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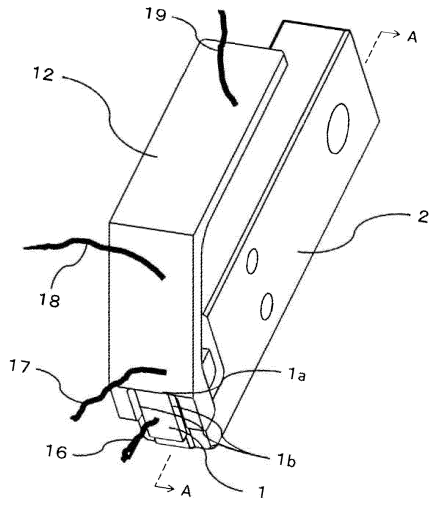
(54) DC CIRCUIT BREAKER

(57) In a DC circuit breaker, in order to achieve life increase by shortening an interruption time and reducing a wear amount of the contact, and the like, it is effective to quickly commutate an arc generated between contacts at the time of interruption to an arc runner. However, it is difficult to achieve high-speed commutation over the entire range from a small current region not larger than a rated value to a large current region such as short-circuit current. Therefore, a fixed-side arc runner (12) is shaped to cover a portion around a fixed contact (1), whereby an arc can be commutated at a high speed from the small current region to the large current region, thereby improving interruption performance.

FIG. 3



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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a DC circuit breaker.

BACKGROUND ART

[0002] A DC circuit breaker includes a fixed element having a fixed contact, a movable element having a movable contact contactable with and separable from the fixed element, arc runners for transferring an arc generated between contacts from the contacts, and an arc extinguishing chamber for extinguishing the arc, and the arc runners are respectively disposed near the fixed element and the movable element.

[0003] In such a configuration, an arc generated between the contacts upon contact separation at the time of current interruption is commutated from the contacts to the arc runners and travels on the arc runners, so as to be driven to the arc extinguishing chamber. Then, the arc enters grids inside the arc extinguishing chamber and is divided, so that an arc voltage not smaller than a power supply voltage of a DC circuit occurs, whereby the current is limited and interrupted.

[0004] At the time of the interruption, the DC circuit breaker quickly commutates an arc generated between contacts to the arc runners and drives the arc to the arc extinguishing chamber, whereby the life of the contacts can be prolonged by a shortened interruption time and a reduced wear amount of the contacts. Therefore, a configuration in which a protrusion is provided at a fixed-side arc runner to promptly commutate a generated arc from contacts to arc runners, is known (e.g., see Patent Document 1).

CITATION LIST

PATENT DOCUMENT

[0005] Patent Document 1: Japanese Laid-Open Patent Publication No. 2010-170876

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0006] In the above-described arc runner configuration, an effect can be expected in a small current region not larger than rated current, in which it is difficult to commutate an arc from the contacts to the arc runners. In contrast, an effect that commutation time is shortened according to the shape of a commutation destination is small in a large current region not smaller than rated current, in which the arc diameter is large and driving force is great. Therefore, it is difficult to improve commutation and traveling performance over the entire region from the small current region to the large current region by using the shape of an arc runner.

[0007] The present disclosure has been made to solve the above problem, and an object of the present disclosure is to provide a DC circuit breaker including an arc runner capable of obtaining high interruption performance by shortening commutation time.

MEANS TO SOLVE THE PROBLEM

[0008] A DC circuit breaker according to the present disclosure includes a fixed element having a fixed contact, a movable element having a movable contact contactable with and separable from the fixed contact, and a fixed-side arc runner that is disposed near the fixed contact and the movable contact and that drives an arc generated at the time of opening of the fixed contact and the movable contact to an arc extinguishing chamber. The fixed contact has an end surface connected to the fixed-side arc runner and side surfaces adjacent to the end surface, and the fixed-side arc runner is formed so as to cover the end surface and the side surfaces of the fixed contact.

EFFECT OF THE INVENTION

[0009] In the DC circuit breaker according to the present disclosure, a biased magnetic flux occurs around the generated arc, whereby driving force toward a fixed-side arc runner is increased and commutation time is shortened, thereby obtaining high interruption performance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

[FIG. 1] FIG. 1 is a schematic sectional view of the entire configuration of a DC circuit breaker.

