arc generated between contactors being swiftly shifted to an arc chute.

Background Art

[0002] When a fault current occurs in an electrical circuit including a circuit breaker, shortening a time for which the fault current is interrupted is necessary in order to reduce damage caused by the fault current. In order to shorten the interruption time, it is necessary for a time at which current limiting starts to be brought forward by an arc generated between contactors being swiftly shifted to inside an arc chute (arc-extinguishing chamber), thereby shortening the interruption time.

[0003] An existing circuit breaker has a fixed contactor having a fixed contact, a movable contactor having a movable contact attachable to and detachable from the fixed contactor, and an arc chute that extinguishes an arc generated by the two contactors being opened, and furthermore, includes a pair of arc runners disposed neighboring one each of the fixed contact and the movable contact and shifting an arc from the contacts, and an arc horn disposed continuously with the two arc runners and shifting an arc to the arc chute while elongating the arc.

[0004] There is considerable demand for an improvement in interruption performance of a circuit breaker formed with this kind of basic configuration, and there is a proposal such that places in which a fixed contactor side arc runner and an arc horn and a movable contactor side arc runner and the arc horn are integrally formed and form resistance are as few as possible, whereby stable current interruption can be realized, as shown in, for example, Patent Document 1.

[0005] Also, as in Patent Document 2, there is a circuit breaker such that a tapered groove whose sectional area becomes gradually larger in an arc extinguishing chamber upper portion direction is provided in a shielding plate on both side faces of an arc contactor, whereby arc gas flows more easily in the arc extinguishing chamber upper portion direction, a flowing out of arc gas in a downward direction is restricted, and a ground fault and arc reignition are prevented.

[0006] Meanwhile, it is important in the case of a direct current high-speed breaker to secure not only large current interruption performance in response to a fault current, but also small current interruption performance, and necessary to realize a balance between the two. A direct current high-speed breaker is such that when an interrupting current is small, electromagnetic force of the circuit breaker caused by the interrupting current is small, because of which an arc driving force is weak, and interruption is difficult. Because of this, there is a need to forcibly blow air against an arc generated between contactors from an air nozzle, leading the arc inside an arc chute. By blowing air against the arc, thereby causing the arc to flow into an arc horn and elongating the arc, arc resistance is increased, and a shortening of an arcing time is achieved.

[0007] An air nozzle of an existing direct current high-speed circuit breaker is fabricated by carrying out plastic working on a metal tube. Air is blown from the air nozzle in conjunction with an operation of main contactors when contacts are opened, a piston inside an air cylinder is driven in a compressing direction, and air compressed thereby is blown from the air nozzle toward an arc, whereby a small current is reliably interrupted (for example, refer to Patent Document 3).

Citation List

Patent Literature

[0008]

Patent Document 1: JP-A-2014-216078
Patent Document 2: JP-A-2015-130277
Patent Document 3: Japanese Unexamined Utility Model Application Publication No. 2-18237

Summary of Invention

Technical Problem

[0009] Herein, the circuit breaker contactor device of Patent Document 1 is such that there is no structure that accelerates commutation, and no measure is taken for shortening an interruption time. Also, in order to carry out an acceleration of commutation with the existing contactor structure, it is necessary to apply a magnetic flux from the exterior or increase contact opening speed, and there is a problem in that the whole device increases in size.

[0010] Also, the circuit breaker contactor device of Patent Document 2 is such that although the structure promotes a flow of arc gas in the upper portion direction by a form of the shielding plate being redesigned, there is no mention of shortening commutation time by increasing an electromagnetic driving force of an arc in an arc runner direction.

[0011] Furthermore, a device in which the air nozzle of Patent Document 3 is used is such that as the air nozzle is made of metal, there is a possibility of foreign objects with a high conductivity rate, such as iron dust, generating from the air nozzle when interrupting being produced, and when these foreign objects encroach inside an arc space around the air nozzle and contactors, there is concern that a short-circuit between contacts or a ground

fault to the earth will be caused via the air nozzle, whose conductive portion is a conductor. Therefore, in order to prevent this, there is a need to secure a predetermined insulating distance between the metal air nozzle and the main contactors, which form a charging portion, and there is a problem in that an arc extinguishing device increases in size.

[0012] Also, in order to improve large current interruption performance, there is a need to shorten the time taken to cause an arc generated between the main contactors to flow to the arc horn, and to guide an arc gas flow in a vicinity of the main contactors so as to head in the direction of the arc chute above, but the ratio of air blown out from the air nozzle leaking to a side of or below the arc space around the air nozzle and the contactors is high, and an air gas flow heading in the direction of the arc chute above cannot be sufficiently obtained. Because of this, a large air cylinder that can maintain a predetermined amount of blown air is needed, particularly in order to provide small current interruption performance, and there is a problem in that the breaker is large.

[0013] When conducting an overall examination of methods for shortening interruption time, the following three methods are suggested.

[0014] A first method is a method whereby an arc is swiftly shifted to the arc runners and the arc chute by increasing the electromagnetic driving force in the arc runner direction of an arc generated between the contactors when the contacts are opened, whereby commutation time is shortened. An arc is an in-air electric discharge phenomenon, and as current is flowing, the arc receives a Lorentz force in a direction of an outer product of a current direction and a magnetic flux direction of the arc due to a magnetic field from the exterior. An arc that receives a Lorentz force moves in a direction in which the force works, starts a discharge in the arc runner that is the movement destination, shifts to the arc chute, and is subsequently extinguished. To date, a method whereby a permanent magnet, a main circuit current generating electromagnet, or the like, is provided in a vicinity of the contactors has been adopted as a method of applying a magnetic flux to an arc between the contactors, but there is a problem in that the device become complex.

[0015] A second method is a method whereby the gas flow from the contactors to the arc runners is improved. As an arc is of a high temperature, the arc has a property of melting and vaporizing an electrode and other peripheral structures while being generated. Therefore, when the contactors separate and an arc is generated during energization, pressure between the contactors increases due to the contactors being melted, and there is a flow of gas to an aperture portion of a mold covering an upper end of the arc chute and the contactors. The gas flow in the direction of the arc chute can be increased by blocking a channel from the contactors to an aperture portion other than that to the arc chute. However, as forces working on the arc are mainly an electromagnetic driving force and an external force caused by a gas flow, a complex and expensive device is needed in order to control the magnitudes and directions of the forces.

[0016] A third method is a method whereby a distance from the movable contactor to the arc runner on the movable side is shortened. An end portion of an arc generated between the contactors moves to an upper end of a contactor piece, and shifts to an arc runner when a spatial distance between the contactor piece and the arc runner decreases. Therefore, it can be said that the distance from the movable contactor to the arc runner on the movable side being shorter is effective in shortening commutation time. A method whereby an upper end portion of the movable contactor is extended, and contact opening speed increased, exists as a method of shortening the distance, but in this case, there is a problem in that the device increases in size due to an increase in contact opening operating force.

[0017] The invention, having been contrived in order to resolve the problems of the existing technology and all of the heretofore described first to third methods, has an object of providing a contactor device for a circuit breaker such that an arc between contactors is swiftly shifted to an arc runner, whereby arc commutation time can be shortened, with a simple configuration.

[0018] The invention also has an object of providing a contactor device for a circuit breaker such that a reduction in size is possible while securing interruption performance when interrupting a small current or when interrupting a large current.

Solution to Problem

[0019] A contactor device for a circuit breaker according to the invention is characterized in that main contactors provided on a fixed side and a movable side, arc contactors provided on the fixed side and the movable side, and an arc generating chamber configured of the fixed side main contactor and the movable side main contactor, and of the fixed side arc contactor and the movable side arc contactor, are such that at least a side face and a bottom face are enclosed by an insulating wall, leaving an opening in a direction facing the arc extinguishing chamber.

Advantageous Effects of Invention

[0020] According to the invention, an arc generating chamber configured of the two main contactors and the two arc contactors is configured so that at least a side face and a bottom face are enclosed by an insulating wall, leaving an opening in a direction facing an arc extinguishing chamber, because of which a gas channel from an arc contactor to an arc runner can be formed of a highly efficient gas channel such that there is little loss due to a gas leak, whereby movement of an arc to the arc runner is promoted by an external force from a gas flow being increased, and a shortening of commutation time can be realized.

[0021] Furthermore, a direct current high-speed breaker including an air nozzle that blows air toward a space between the fixed side contact and the movable side contact is such that, compared with an existing air nozzle type of direct current high-speed breaker, an air supply device for blowing can be reduced in size, and air can be efficiently blown against an arc, because of which a reduction in size can be realized while securing interruption performance when interrupting a small current or when interrupting a large current.

Brief Description of Drawings

[0022]

Fig. 1 is a side sectional view of a direct current high-speed breaker showing a first embodiment of the invention, and is a view of a closed contact state.
Fig. 2 is a side sectional view of the direct current high-speed breaker showing the first embodiment of the invention, and is a view of an open contact state.
Fig. 3 is a side sectional view showing an enlarged structure of an interrupting unit in the open contact state of Fig. 2.
Fig. 4 is a sectional view seen in an A-A direction of Fig. 3.
Fig. 5 is a sectional view seen in a B-B direction of Fig. 3.
Fig. 6 is a side sectional view seen in a C-C direction of Fig. 4, and is a drawing illustrating an image of airtightness of an arc generating chamber.
Fig. 7 is a plan view showing an air nozzle of the first embodiment of the invention.
Fig. 8 is a side view of Fig. 7.
Fig. 9 is a front view of Fig. 7.
Fig. 10 is a back view of Fig. 7.
Fig. 11 is a side sectional view seen in a D-D direction of Fig. 7.
Fig. 12 is a side sectional view seen in the D-D direction of Fig. 7, and is a view showing sectional positions of a ventilation hole.
Fig. 13 is a plan view seen in an E direction of Fig. 12.
Fig. 14 is a sectional view seen in an F-F direction of Fig. 12.
Fig. 15 is a sectional view seen in a G-G direction of Fig. 12.
Fig. 16 is a sectional view seen in an H-H direction of Fig. 12.
Fig. 17 is a sectional view seen in a J-J direction of Fig. 12.
Fig. 18 is a plan view showing an air nozzle of a second embodiment of the invention.
Fig. 19 is a side sectional view showing a structure of an interrupting unit of a third embodiment of the invention.
Fig. 20 is a side view of a contactor device showing a fourth embodiment of the invention, and is a view illustrating a gas flow working on an arc in an open contact state.
Fig. 21 is a side view of the contactor device showing the fourth embodiment of the invention, and is a view in a closed contact state.
Fig. 22 is a perspective view for describing an electromagnetic driving force that works on an arc of an arc contactor according to the invention.
Fig. 23 is a parts development view for describing an assembly of a movable side contactor of the fourth embodiment.
Fig. 24 is a parts development view for describing an assembly of a fixed side contactor of the fourth embodiment.
Fig. 25 is a plan view showing an enlargement of a main portion of a movable contactor of the fourth embodiment.
Fig. 26 is perspective views showing a configuration of a contactor mold and a shielding plate of the fourth embodiment.
Fig. 27 is a perspective view showing, of configurations of the movable contactor shown in Fig. 23, a movable side arc contactor and an arc contactor guide. Description of Embodiments

First Embodiment

[0023] Hereafter, a first embodiment of the invention will be described based on Fig. 1 to Fig. 17, but the description will be given allotting the same reference signs to identical or corresponding members and regions in each drawing.

[0024] Fig. 1 and Fig. 2 show an overall configuration of a direct current high-speed breaker in a first embodiment for implementing the invention. Fig. 1 is a side sectional view showing a closed contact state (operating state) of the direct current high-speed breaker according to the first embodiment of the invention. Fig. 2 is a side sectional view showing a state wherein contacts of the direct current high-speed breaker according to the first embodiment of the invention are carrying out a separating operation (carrying out an interrupting operation).

[0025] Firstly, a configuration of the direct current high-speed breaker will be described, based on Fig. 1 and Fig. 2. In Fig. 1, a direct current high-speed breaker 101 is configured so that between an upper conductor 103 disposed in a lower portion of an arc extinguishing chamber 102 in which an arc extinguishing space is formed and a lower conductor 104 disposed below the upper conductor 103, a fixed side contact 105 connected to the upper conductor 103 and a movable side contact 107 mounted on one end of a movable element 106 connected via a flexible conductor 106a to the lower conductor 104 are brought into contact, whereby a current is caused to flow between the upper conductor 103 and the lower conductor 104 via the movable element 106 in a normal operating state (a closed contact state).

[0026] The fixed side contact 105 and the movable side contact 107 are disposed so as to be housed on an inner

side of the lower portion of the arc extinguishing chamber 102. Also, an arc contactor in which an arc K is generated when interrupting is disposed above the fixed side contact 105 and the movable side contact 107, and the arc contactor is configured of a fixed side arc contactor 108 and a movable side arc contactor 109.

[0027] Also, the movable element 106 is pivotally supported by a shaft 110, and coupled to an operating mechanism unit 111, and when the movable side contact 107 is caused to operate in a direction of the fixed side contact 105 in order to switch the direct current high-speed breaker 101 from the open contact state of Fig. 2 to the operating state, the movable element 106 is pivoted in a counter-clockwise direction by the operating mechanism unit 111, with the shaft 110 as a pivoting fulcrum, and driven as far as the position shown in Fig. 1 in which the fixed side contact 105 and the movable side contact 107 are closed. 112 is a latch, engages with the other end of the movable element 106 in the position in which the fixed side contact 105 and the movable side contact 107 are closed, and holds the movable element 106 in the closed position (operating position). 113 is a tripping spring, the tripping spring 113 is mounted between the movable element 106 and a frame 114, energy is accumulated by the pivoting of the movable element 106 in the counter-clockwise direction, and the tripping spring 113 biases the movable element 106 so as to pivot in a clockwise direction (that is, an interrupting direction) in the position in which the fixed side contact 105 and the movable side contact 107 are closed (the operating state).