[FIG. 2] FIG. 2 is a sectional view illustrating movement of an arc in an interruption process of the DC circuit breaker.

[FIG. 3] FIG. 3 is a perspective view of a fixed element and a fixed-side arc runner according to embodiment 1.

[FIG. 4] FIG. 4 is a sectional view of the fixed element and the fixed-side arc runner, along line A-A in FIG. 3.

[FIG. 5] FIG. 5 is a front view of the fixed element and the fixed-side arc runner according to embodiment 1 when seen from a contact abutting surface side.

[FIG. 6] FIG. 6 is a sectional view of a fixed element and a fixed-side arc runner according to embodiment 2.

[FIG. 7] FIG. 7 is a sectional view of a fixed element and a fixed-side arc runner according to embodiment 3.

[FIG. 8] FIG. 8 is a perspective view of a fixed element

and a fixed-side arc runner according to embodiment 4.

[FIG. 9] FIG. 9 is a perspective view of a fixed element and a fixed-side arc runner according to embodiment 5.

[FIG. 10] FIG. 10 is a sectional view of the fixed element and the fixed-side arc runner along a line A-A in FIG. 9.

DESCRIPTION OF EMBODIMENTS

[0011] Hereinafter, preferred embodiments of a DC circuit breaker according to the present disclosure will be described with reference to the drawings. The same features and corresponding parts are denoted by the same reference characters, and detailed descriptions thereof will be omitted. In the subsequent embodiments as well, redundant descriptions of components denoted by the same reference characters will be omitted.

Embodiment 1

[0012] FIG. 1 is a schematic sectional view of the entire configuration of the DC circuit breaker of embodiment 1, FIG. 2 is a sectional view illustrating movement of an arc in an interruption process of the DC circuit breaker, FIG. 3 is a perspective view of a fixed element and a fixed-side arc runner of the DC circuit breaker, and FIG. 4 is a sectional view along line A-A in FIG. 3.

[0013] First, the configuration of the DC circuit breaker will be described. The DC circuit breaker includes a fixed element 3 composed of a fixed contact 1 and a fixed contact base metal 2, and a movable element 6 composed of a movable contact 4 and a movable contact base metal 5 contactable with and separable from the fixed contact 1. When current is conducted, the movable element 6 is moved toward a fixed element by a closing actuator 7 so as to contact with the fixed element 3, whereby current is conducted via an upper conductor 8 connected to the fixed element 3 and a lower conductor 9 connected to the movable element 6.

[0014] When failure current flows at the time of current interruption, a detector 10 disposed on the lower conductor 9 detects the failure current and is operated, and releases a latch 11 having held the movable element 6, whereby the movable element 6 is separated from the fixed element 3 to perform an opening operation.

[0015] When the opening operation is performed at the time of current interruption, an arc 16 shown in FIG. 2 is generated (hereinafter referred to as arcing) between the fixed contact 1 and the movable contact 4. As shown by an arc 17, the arc 16 generated between the contacts is transferred (hereinafter referred to as commutated) to a fixed-side arc runner 12 disposed near the fixed element 3 (fixed contact 1) and a movable-side arc runner 13 disposed near the movable element 6 (movable contact 4). Then, as shown by an arc 18, the arc 17 generated between the fixed-side arc runner 12 and the movable-side arc runner 13 travels in a direction away from the contacts by an electromagnetic force due to current flowing on each arc runner or a flow of a conductive hot gas generated in arcing or the like.

[0016] As shown by an arc 19, the arc 18 enters an arc extinguishing chamber 15 in which many grids 14 each formed of a thin-plate-shaped magnetic material are arranged, and the arc 19 is divided by the grids 14, so that an arc voltage is increased and becomes a power supply voltage of the circuit or higher, whereby the current is limited and interrupted. As described above, the arc 16 generated by separation of the movable contact 4 is commutated to the fixed-side arc runner 12, travels in a direction opposite to the contacts, and then enters the grids 14 so as to be interrupted.