[0028] Also, 115 is an overcurrent detector, and operates when current flowing into the lower conductor 104 exceeds a predetermined value. 116 is a latch disengaging mechanism, is driven by an operation of the overcurrent detector 115, and operates so as to disengage the latch 112 and the other end of the movable element 106. 117 is an air nozzle made of an insulator mounted in the lower portion of the arc extinguishing chamber 102. The air nozzle 117 is a member molded in block form from a solid insulator such as epoxy or polyester, and has a ventilation hole 117a penetrating an interior thereof. Details of a structure of the air nozzle 117 will be described hereafter. 118 is an air cylinder, and incorporates a piston 120 driven by a drive link 119 coupled to the movable element 106. In Fig. 1, the piston 120 carries out a sliding operation in left and right directions, carrying out a compressing operation by a slide in the right direction, and feeds air pressurized by the compressing operation to the ventilation hole 117a of the air nozzle 117 via an air feed pipe 121.

[0029] The fixed side arc contactor 108 and the movable side arc contactor 109 are configured so as to separate slightly after the fixed side main contact 105 and the movable side main contact 107 carry out a separating operation during a contact opening operation, and the arc K is generated between the fixed side arc contactor 108 and the movable side arc contactor 109. By the arc K being prevented from being generated between the fixed side main contact 105 and the movable side main contact 107 in this way, the fixed side contact 105 and the movable side contact 107 are protected from being melted by the heat of the arc K.

[0030] An arc horn for commutating the generated arc K is disposed above the fixed side arc contactor 108 and the movable side arc contactor 109 in order to lead the generated arc K to an upper portion inside the arc extinguishing chamber 102, and the arc horn is configured of a fixed side arc horn 122 and a movable side arc horn 123. One end of the fixed side arc horn 122 and the movable side arc horn 123 is disposed at the fixed side arc contactor 108 and the movable side arc contactor 109 respectively, and the other ends of the fixed side arc contactor 108 and the movable side arc contactor 109 are disposed so as to face diagonally upward so as to separate farther from each other in a front-back direction of the arc extinguishing chamber 102 heading toward the upper portion of the arc extinguishing chamber 102.

[0031] Also, a grid assembly 125, in which a multiple of a grid 124 formed of a magnetic body of a thin plate form are arrayed, is disposed on an upper side of the arc extinguishing chamber 102 in an extension direction of the fixed side arc horn 122 and the movable side arc horn 123 (that is, the front-back direction of the arc extinguishing chamber 102). The arc K reaches the grid assembly 125, and an arc current is limited and interrupted utilizing an electrode drop voltage generated by the existence of the grids 124 and an arc voltage that increases owing to a length of the arc K being extended. Also, an exhaust port 126 for discharging arc gas to an exterior of the arc extinguishing chamber 102 is provided on an upper side of the grid assembly 125.

[0032] Fig. 2 is a side sectional view showing a state while the contacts of the direct current high-speed breaker 101 according to the first embodiment of the invention are carrying out a separating operation (carrying out an interrupting operation). For example, when a large current of a predetermined value or greater flows in an operating state due to a failure or the like, the overcurrent detector 115 detects the large current, and disengages the latch 112 and the movable element 106 via the latch disengaging mechanism 116. As a result of this, the movable element 106 is driven in the clockwise direction (interrupting direction) by the tripping screw 113, with the shaft 110 as a fulcrum, because of which, firstly, the fixed side main contact 105 and the movable side main contact 107 separate, then the fixed side arc contactor 108 and the movable side arc contactor 109 separate, and the arc K is generated.

[0033] Together with the movable element 106 pivoting in the clockwise direction (interrupting direction), the piston 120 inside the air cylinder 118 is driven in a right direction in Fig. 2 via the drive link 119 coupled to the movable element 106. Air compressed by this operation is fed to the air nozzle 117 via the air feed pipe 121, and passes through the ventilation hole 117a in the air nozzle 117, whereby an air flow is blown from down to up toward

the arc K generated between the fixed side arc contactor 108 and the movable side arc contactor 109. Owing to this air flow, the arc K is driven upward, and shifts to the fixed side arc horn 122 and the movable side arc horn 123.

[0034] Next, using Fig. 3 to Fig. 6, a structure whereby air is blown toward the arc K will be described. Fig. 3 shows a configuration of an interrupting unit 130, which is an essential portion of the direct current high-speed breaker. The interrupting unit 130 is configured of the lower portion of the arc extinguishing chamber 102, the fixed side contact 105, the fixed arc contactor 108, the movable element 106, the movable side contact 107, the movable side arc contactor 109, the air nozzle 117, the fixed side arc horn 122, and the movable side arc horn 123.

[0035] A characteristic of the interrupting unit 130 is that, excepting an upper opening 132 (a space between the fixed side arc horn 122 and the movable side arc horn 123) that communicates with the inside of the arc extinguishing chamber 102 above, an arc generating chamber 131 is configured in a form such that an interior thereof is isolated from a periphery by being enclosed by the fixed side arc horn 122, the movable side arc horn 123, and an insulating wall, and the interrupting unit 130 is configured so that air is blown upward from a lower portion against the arc K generated in the arc generating chamber 131, driving the arc K from the upper opening 132 into the arc extinguishing chamber 102 above.

[0036] In Fig. 3, a space enclosed by the air nozzle 117 below, the movable side arc horn 123 on a right side, and the fixed side main contact 105, the fixed arc contactor 108, and the fixed side arc horn 122 on a left side configures the interrupting portion 130.

[0037] Also, Fig. 4 shows a structure seen in an A-A direction of Fig. 3. The movable element 106 is disposed penetrating a movable element through hole 117c of the air nozzle 117 in a vertical direction, and a side wall 102a, made of an insulator, of the lower portion of the arc extinguishing chamber 102 is disposed so as to sandwich the movable element 106 from the sides on either side of an upper portion of the air nozzle 117.

[0038] A gap between an inner wall of the movable element through hole 117c of the air nozzle 117 and the two sides of the movable element 106 is of a minimum necessary dimension, and a gap between the side wall 102a of the lower portion of the arc extinguishing chamber 102 and the two sides of the movable element 106 is also of a minimum necessary dimension. In Fig. 4, a space long and narrow in a vertical direction in front of the movable element 106 configures the arc generating chamber 131. As the configuration is such that at least side faces and a bottom face of the arc generating chamber 131 are enclosed by an insulating wall in this way, an air flow leaking downward from the gap between the movable element through hole 117c of the air nozzle 117 and the movable element 106 can be limited to a slight amount.

[0039] Also, Fig. 5 shows a structure seen in a B-B direction of Fig. 3. In the drawing, the fixed side contact 105 and the fixed side arc contactor 108 are disposed in positions at an upper end of the movable element through hole 117c of the air nozzle 117, and the side wall 102a of the arc extinguishing chamber 102 is disposed so as to sandwich the fixed side contact 105 and the fixed side arc contactor 108 from the sides on either side of the upper portion of the air nozzle 117. The gap between the side wall 102a of the arc extinguishing chamber 102 and the movable element 106 is of a minimum necessary dimension. In Fig. 5, a narrow space in front of the fixed side main contact 105 and the fixed side arc contactor 108 configures the arc generating chamber 131, in the same way as in the description of Fig. 4.

[0040] Also, Fig. 6 corresponds to the structure of Fig. 3, and is a drawing illustrating an image of a hermetic structure, excluding the upper opening 132, in the hermetically structured arc generating chamber 131.

[0041] Next, using Fig. 7 to Fig. 11, a structure of the air nozzle 117 will be described. Fig. 7 is a plan view showing the air nozzle 117 of insulating block form. In the drawing, 117a is a ventilation hole penetrating the interior, 117b is a nozzle out of which air from the ventilation port 117a is blown (that is, an air outlet), and 117c is a movable element through hole for disposing the movable element 106 so as to penetrate the air nozzle 117.

[0042] 117d is a flat portion of an upper face of the air nozzle 117, and the flat portion 117d configures a bottom face wall of the arc generating chamber 131. The nozzle 117b has a long and thin aperture in a surface of the flat portion 117d in a direction perpendicular to an axial line in a length direction of the air nozzle 117 (corresponding to a sectional line D-D) . A form of the long and thin aperture may be a long hole of an elliptical form, a rectangular form, or a polygonal form wherein an end portion is polygonal.

[0043] Also, 117e are side wall holding portions, and are disposed parallel with the axial line in the length direction of the air nozzle 117 (corresponding to the sectional line D-D) so as to protrude on either side of the flat portion 117d and upward from the flat portion 117d. By the arc extinguishing chamber 102 being placed on an upper face of the flat portion 117d, a lower portion of the side wall 102a of the arc extinguishing chamber 102 is disposed between the two side wall holding portions 117e, and the side wall holding portions 117e, being disposed along inner sides of the protruding portion 117d, hold the lower portion of the side wall 102a of the arc extinguishing chamber 102 in a predetermined position.

[0044] Fig. 8 is a side view of Fig. 7, wherein forms of the ventilation hole 117a and the movable element through hole 117c inside the air nozzle are indicated by broken lines. The ventilation hole 117a has an aperture in a left side end, and the nozzle 117b is disposed facing upward at the other end. Also, the movable element through hole 117c is such that a side on which the movable element 106 falls by operating in the interrupting

direction, as shown in Fig. 2, is of an inclined form rather than being vertical, so that even when the movable element 106 pivots in the clockwise direction with the shaft 110 as a fulcrum during the interrupting operation, the gap between the movable element 106 and the inner wall of the movable element through hole 117c is minimal.

[0045] Fig. 9 is a front view of Fig. 8, and shows the ventilation hole 117a. Also, Fig. 10 is a back view of Fig. 8. Also, Fig. 11 is a D-D sectional view of Fig. 7, and in the same way as Fig. 8, shows the positions and forms of the ventilation hole 117a and the movable element through hole 117c in the air nozzle 117.

[0046] Next, using Fig. 12 to Fig. 17, a structure of the ventilation hole 117a penetrating the interior of the air nozzle 117 will be described. Fig. 13 is a view seen in a direction of an arrow E of Fig. 12, and shows that the nozzle 117b opens facing upward, and is disposed in a long hole form extended so as to be long and thin in a width direction of the arc generating chamber 131.

[0047] Also, Fig. 14 to Fig. 17 show a change in the sectional form of the ventilation hole 117a penetrating an interior of the air nozzle 118, and show a form of a section F-F (Fig. 14), a section G-G (Fig. 15), a section H-H (Fig. 16), and a section J-J (Fig. 17) in Fig. 12.

[0048] In this way, it is shown that the ventilation hole 117a is such that a portion connecting with the air feed pipe 121 is circular, and the sectional form of the ventilation hole 117a changes continuously and smoothly from circular to a long and thin form by the time the ventilation hole 117a reaches the nozzle 117b of long hole form. By the ventilation hole 117a being of a long and thin form in the width direction of the arc generating chamber 131 in the position of the nozzle 117b, which is a final stage, air can be blown with no omission over the whole width of the extended arc K, whereby the arc K can be efficiently driven upward.

[0049] Furthermore, by the nozzle 117b being spread to the same extent as the width direction of the arc generating chamber 131, as shown in Fig. 18, air can reliably be blown over the whole width of the extended arc K, whereby the arc K can be still more efficiently driven upward.

[0050] According to the configuration of the first embodiment, as heretofore described, the air nozzle 117 configuring the bottom face of the arc generating chamber 131 is configured of a block of a solid insulator that does not include a conductive material, because of which there is no need to secure an insulating distance between the air nozzle 117 and a charging portion of the direct current high-speed breaker equivalent to that needed between, for example, the charging portion and the earth, meaning that the direct current high-speed breaker 101 can be reduced in size.

[0051] Also, excepting the upper opening 132 communicating with the arc extinguishing chamber 102 above, the fixed side arc horn 122 and the movable side arc horn 123 are enclosed by insulators, whereby the arc generating chamber 131 can be configured in a form isolated from the periphery, because of which a leakage of a gas such as air in a side or downward direction can be considerably reduced, and an air supply device for blowing can be reduced in size. Also, efficiency for driving the arc K in the arc generating chamber 131 upward increases, because of which an advantage is obtained in that interruption performance can be improved without increasing the size of the direct current high-speed breaker 101.

[0052] Also, as shown in Fig. 3, the nozzle 117b is disposed below the fixed side arc contactor 108, and furthermore, is opened facing diagonally upward toward the space between the fixed side arc contactor 108 and the movable side arc contactor 109 in the interrupting position, because of which air is blown out in a direction of an arrow N, that is, diagonally upward, whereby, with respect to the whole length of the arc K extended from the fixed side arc contactor 108 to the movable side arc contactor 109 in the interrupting position during the interrupting operation, the arc K can be efficiently blown toward the arc extinguishing chamber 102 side.

[0053] According to the description above, main energization is carried out at the fixed side main contact 105 and the movable side main contact 107, and interruption is carried out by controlling the arc K generated between the fixed side arc contactor 108 and the movable side arc contactor 109, which separate later than the fixed side contact 105 and the movable side contact 107 when the interrupting operation is carried out, but as it is not the case that two kinds of contactor are always necessary, the arc K may be generated at the fixed side contact 105 and the movable side contact 107.

Second Embodiment

[0054] In the first embodiment, as shown in Fig. 3 and Fig. 7, the blowing port (nozzle 117b) of the air nozzle 117 is provided below the fixed side contact 105 and the movable side contact 107, and a width of the nozzle 117b is less than that of the movable element through hole 117c of the air nozzle 117, but by the width of the nozzle 117b being greater than that of the first hole 117c of the air nozzle 117, as shown in Fig. 18, air can more efficiently be blown against the whole width of the arc K generated between the fixed side arc contactor 108 and the movable side arc contactor 109, and interruption performance can be further improved.

Third Embodiment

[0055] Also, in the first and second embodiments, the arc generating chamber 131 is configured of the fixed side main contact 105, the fixed side arc contactor 108, the fixed side arc horn 122, the movable side arc horn 123, the side wall 102a of the arc extinguishing chamber 102, and the air nozzle 117. That is, the air nozzle 117 made of an insulating block forms the bottom face insulator, the side plate 102a made of an insulator forms the side portion insulator, and end portions in the operating

direction of the movable element 106 are such that the movable side arc horn 123 and an assembly of the fixed side main contact 105, the fixed side arc contactor 108, and the fixed side arc horn 122 configure the side walls of the arc generating chamber 131.