[0017] Next, with reference to the perspective view of the fixed-side arc runner 12 shown in FIG. 3 and the sectional view along line A-A shown in FIG. 4, the configuration of the fixed-side arc runner 12 will be described. In FIG. 3 and FIG. 4, components other than the fixed-side arc runner 12 and the fixed element 3 are omitted. Also, appearance of each arc only on the fixed side is shown.

[0018] In FIG. 3 and FIG. 4, the fixed contact 1 made of a silver alloy, the fixed contact base metal 2 made of copper, and the fixed-side arc runner 12 made of iron are brazed and configured so as to be in contact with each other. The fixed contact 1 has an end surface 1a (hereinafter, referred to as upper surface) that is connected to the fixed-side arc runner 12, and side surfaces 1b adjacent to the upper surface 1a. The side surfaces 1b of the fixed contact 1 are opposed to the fixed-side arc runner 12, and the fixed-side arc runner 12 is formed so as to cover the upper surface 1a and the side surfaces 1b of the fixed contact 1.

[0019] Next, operation and effect of the fixed-side arc runner 12 will be described. When the arc 16 is generated, an electromagnetic force from the fixed contact 1 toward the fixed-side arc runner 12 is generated due to a self-magnetic field of a main circuit current path. The arc 16 subjected to the electromagnetic force is elongated form the fixed contact 1 to the fixed-side arc runner 12 side and an arcing point thereof is commutated from the fixed contact 1 to the fixed-side arc runner 12.

[0020] In the present configuration, the fixed-side arc runner 12 as a magnetic material is formed in a range including a portion around the fixed contact 1, whereby not only the electromagnetic force due to the self-magnetic field but also a biased magnetic flux can occur. More specifically, the fixed-side arc runner 12 is formed in a shape covering from the upper part of the fixed contact 1 to the side surfaces 1b of the fixed contact 1, that is, the fixed-side arc runner 12 covers in a U shape from the upper part of the fixed contact 1, whereby the biased magnetic flux is used.

[0021] FIG. 5 is a view of the fixed-side arc runner 12 when seen from an abutting surface side of the fixed contact 1. In FIG. 5, the current due to the arc 16 generated

between the fixed contact 1 and the movable contact 4 flows toward a frontward direction 20 of the drawing sheet, and a magnetic flux 21 occurs in a right-hand screw direction with respect to the current. When a magnetic material (fixed-side arc runner 12) is disposed near the magnetic flux 21 that has occurred, the magnetic flux passes in the magnetic material having high magnetic permeability, and the magnetic flux that is originally concentric with current is biased. As a result, an electromagnetic force 22 toward the fixed-side arc runner 12 occurs in the arc through which current flows, and the arc is quickly elongated, thereby shortening commutation time.

[0022] Such a shape that the side surfaces 1b of the fixed contact 1 are covered by the fixed-side arc runner 12 corresponds to a configuration for generating larger bias in a magnetic flux and increasing an electromagnetic force. The fixed-side arc runner 12 only has to cover at least a part of the side surfaces 1b of the fixed contact 1. However, if the length of the side surface portions of the fixed-side arc runner 12 covering the fixed contact 1 extends to a position lower than a bottom part of the contact, the magnetic flux positioned lower than an arcing position also passes the fixed-side arc runner 12, so that the electromagnetic force toward the fixed-side arc runner 12 decreases. Thus, the length of the side surface portions of the fixed-side arc runner 12 covering the fixed contact 1 preferably extends to a contact intermediate position substantially corresponding to the arcing position.

[0023] In addition, the upper part (upper surface 1a) of the fixed contact 1 is brazed so as to be in contact with the fixed-side arc runner 12. The arc generated between the contacts is commutated to the fixed-side arc runner 12. However, if there is a step or a gap between the fixed contact 1 and the fixed-side arc runner 12, commutation is not smoothly performed, so that interruption performance may decrease or failure of interruption may be caused. Thus, the upper part of the fixed contact 1 and the fixed-side arc runner 12 are in contact with each other, thereby promoting commutation.

[0024] In addition, the contact-direction height of the fixed-side arc runner 12 at the side surface portions of the fixed contact 1 is preferably the same as that of a contact abutting surface or lower than the contact abutting surface. If the fixed-side arc runner 12 at the side surface portions of the fixed contact 1 is made higher than the contact abutting surface and disposed nearer the movable contact 4 than the fixed contact 1, an opening distance between the movable element 6 and the fixed element 3 is shorter than the distance between the contacts, so that withstand voltage performance may be deteriorated, and the movable contact 4 may come into contact with the fixed-side arc runner 12 at the time of closing and thus conduction fault may be caused.

[0025] The height of the contact abutting surface (surface to separate/contact from/to movable contact 4) of the fixed contact 1 means a height from a lower surface (surface opposite to the contact abutting surface) of the fixed contact 1. When a plane including the lower surface of the fixed contact 1 is defined as a reference plane, the height of portions, which respectively cover the side surfaces 1b of the fixed contact 1, of the fixed-side arc runner 12 means a height in a contact direction (the left direction in FIG. 4) from the reference surface.

[0026] As described above, according to the present embodiment, the end surface (upper surface) and the side surfaces adjacent to the upper surface of the fixed contact 1 are covered with the fixed-side arc runner 12, and the upper part of the fixed contact 1 and the fixed-side arc runner 12 are connected with each other. Accordingly, the biased magnetic flux occurs with respect to the generated arc and thus an electromagnetic force toward the fixed-side arc runner 12 is increased and a driving force is increased, whereby commutation time is shortened, so that high interruption performance can be obtained.

Embodiment 2

[0027] The fixed-side arc runner 12 does not cover a back surface of the fixed contact 1 in embodiment 1, but a fixed-side arc runner 12 has a shape covering not only side surfaces but also a contact back surface of a fixed contact 1 in embodiment 2. The configuration of a DC circuit breaker of embodiment 2 is the same as that of embodiment 1 except that the fixed-side arc runner 12 covers the contact back surface. FIG. 6 is a sectional view showing the fixed-side arc runner of embodiment 2. As shown in FIG. 6, the fixed-side arc runner 12 also covers the contact back surface, and thus a high effect of improving an electromagnetic force is obtained. In addition, the arc runner covering the contact back surface is disposed in such a position as not to be in contact with the arc, and thus the part covering the contact back surface and the fixed-side arc runner 12 may be formed as separate members.

Embodiment 3

[0028] In embodiment 3, a slit 23 is provided in the fixed contact base metal 2. In the configuration, an electromagnetic force due to the self-magnetic field is increased. The configuration of a DC circuit breaker in embodiment 3 is the same as those of embodiments 1 and 2 except that the slit 23 is provided.

[0029] FIG. 7 is a sectional view of the fixed-side arc runner 12 of the present embodiment when seen from a side surface thereof. The slit 23 is formed rearward of a contact back surface of the fixed contact base metal 2 so as to be parallel to the abutting surface of the fixed contact 1. In FIG. 7, an example in which the slit 23 is formed in the fixed-side arc runner 12 of embodiment 2 is shown, but the slit may be formed in the fixed-side arc runner 12 of embodiment 1.

[0030] As in the present configuration, the slit 23 is formed in a portion (an upper surface of the fixed contact

base metal 2 in FIG. 7), on the fixed-side arc runner 12 side in the fixed contact base metal 2, whereby a path 24 is formed such that a current path thereof near the fixed contact 1 circumvents the slit 23 and advances from below, and by the magnetic flux that occurs from the path 24, an electromagnetic force 25 toward the fixed-side arc runner 12 acts on the arc 16 generated between the contacts. Accordingly, elongation of the arc is promoted and commutation time can be shortened.

[0031] In the above configuration, a higher effect is obtained, as the slit 23 provided in the fixed contact base metal 2 approaches the abutting surface of the fixed contact 1. In addition, a higher effect is obtained, when the slit 23 is formed deeper so as to reach the vicinity of a lower part of the fixed contact base metal 2. It is effective and preferable that the slit 23 has such an angle as to be parallel to the abutting surface of the fixed contact 1. However, even if the above angle is changed to a predetermined angle other than the above angle, a similar effect is obtained. Furthermore, a position where the slit 23 is provided may be determined, in consideration of mechanical strength that can withstand contact opening/closing and a limit value of temperature increase due to energization, and the slit 23 may be provided in a different position for another configuration having a different rated value or the like.