[0056] As opposed to this, in a third embodiment, end portions in the operating direction of the movable element 106 are also enclosed by insulating walls 133 and 134, as shown in Fig. 19. According to this kind of configuration, the components of the interrupting unit 130, that is, the lower portion of the arc extinguishing chamber 102, the fixed side contact 105, the fixed arc contactor 108, the movable element 106, the movable side contact 107, the movable side arc contactor 109, the air nozzle 117, the fixed side arc horn 122, and the movable side arc horn 123, can be more reliably enclosed, driving the arc K to the arc extinguishing chamber 102 by blowing air against the arc K can be more efficiently carried out, and interruption performance improves.

Fourth Embodiment

[0057] Fig. 20 to Fig. 22 show other embodiments of the invention, and are schematic configuration diagrams for describing an operational change from a state in which the contacts of the contactor device are closed to a state in which the contacts are opened, and a driving force acting on the arc K when the contacts are opened. Portions identical to or corresponding to those in the first to third embodiments are indicated by the same reference signs. In this embodiment, the contactor device has a movable side main contactor 4 and a fixed side main contactor 5, includes the movable side arc contactor 109 and a movable side main contactor piece 13a on a surface of the movable side main contactor 4, and includes the fixed side arc contactor 108 disposed opposing the movable side arc contactor 109 and a fixed side main contactor piece 13b (corresponding to the fixed side contact 105 of the first embodiment) disposed opposing the movable side main contactor piece 13a (corresponding to the movable side contact 107 of the first embodiment) on a surface of the fixed side main contactor 5. Further, the movable side main contactor 4 is pivoted by an unshown operating mechanism unit, with the shaft 110 as a center.

[0058] In the fourth embodiment, a positional relationship between the movable side main contactor 4 and the fixed side main contactor 5 is the reverse of that described in the first to third embodiments.

[0059] As in Fig. 20, the movable side arc contactor 109 is provided so as to be covered by a cover 3a, and the fixed side arc contactor 108 is provided so as to be covered by a cover 3b. A periphery of the contactors is configured so as to be covered by a contactor mold 7, and a shielding plate 6, to be described hereafter, is provided below the fixed side main contactor 5. This kind of structure is such that the arc K generated when the contacts of the circuit breaker in an energized state are opened receives the force of a kind of gas flow, indicated by solid arrows F, that heads from the contactors 109 and 108 to the arc chute (arc extinguishing chamber) 102.

[0060] Also, the force of a kind of gas flow, indicated by broken arrows, that heads from the contactors 109 and 108 to a place other than the arc chute 102 is restricted by the cover 3a, the cover 3b, and the shielding plate 6. Owing to the force of the gas flow heading to the arc chute 102, time taken for the arc K to move to arc runners 9a and 9b provided in the arc chute 102 is shortened, whereby arc commutation time is shortened.

[0061] Fig. 22 is a perspective view schematically illustrating an electromagnetic driving force that works on the arc K, which has an arc contactor piece 10a as a generating point. The arc contactor piece 10a is provided so that a sectional area thereof in an energizing direction is small. That is, a thickness of the arc contactor piece 10a is less than that of a conductor in another conduction path. By adopting this kind of configuration, a magnetic path that generates current flowing into the arc contactor piece 10a becomes smaller, whereby a density of a magnetic flux passing through the arc K increases. Consequently, the electromagnetic driving force working on the arc K increases, and by pulling away the arc adhering between the contactors, the arc commutation time is shortened.

[0062] Also, by an apex portion of the contactor piece 10a being extended to near the arc runner 9a, a distance between the movable side arc contactor 109 and the arc runner 9a immediately after the contacts are opened becomes shorter, whereby the arc commutation time is shortened.

[0063] As heretofore described, the contactor device of this embodiment is such that, with no need of a magnetic flux application or an inflow of gas from the exterior, an increase in the force driving the arc in the direction of the arc chute is achieved with a simple structure, and a reduction in interruption time owing to a shortening of commutation time is realized.

[0064] Fig. 21 to Fig. 24 are drawings showing a structure of the circuit breaker contactor device according to the fourth embodiment.

[0065] Fig. 21 is a side view showing the contactor device in a state in which the circuit breaker contacts are closed, wherein the movable side main contactor 4, for conducting a steady current flowing from the main circuit conductor 103, the fixed side main contactor 5, the movable side arc contactor 109 and the fixed side arc contactor 108, which by opening later than the main contactors 4 and 5 prevent melting by the arc of the main contactors 4 and 5, which form arc generating points, the contactor mold 7 and the shielding plate 6, which are provided so that gas generated by the arc is led to the arc chute 102, and the arc runners 9a and 9b for shifting the arc to the arc chute 102, are provided in the contactor device. Fig. 25 is a plan view of the contactor device seen from above.

[0066] The contactor mold 7 is of a box form having an

aperture facing in the direction of the arc chute 102, and is configured of an insulator. Also, the shielding plate 6 is provided in a portion of the box-form contactor mold 7 below the fixed side main contactor 5. The shielding plate 6 may be provided so as to be attachable to and detachable from the contactor mold 7. Fig. 26 is perspective views of a case in which the shielding plate 6 is provided so as to be freely attached to and detached from the contactor mold 7, wherein Fig. 26(a) shows a state wherein the shielding plate 6 is housed in the contactor mold 7, and Fig. 26(b) shows a state before the shielding plate 6 is attached.

[0067] Fig. 23 is a parts development view for describing a movable side contact device. In Fig. 23, the movable side main contactor 4, to which the main contactor piece 13a for conducting a steady current is joined, a contactor guide 14 for transmitting an operational force to the movable side main contactor 4, a contact pressure spring 15 for applying a contact pressure load to the movable side arc contactor 109, an arc contactor guide 16 that transmits power for the movable side arc contactor 109 to operate following the movable contactor after the movable side main contactor 4 opens, a stopper bolt 17, provided in the arc contactor guide 16, for regulating a wipe when the movable side arc contactor 109 operates following the movable side main contactor 4, the shaft 110, which forms a central axis of rotating operations of the movable side main contactor 4 and the movable side arc contactor 109, the cover 3a for controlling a gas flow in a vicinity of the movable side arc contactor 109 in the direction of the arc extinguishing chamber 102, a pin 20 for fixing the movable side arc contactor 109 in the arc contactor guide 16, and a shunt 19 for causing the movable side main contactor 4 to conduct an energizing current of the movable side arc contactor 109, are provided in the movable side contactor device. Fig. 27 shows a state wherein the movable side arc contactor 109 and the arc contactor guide 16 are assembled.

[0068] The sectional area in the energizing direction of the arc contactor piece 10a of the movable side arc contactor 109 is small, as is also shown in Fig. 22, and the arc contactor piece 10a is extended in the arc runner direction. The movable side arc contactor 109 is provided so that even when abrasion caused by the arc occurs, part replacement can be carried out easily.

[0069] Fig. 24 is a parts development view for describing a fixed side contactor.

[0070] In Fig. 24, the fixed side main contactor 5, to which the main contactor piece 13b for conducting a steady current is joined, the main circuit conductor 103 for conducting a circuit current, the fixed side arc contactor 108 having the conductor piece 10b, the cover 3b for controlling a gas flow in a vicinity of the fixed side arc contactor 108 in the direction of the arc extinguishing chamber 102, and a bolt 21 for fastening the fixed side arc contactor 108 to the fixed side main contactor 5, are provided in the fixed side contactor device. The fixed side arc contactor 108 is provided so that even when abrasion caused by the arc occurs, part replacement can be carried out easily.

[0071] The contact opening operation of Fig. 20 is carried out by the movable side main contactor 4 moving in a direction of an opened contact position, centered on the shaft 110, owing to the contactor guide 14 fastened to the movable side main contactor 4 receiving a contact opening load from the operating mechanism unit. During the contact opening operation of the movable side main contactor 4, the contactor guide 14 collides with the stopper bolt 17 provided in the arc contactor guide 16, and operates integrally therewith, whereby the arc contactors open later than the main contactors.

[0072] A distance by which the arc contactors lag behind the main contactors, that is, a wipe amount of the arc contactors, is regulated by an interval between the stopper bolt 17 and the arc contactor guide 16, and the configuration is such that regulation can be carried out easily by controlling a projection of the stopper bolt 17.

[0073] As the contactor device according to the fourth embodiment has arc contactors, there is hardly any melting of the main contactors due to the arc when contacts are opened. Consequently, pure silver having a high conduction performance is preferable for the main contactor pieces, after which an alloy including silver is preferable. Meanwhile, the arc contactor pieces do not need conduction performance with respect to a steady current, but need durability against melting caused by the arc, because of which a metal with a high melting point, specifically an alloy including tungsten, is preferable.

[0074] Also, in the fourth embodiment, a structure having arc contactors is described, but by providing one portion of the main contactor pieces with a structure equivalent to an arc contactor, a structure that does not have an arc contactor can also be configured, and there are the same advantages as in the fourth embodiment.

[0075] Even when the structure wherein the sectional area of the movable side arc contactor piece 10a is small and the movable side arc contactor piece 10a extends in the arc runner direction, the covers 3a and 3b provided in the contactors, and the shielding plate 6 provided below the fixed side contactor, are each provided independently, as in the description of the fourth embodiment, there is an advantage in increasing external power working on the arc, and a shortening of commutation time is realized.

[0076] Also, one portion or all of the embodiments can be combined, and each embodiment can be modified or abbreviated as appropriate, without departing from the scope of the invention.

Reference Signs List

[0077] 3a Movable side arc contactor cover, 3b Fixed side arc contactor cover, 4 Movable side main contactor, 5 Fixed side main contactor, 6 Shielding plate, 7 Contactor mold, 9a, 9b Arc runner, 10a, 10b Arc contactor piece, K Arc, 13a, 13b Main contactor piece, 14 Contactor guide,

15 Contact pressure spring, 16 Arc contactor guide, 17 Stopper bolt, 19 Pin, 20 Shunt, 21 Bolt, 101 Direct current high-speed breaker, 102 Arc extinguishing chamber, 102a Side wall, 103 Upper conductor, 104 Lower conductor, 105 Fixed side contact, 106 Movable element, 106a Flexible conductor, 107 Movable side contact, 108 Fixed side arc contactor, 109 Movable side arc contactor, 110 Shaft, 111 Operating mechanism unit, 112 Latch, 113 Tripping spring, 114 Frame, 115 Overcurrent detector, 116 Latch disengaging mechanism, 117 Air nozzle, 117a Ventilation hole, 117b Nozzle (air blowing port), 117c Movable element through hole, 117d Flat portion (bottom face wall), 117e Side wall holding portion, 118 Air cylinder, 119 Drive link, 120 Piston, 121 Air feed pipe, 122 Fixed side arc horn, 123 Movable side arc horn, 124 Grid, 125 Grid assembly, 126 Exhaust port, 130 Interrupting unit, 131 Arc generating chamber, 132 Upper opening, 133, 134 Insulating wall

Claims

1. A contactor device for a circuit breaker including:

a fixed side main contactor connected to a main circuit conductor;
a movable side main contactor having a movable side contact that comes into contact with and separates from a fixed side contact provided on one portion of the fixed side main contactor;
an arc extinguishing chamber disposed above the fixed side main contactor and the movable side main contactor;
a fixed side arc contactor and a movable side arc contactor, provided above the fixed side contact and the movable side contact respectively, between which an arc is generated when interrupting; and
an operating mechanism unit that drives the movable side main contactor and the movable side arc contactor so as to open and close, wherein
an arc generating chamber configured of the fixed side main contactor and the movable side main contactor, and the fixed side arc contactor and the movable side arc contactor, is such that at least a side face and a bottom face thereof are enclosed by an insulating wall, leaving an opening in a direction facing the arc extinguishing chamber.

2. The contactor device for the circuit breaker according to claim 1, wherein the arc generating chamber is enclosed by the insulating wall, leaving the opening.

3. The contactor device for the circuit breaker according to claim 1 or claim 2, wherein the insulating wall of the side face of the arc generating chamber is a side wall of the arc extinguishing chamber.

4. The contactor device for the circuit breaker according to any one of claim 1 to claim 3, in which an air nozzle having an air blowing port that blows air from below toward the aperture of the arc generating chamber is disposed.

5. The contactor device for the circuit breaker according to claim 1 or claim 2, wherein the insulating wall of the bottom face of the arc generating chamber is an air nozzle of an insulating block form having an air blowing port that blows air toward a space between the fixed side contact and the movable side contact.

6. The contactor device for the circuit breaker according to claim 1 or claim 2, wherein an energizing sectional area of an arc contactor piece of the movable side arc contactor is smaller than that of a conductor in another conduction path.

7. The contactor device for the circuit breaker according to claim 2, wherein the insulating wall enclosing the arc generating chamber is configured of a box-form contactor mold.

8. The contactor device for the circuit breaker according to claim 7, wherein a shielding plate is provided in the contactor mold below the fixed side main contactor.

9. The contactor device for the circuit breaker according to claim 8, wherein the shielding plate is provided so as to be freely attached to and detached from the contactor mold.

10. The contactor device for the circuit breaker according to any one of claim 7 to claim 9, wherein a flat portion is formed in the main circuit conductor and an upper face of the contactor mold, opening and closing portions of the fixed side arc contactor and the movable side arc contactor are disposed in a region immediately below the flat portion, and an arc runner is disposed in contact with, or in a region above, an upper face of the flat portion.

11. The contactor device for the circuit breaker according to any one of claim 1, claim 2, claim 6, claim 8, or claim 9, wherein both sides of the fixed side arc contactor and the movable side arc contactor are covered by a cover made of an insulator.

12. The contactor device for the circuit breaker according to claim 1 or claim 2, wherein the movable side main contactor is supported by a contactor guide.

13. The contactor device for the circuit breaker according to claim 1 or claim 2, wherein the movable side arc contactor is supported by an arc contactor guide.

14. The contactor device for the circuit breaker according to claim 4 or claim 5, wherein the air blowing port of the air nozzle is formed extending in a direction of the insulating wall on both side faces of the arc generating chamber.

15. The contactor device for the circuit breaker according to claim 5, wherein a section of a ventilation hole of the air nozzle changes continuously from a circular hole of a connection portion of the air nozzle and an air feed pipe to a long hole of the air blowing port.

16. The contactor device for the circuit breaker according to any one of claim 4, claim 5, claim 14, or claim 15, wherein the long hole of the air nozzle blowing port is formed to be of the same extent or greater than a width direction of the arc generating chamber.

17. The contactor device for the circuit breaker according to claim 1 or claim 2, wherein the fixed side main contactor is configured of either one of the fixed side contact or the fixed side arc contactor.

18. The contactor device for the circuit breaker according to claim 1 or claim 2, wherein the movable side main contactor is configured of either one of the movable side contact or the movable side arc contactor.

19. A circuit breaker including the contactor device according to any one of claim 1 to claim 18.

FIG. 1

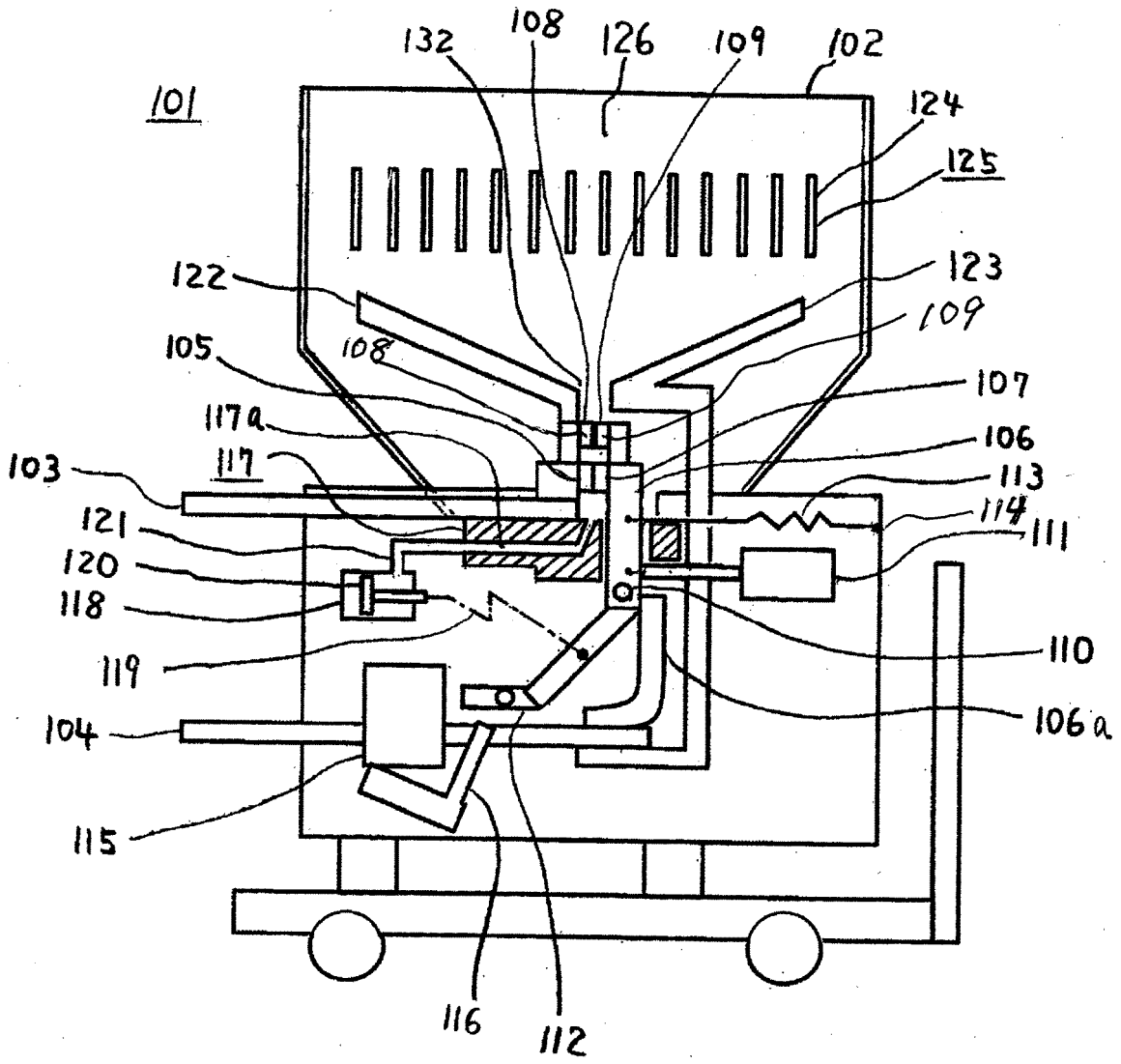
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FIG. 2

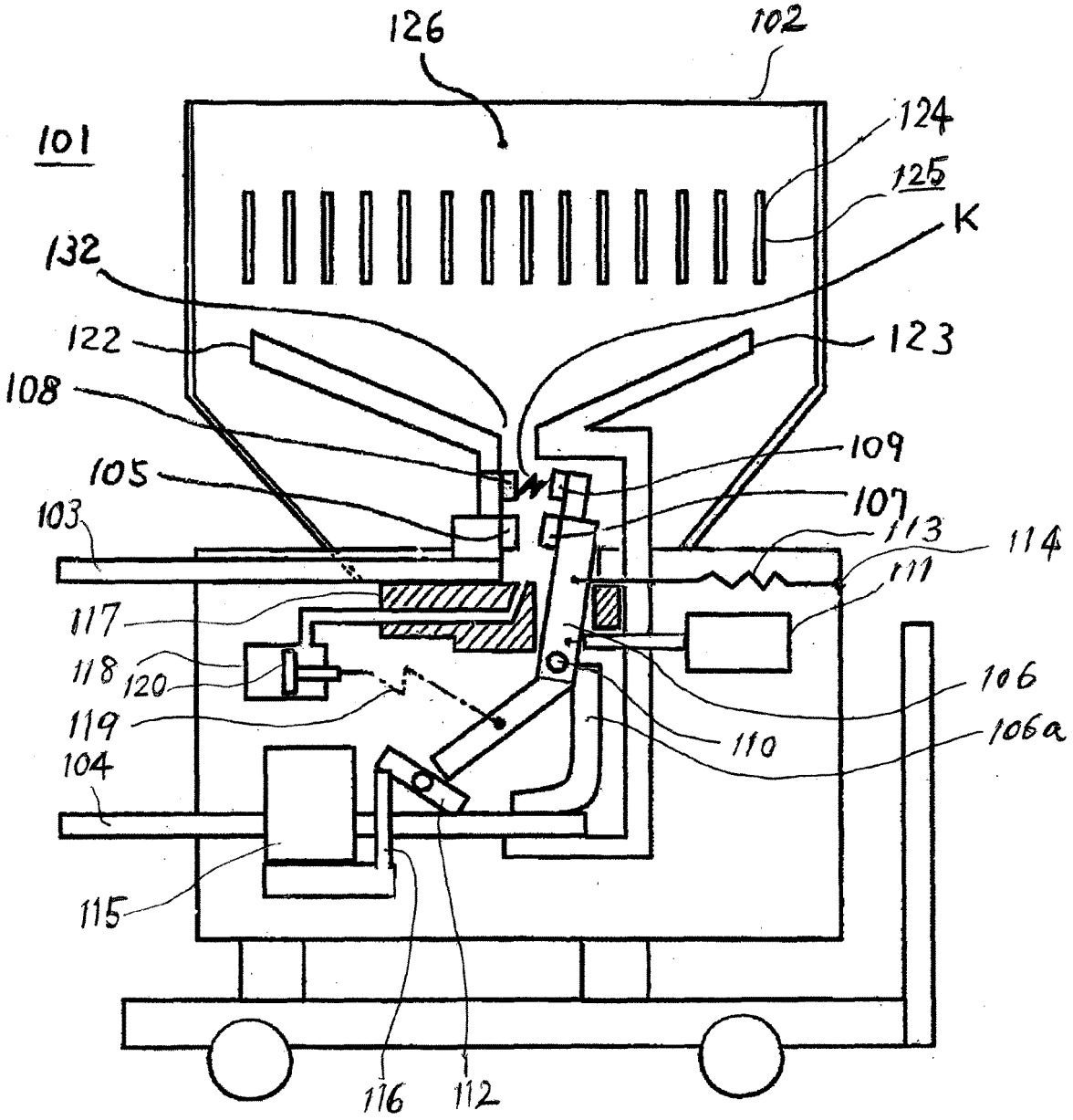
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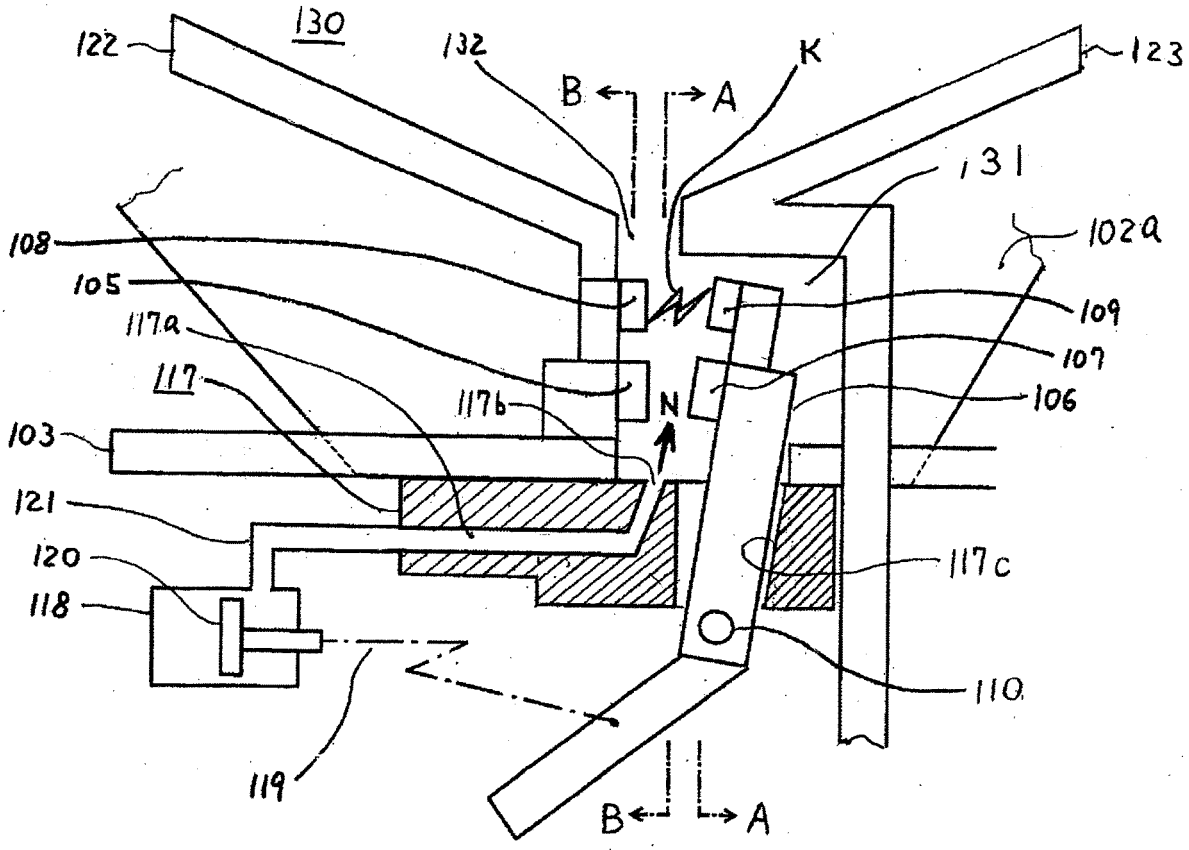
FIG. 3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117c
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119
B
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FIG. 4