[0032] A part of the fixed-side arc runner 12 as described in embodiments 1 and 2 may be disposed rearward of the slit 23 to ensure the strength. Such a configuration increases not only strength, but also an effect caused by the electromagnetic force when a deep slit is provided. In this configuration, the slit 23 is partially closed with the fixed-side arc runner 12, and thus a current path flowing from above to the contact direction via the fixed-side arc runner 12 occurs. In this case, a difference between conductivity of copper, which is a material of the fixed contact base metal 2, and conductivity of iron, which is a material of the fixed-side arc runner 12, allows lower-path current passing through copper to be dominant, and thus strength is ensured without significantly reducing the electromagnetic force.

Embodiment 4

[0033] In embodiment 4, ribs 26 are provided at the side surfaces of the fixed-side arc runner 12. FIG. 8 is a perspective view of the fixed element and the fixed-side arc runner of the present embodiment. As shown in FIG. 8, the ribs 26 continuing from the vicinity of the contact to the end of the fixed-side arc runner 12 are respectively erected on the side surfaces of the fixed-side arc runner 12. The present configuration promotes commutation and traveling of an arc, in small current that is not larger than a rated current value and that has a weak arc driving force. The configuration of a DC circuit breaker in embodiment 4 is the same as those in embodiments 1 to 3 except that the ribs 26 are provided.

[0034] In an arc in a small current region not greater than rated current, since current is small as compared to a large current region, an electromagnetic force due to a self-magnetic field and a biased magnetic flux is small. In addition, an arc causes less ablation of the contact and the arc runner, and thus conductivity is less likely to be increased in a space to which the arc has been commutated. For these reasons, there is a problem that an arc driving force is small and commutation and travelling are poor. In contrast, to interrupt small current, a configuration in which an air puffer for blowing air from under a contact during contact opening is provided, and an arc is forcibly driven to the arc extinguishing chamber 15 to perform interruption, can be used. However, in the configuration using the air puffer, the device tends to be upsized.

[0035] In the present embodiment, such a characteristic that an arc is likely to be generated at the edge is utilized, the ribs 26 are respectively erected on the side surfaces of the fixed-side arc runner 12, and furthermore, the ribs 26 are provided so as to continue to the end of the fixed-side arc runner 12, whereby commutation performance and traveling performance are improved and elongation of an arc is promoted, so that a high arc voltage can be obtained, thereby improving interruption performance for small current. The same effects are provided even in a case where this configuration is provided in the movable-side arc runner 13. In addition, the DC circuit breaker of the present embodiment leads to reduction in size and weight thereof, compared to the DC circuit breaker using the air puffer.

[0036] In the present configuration, each rib 26 and the fixed-side arc runner 12 are integrally formed through cutting processing, but may be produced as different members and may be fastened by a bolt, a rivet, or the like or welded to each other. Alternatively, the rib 26 may be formed through not only cutting processing but also sheet metal bending processing.

[0037] When the fixed-side arc runner 12 and each rib 26 of the side surface thereof are formed as separate members, a portion (e.g., a screwing portion in a case where they are fixed by screwing) where they are connected and the other portion have different contact degrees. Since current flows concentratedly through the connection portion having a high contact degree, current having flowed through the connection portion may apply an electromagnetic force in a contact direction to an arc, depending on a position where the connection portion is formed, so that the arc flows backward toward the contact side in some cases. In contrast, when the ribs 26 and the fixed-side arc runner 12 are integrally formed, current does not flow concentratedly through the connection positions, and the arc driving force only toward the arc extinguishing chamber 15 can be obtained. Thus, the ribs 26 on the side surfaces of the fixed-side arc runner 12 are preferably formed integrally with the fixed-side arc runner 12.