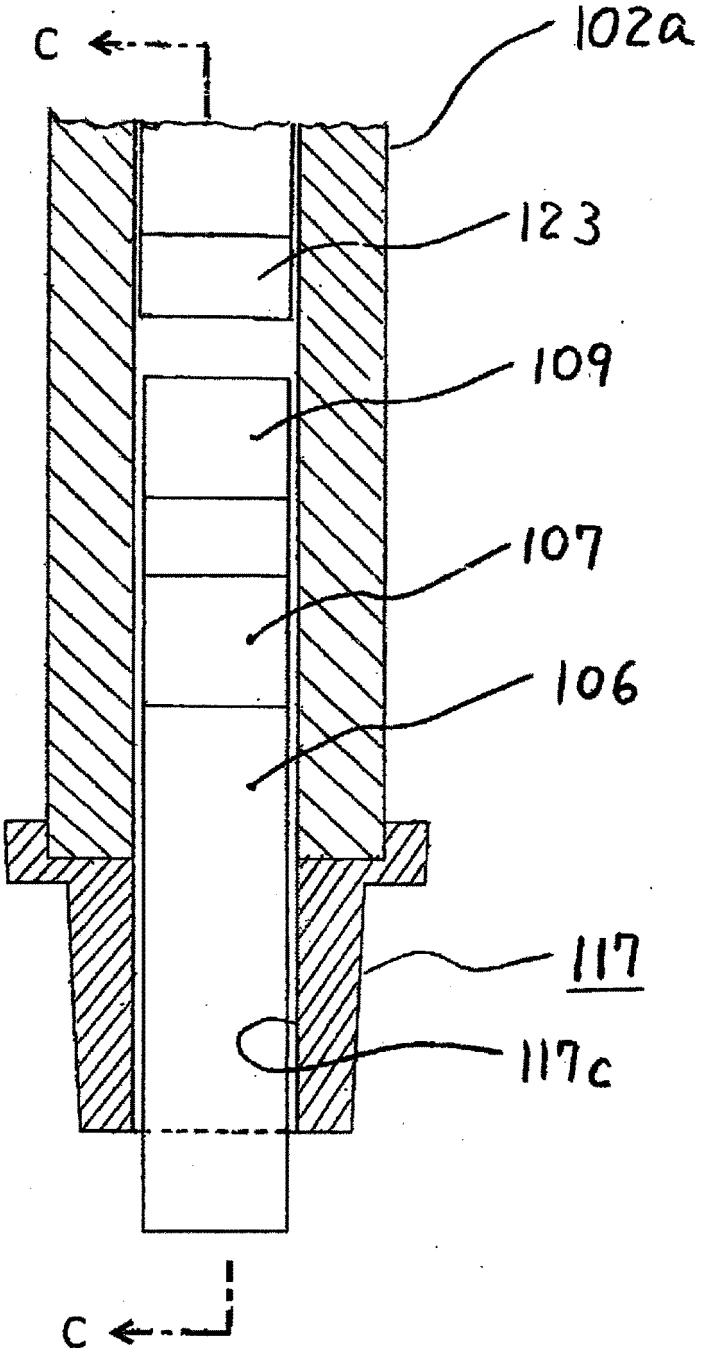

FIG. 5

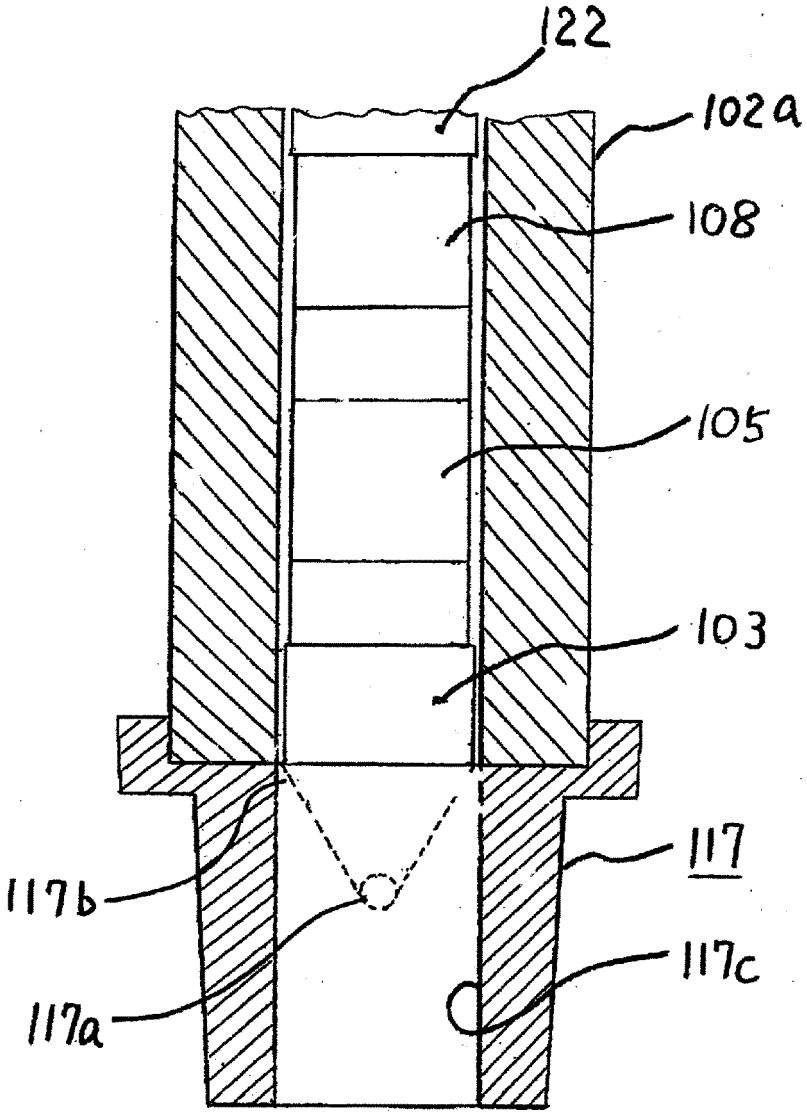

FIG. 6

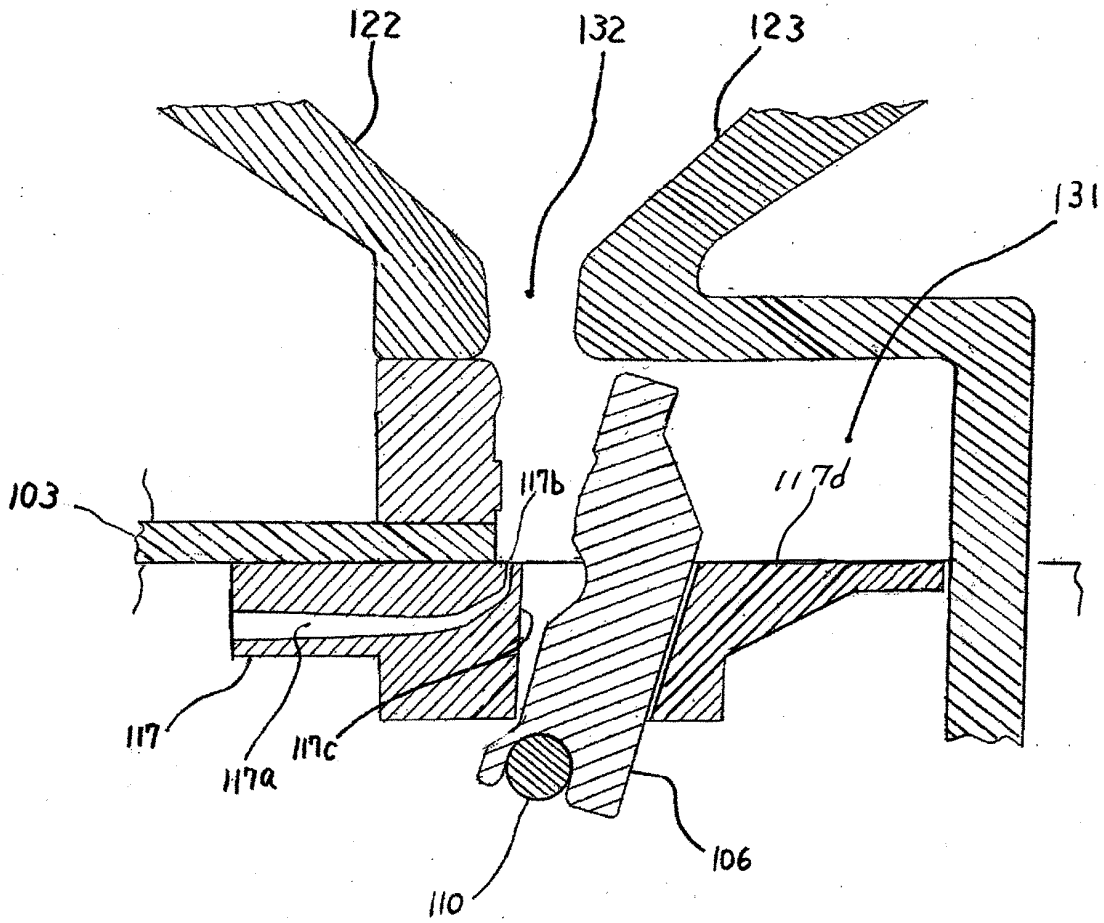
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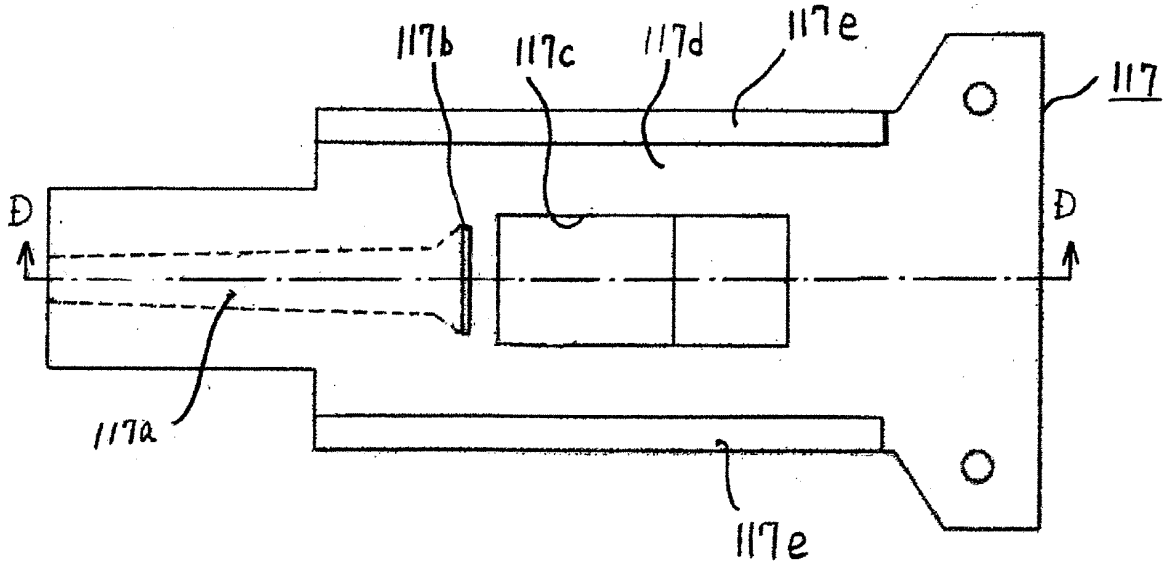
FIG. 7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117a
117e

FIG. 8

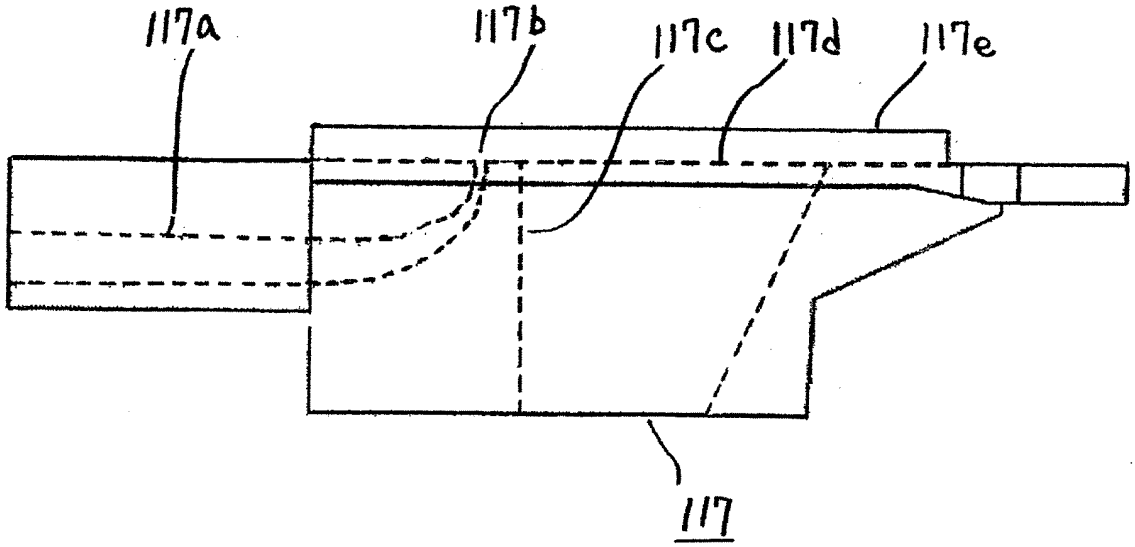

FIG. 9

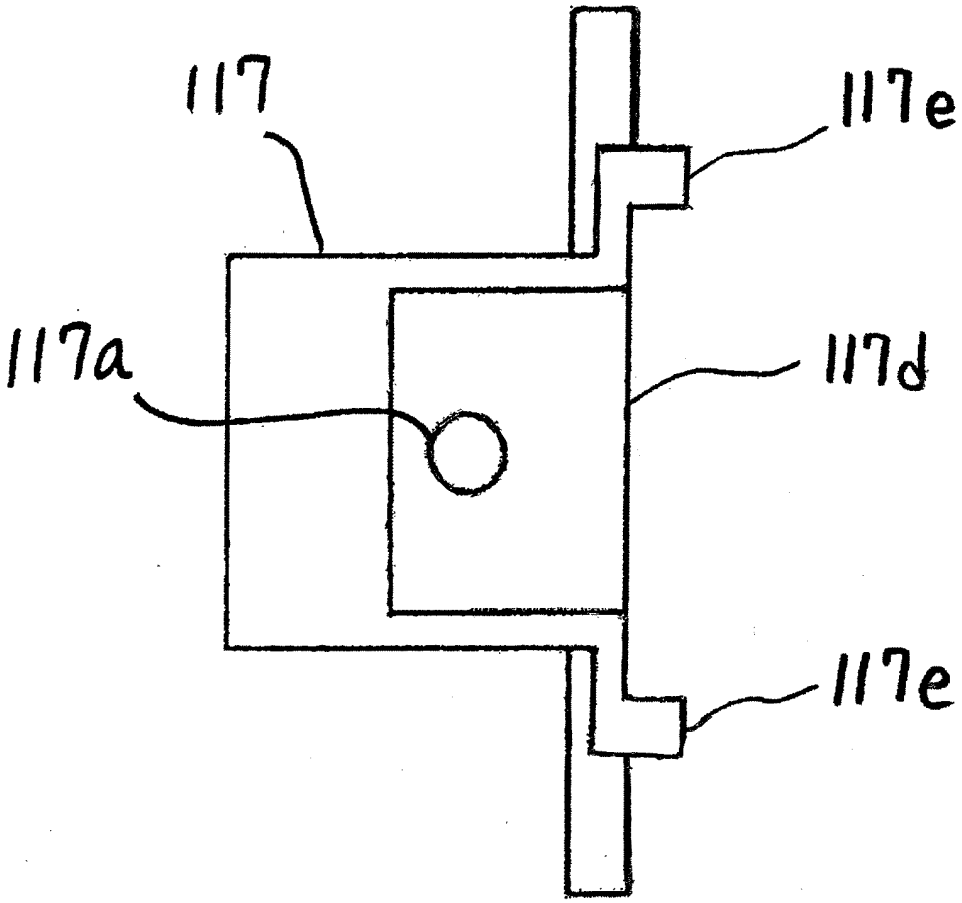

FIG. 10

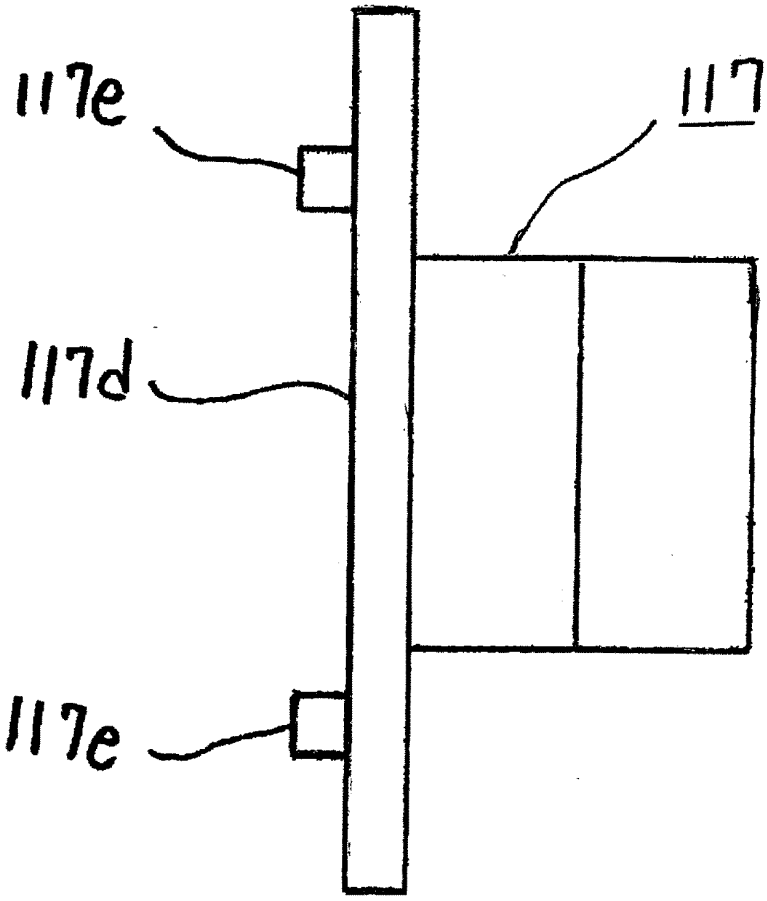

FIG. 11

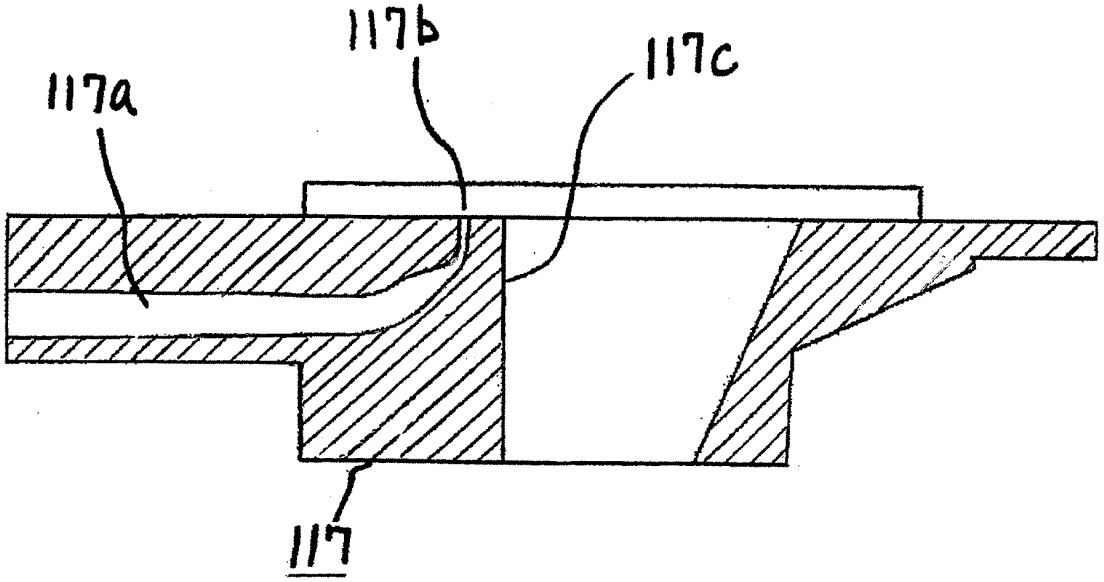

FIG. 12

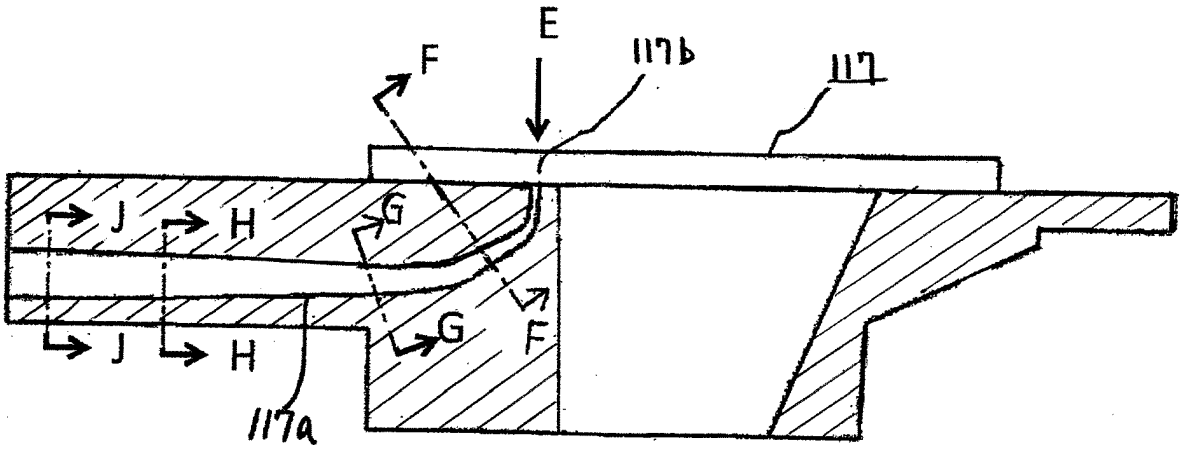

FIG. 13

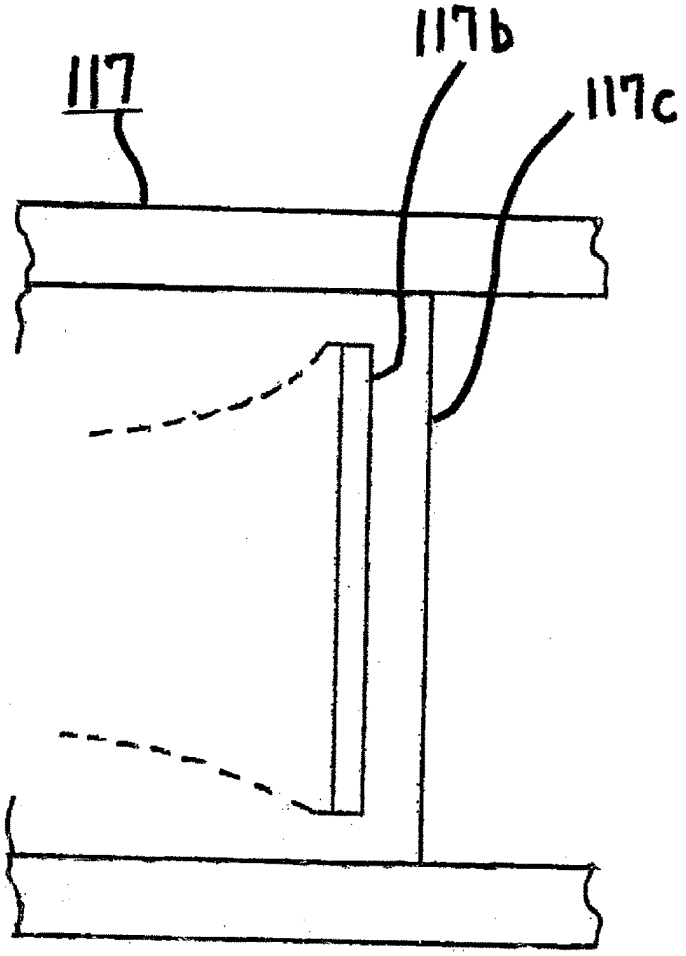

FIG. 14

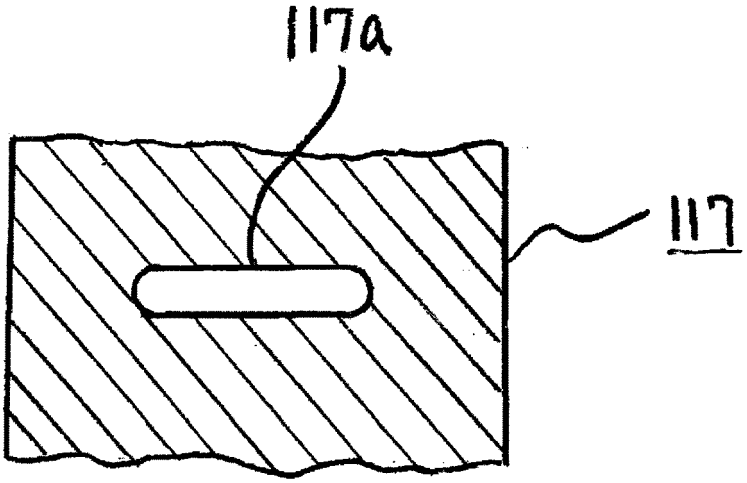

FIG. 15

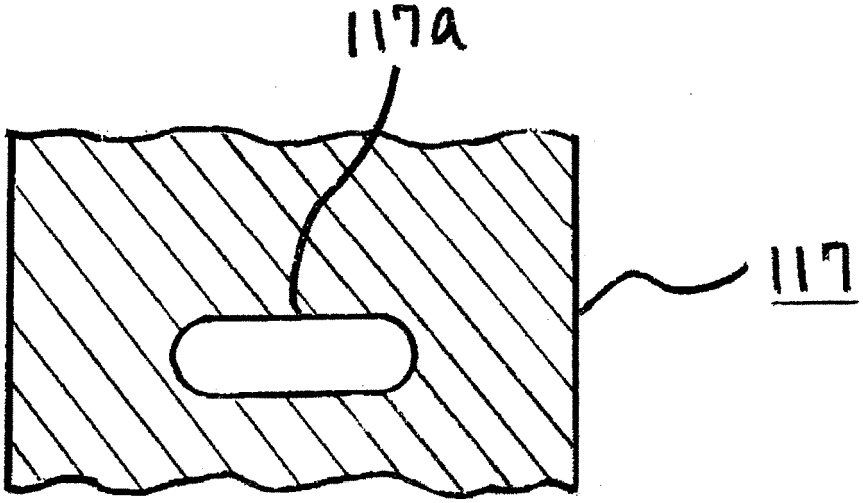

FIG. 16

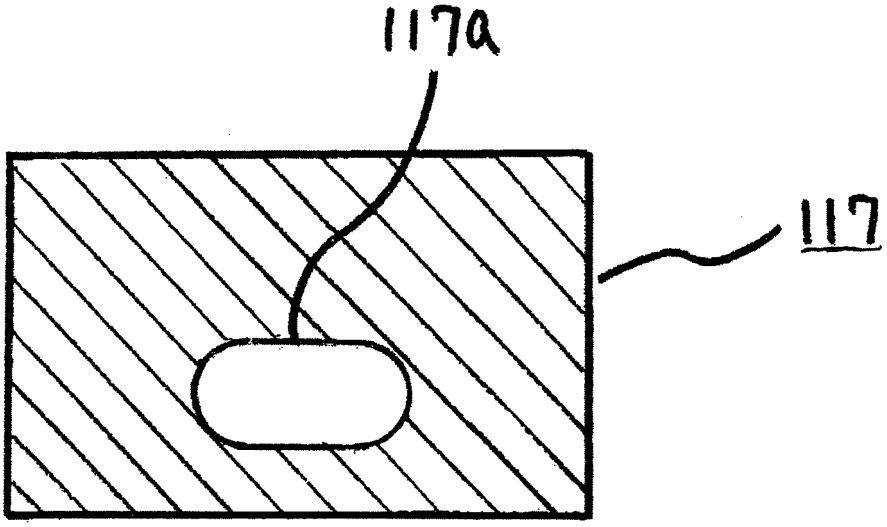

FIG. 17

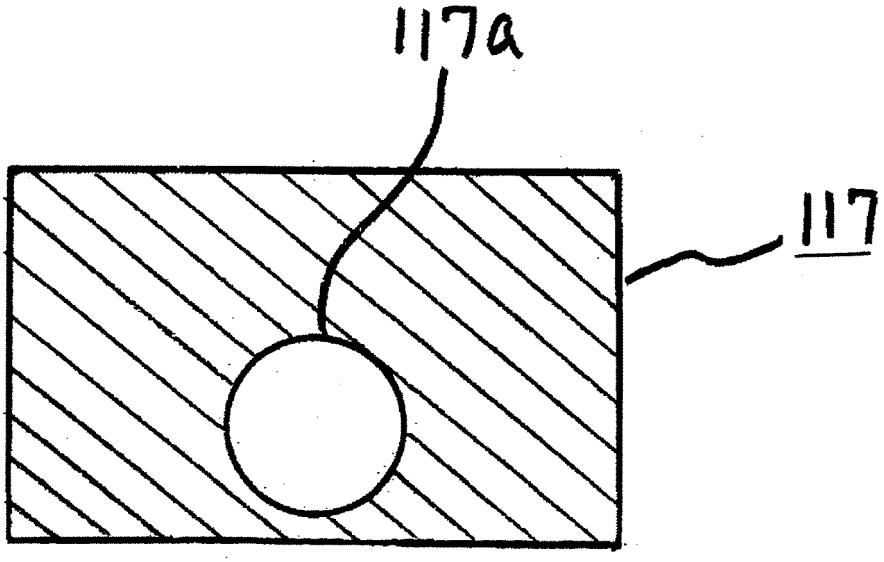

FIG. 18

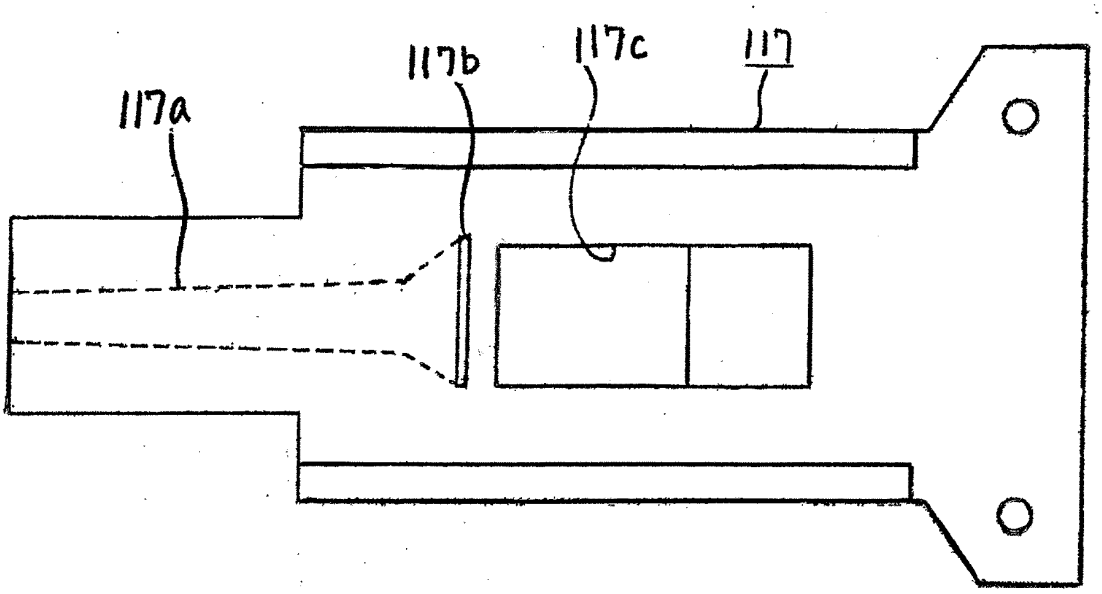
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FIG. 19

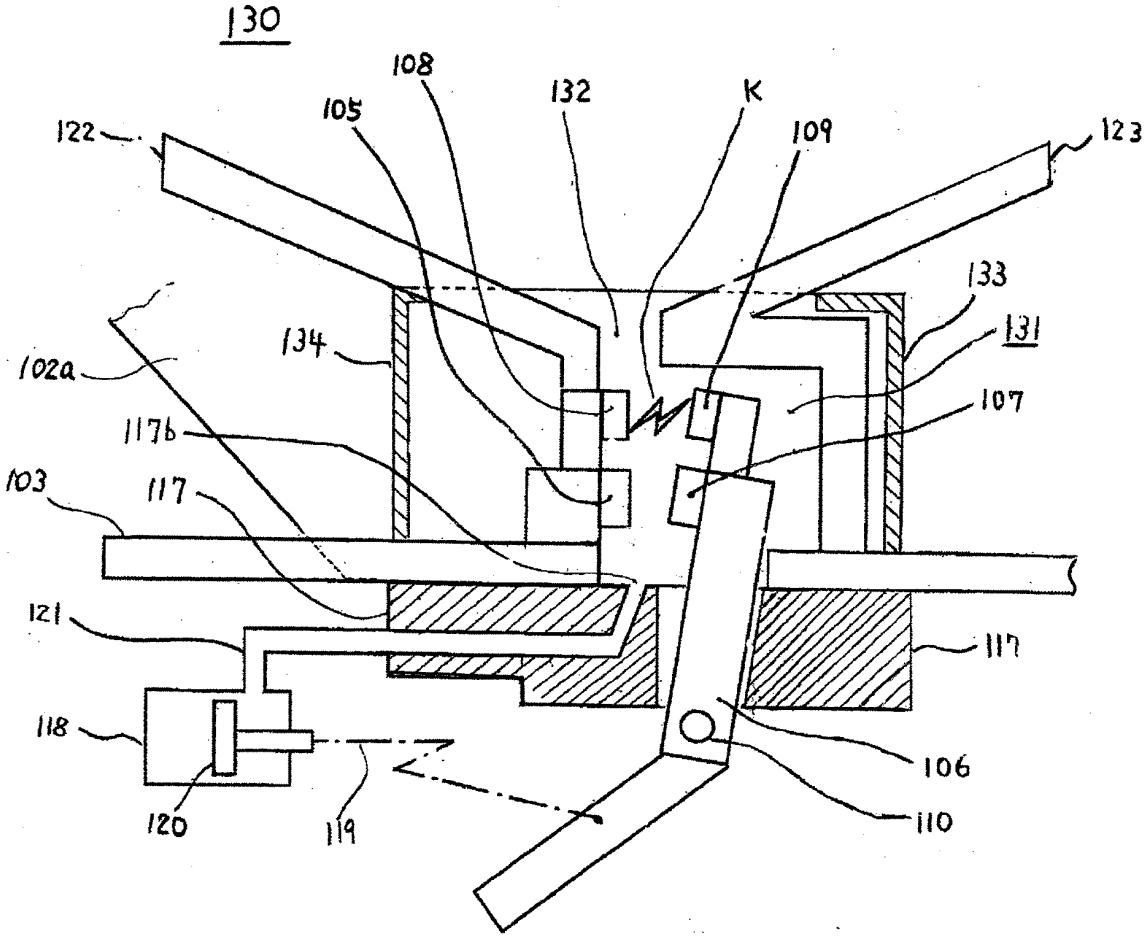
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FIG. 20

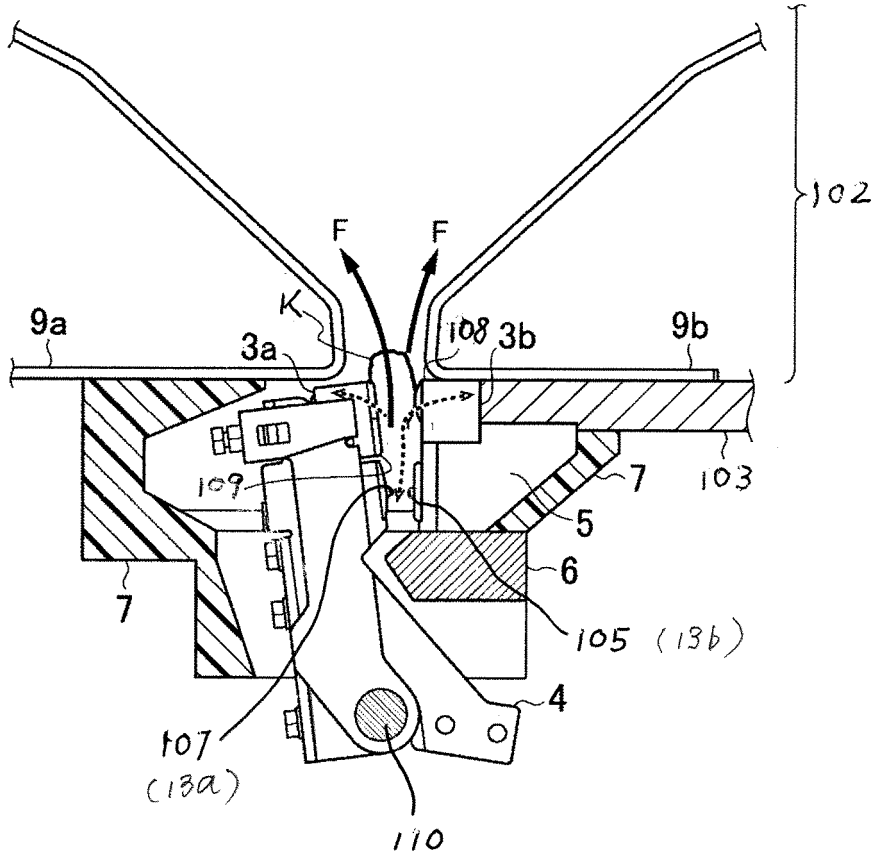


FIG. 21

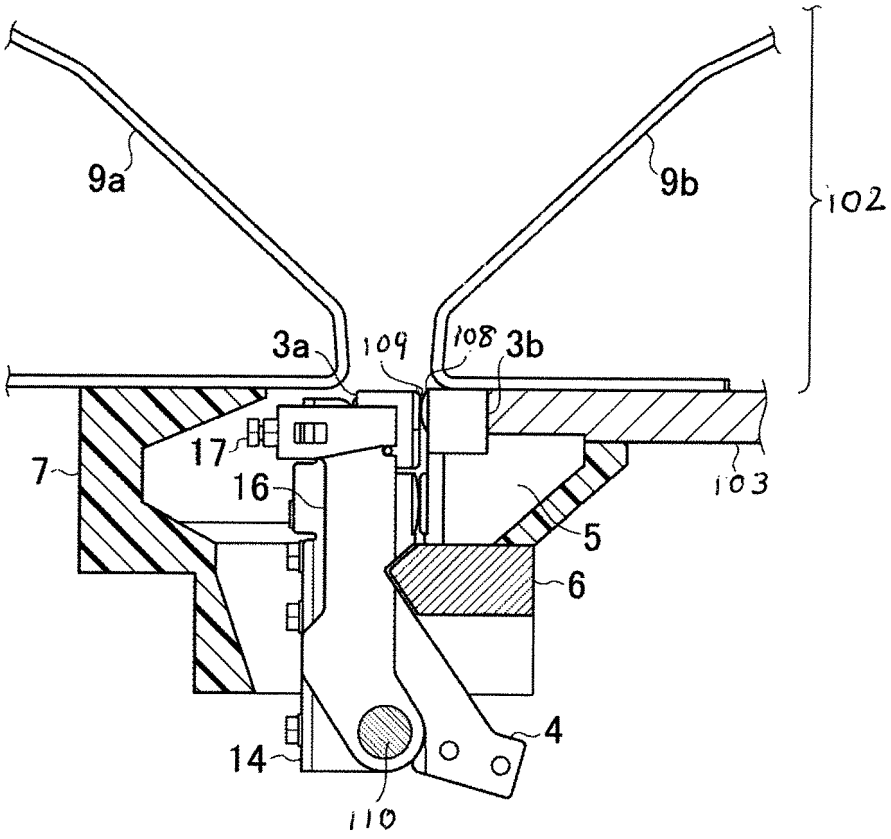


FIG. 22

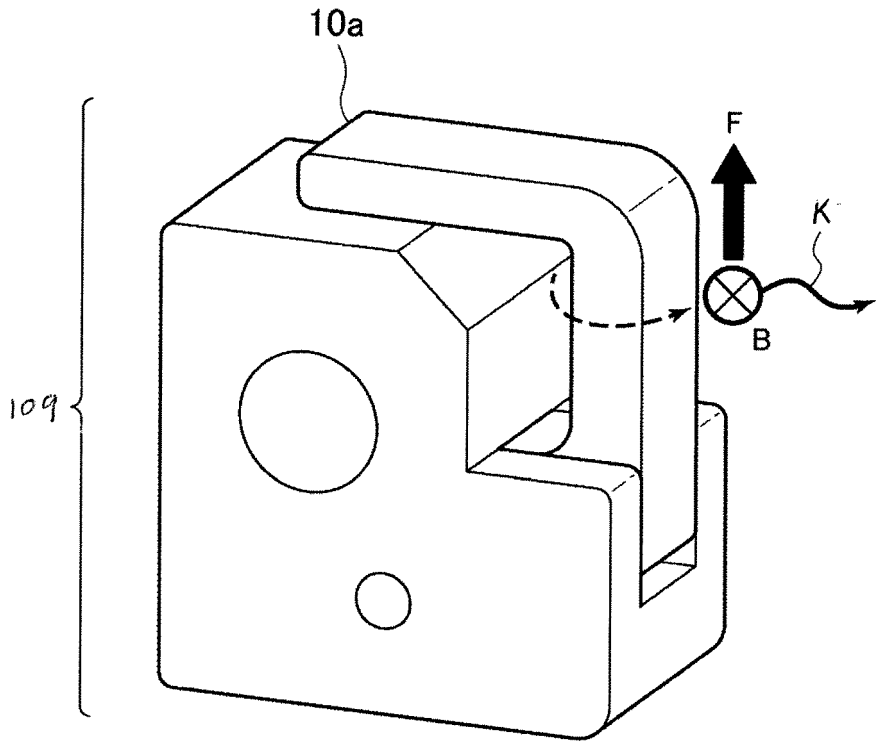


FIG. 23

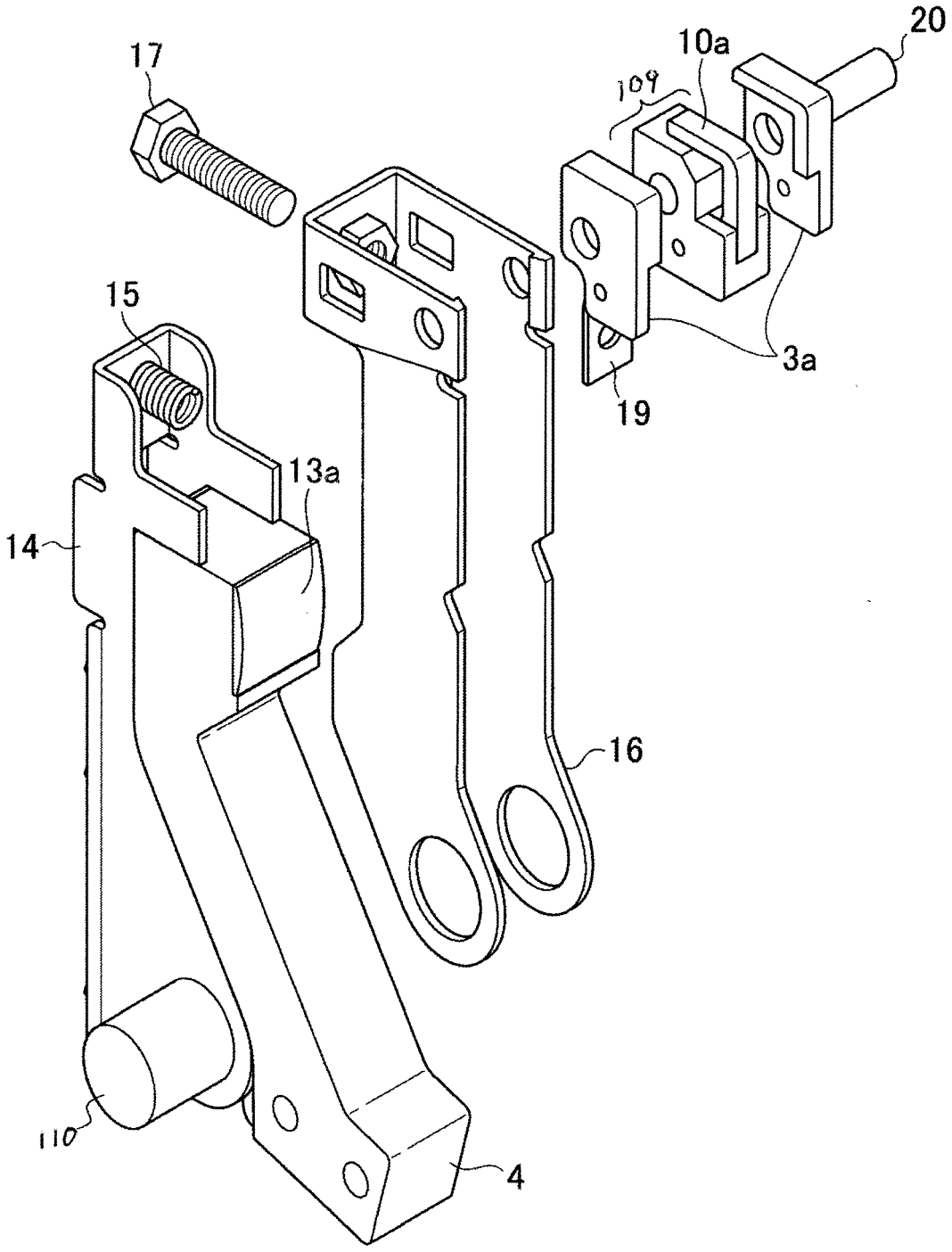


FIG. 24

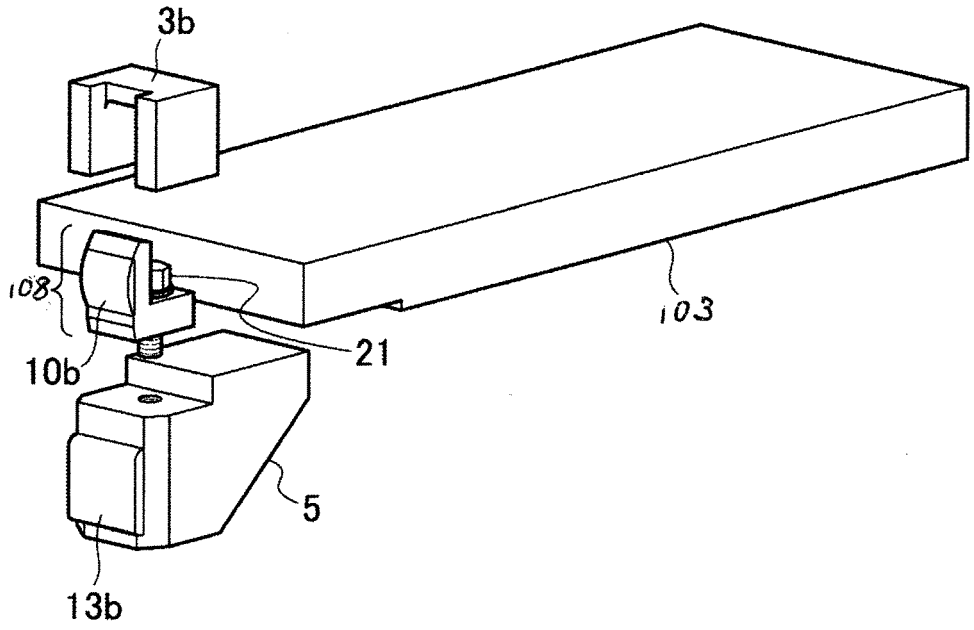


FIG. 25

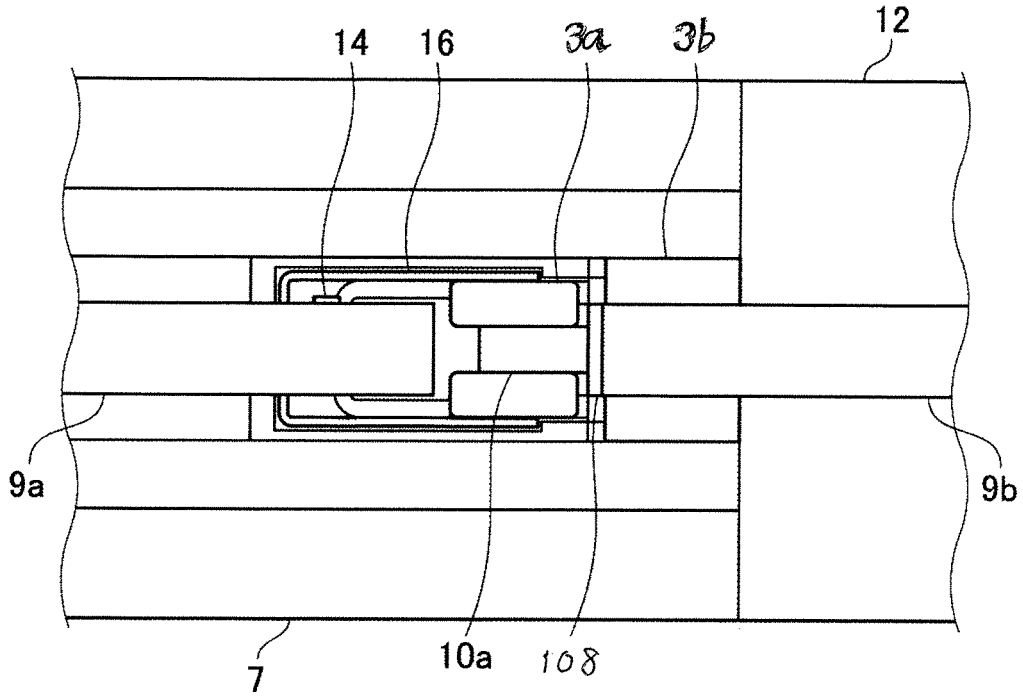
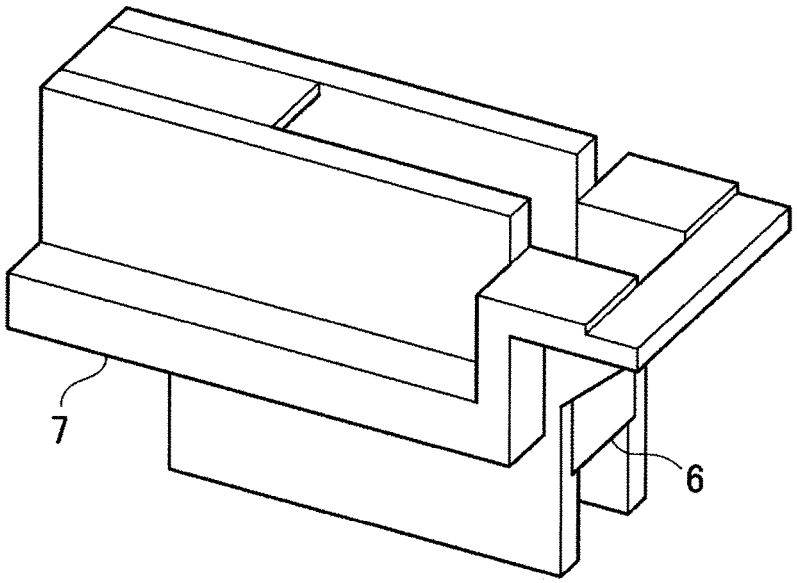


FIG. 26

(a)



(b)

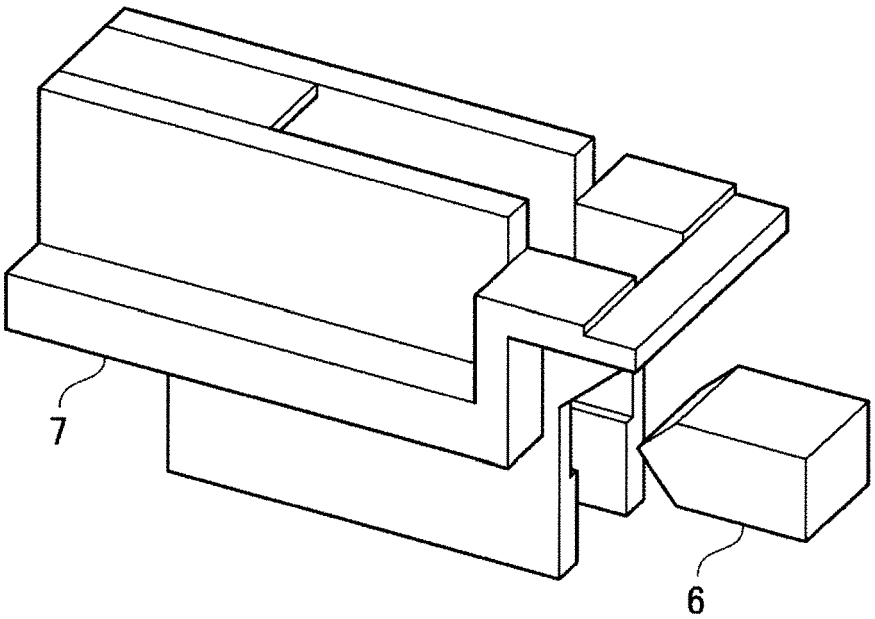
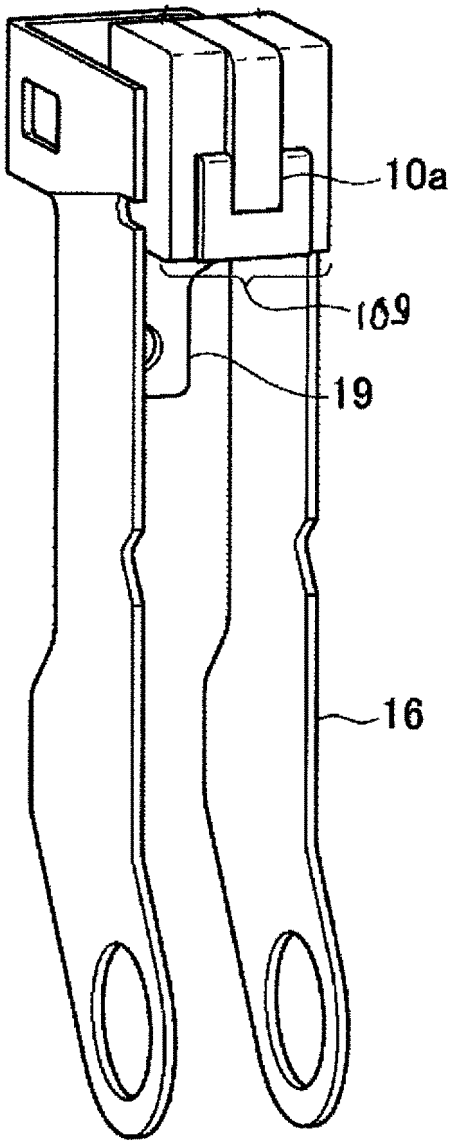


FIG. 27



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/015829

A. CLASSIFICATION OF SUBJECT MATTER
H01H33/08(2006.01)i, *H01H33/12*(2006.01)i, *H01H33/18*(2006.01)i, *H01H33/20*(2006.01)i, *H01H73/02*(2006.01)n, *H01H73/18*(2006.01)n

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)
H01H33/08, H01H33/12, H01H33/18, H01H33/20, H01H73/02, H01H73/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017
Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 52-3464 B1 (Siemens AG.), 28 January 1977 (28.01.1977), column 3, line 9 to column 4, line 34; fig. 1 to 2 & DE 1926693 A1	1-3,7-8, 12-13,17-19 4-6,9-11, 14-16
Y A	JP 2015-130277 A (Mitsubishi Electric Corp.), 16 July 2015 (16.07.2015), paragraphs [0014] to [0015]; fig. 1 to 3 (Family: none)	1-3,7-8, 12-13,17-19 4-6,9-11, 14-16

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

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Date of the actual completion of the international search	Date of mailing of the international search report
24 July 2017 (24.07.17)	01 August 2017 (01.08.17)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/015829

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 173933/1985(Laid-open No. 82536/1987) (Yaskawa Electric Mfg. Co., Ltd.), 26 May 1987 (26.05.1987), (Family: none)	1-19
A	EP 0955659 A2 (EATON CORP.), 10 November 1999 (10.11.1999), & US 5899323 A & CN 1238539 A	1-19
A	JP 10-269923 A (Mitsubishi Electric Corp.), 09 October 1998 (09.10.1998), (Family: none)	1-19
A	JP 7-320624 A (Fuji Electric Co., Ltd.), 08 December 1995 (08.12.1995), & US 5569894 A & CN 1121635 A	1-19
A	JP 2015-170537 A (Mitsubishi Electric Corp.), 28 September 2015 (28.09.2015), (Family: none)	1-19

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2014216078 A **[0008]**
- JP 2015130277 A **[0008]**
- JP 2018237 A **[0008]**