Embodiment 5

[0038] In embodiment 5, the fixed-side arc runner 12, the fixed contact 1, and the fixed contact base metal 2 are integrated. FIG. 9 is a perspective view of the fixed element and the fixed-side arc runner of the present embodiment, and FIG. 10 is a sectional view of the fixed element and the fixed-side arc runner along line A-A in FIG. 9. The configuration of a DC circuit breaker of embodiment 5 is the same as that of embodiment 4 except that the fixed-side arc runner 12, the fixed contact 1, and the fixed contact base metal 2 are integrated. In FIG. 9 and FIG. 10, the fixed contact 1, the fixed contact base metal 2, and the fixed-side arc runner 12 are integrally brazed, and then a cutting processing 27 is performed on a portion from an upper end surface of the fixed contact 1 to the fixed-side arc runner 12, whereby a boundary between the upper end surface of the fixed contact 1 and the fixed-side arc runner 12 is formed to be smoothly continuous. In such a configuration, a generated small current arc is prevented from being stagnant and staying at the boundary that is a joint between the fixed contact 1 and the fixed-side arc runner 12 and that is formed after brazing, commutation to the fixed-side arc runner 12 is promoted, and interruption performance can be improved.

[0039] As shown in FIG. 9 and FIG. 10, when an inclined portion 1c inclined toward the fixed-side arc runner 12 is formed on an upper portion of the contact surface of the fixed contact 1, the cutting faces of the inclined portion 1c and the fixed contact 1 can be flush, and a boundary between the inclined portion 1c of the fixed contact 1 and the fixed-side arc runner 12 can be smoothly continuous through cutting processing.

[0040] In the present configuration, for the joint between the contact and the arc runner, cutting processing is performed to reach an upper end of the arc runner. However, effects are provided even in a case where cutting processing is performed only on a portion around the bonding surface between the upper surface of the contact and a lower portion of the arc runner.

[0041] In FIG. 9 and FIG. 10, although an example in which the above integrated configuration is applied to the DC circuit breaker of embodiment 4, the above integrated configuration may be applied to the DC circuit breaker in each of embodiments 1 to 3.

[0042] 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.

[0043] It is therefore understood that numerous modifications which have not been exemplified can be devised without departing from the 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

[0044]

1	fixed contact
2	fixed contact base metal
3	fixed element
4	movable contact
5	movable contact base metal
6	movable element
7	closing actuator
8	upper conductor
9	lower conductor
10	detector
11	latch
12	fixed-side arc runner
13	movable-side arc runner
14	grid
15	arc extinguishing chamber
16, 17, 18, 19	arc
23	slit
26	rib

Claims

1. A DC circuit breaker comprising:

a fixed element having a fixed contact;
a movable element having a movable contact contactable with and separable from the fixed contact; and
a fixed-side arc runner that is disposed near the fixed contact and the movable contact and that drives an arc generated at a time of opening of the fixed contact and the movable contact to an arc extinguishing chamber, wherein
the fixed contact has an end surface connected to the fixed-side arc runner and side surfaces adjacent to the end surface, and
the fixed-side arc runner is formed so as to cover the end surface and the side surfaces of the fixed contact.

2. The DC circuit breaker according to claim 1, wherein the fixed-side arc runner is formed so as to cover a back surface of the fixed contact.

3. The DC circuit breaker according to claim 1 or 2, wherein

a slit is formed rearward of a connection part with the fixed contact, of a fixed contact base metal connected to the fixed contact to form the fixed element, and
the slit is formed in a portion on the fixed-side arc runner side of the fixed contact base metal.

4. The DC circuit breaker according to any one of claims 1 to 3, wherein a rib is formed on a side surface portion of the fixed-side arc runner.

5. The DC circuit breaker according to claim 4, wherein the rib formed on the side surface portion of the fixed-side arc runner is integrally formed with the fixed-side arc runner.

6. The DC circuit breaker according to any one of claims 1 to 3, wherein

the fixed-side arc runner, the fixed contact, and the fixed contact base metal connected to the fixed contact to form the fixed element are integrated,
an inclined portion inclined toward the fixed-side arc runner is disposed on the end surface side of the fixed contact, and
a boundary between the fixed contact and the fixed-side arc runner has a smooth shape.

7. The DC circuit breaker according to any one of claims 1 to 6, wherein
a height of a contact abutting surface of the fixed contact is the same as or higher than that of a portion, covering the side surface of the fixed contact, of the fixed-side arc runner.

FIG. 1

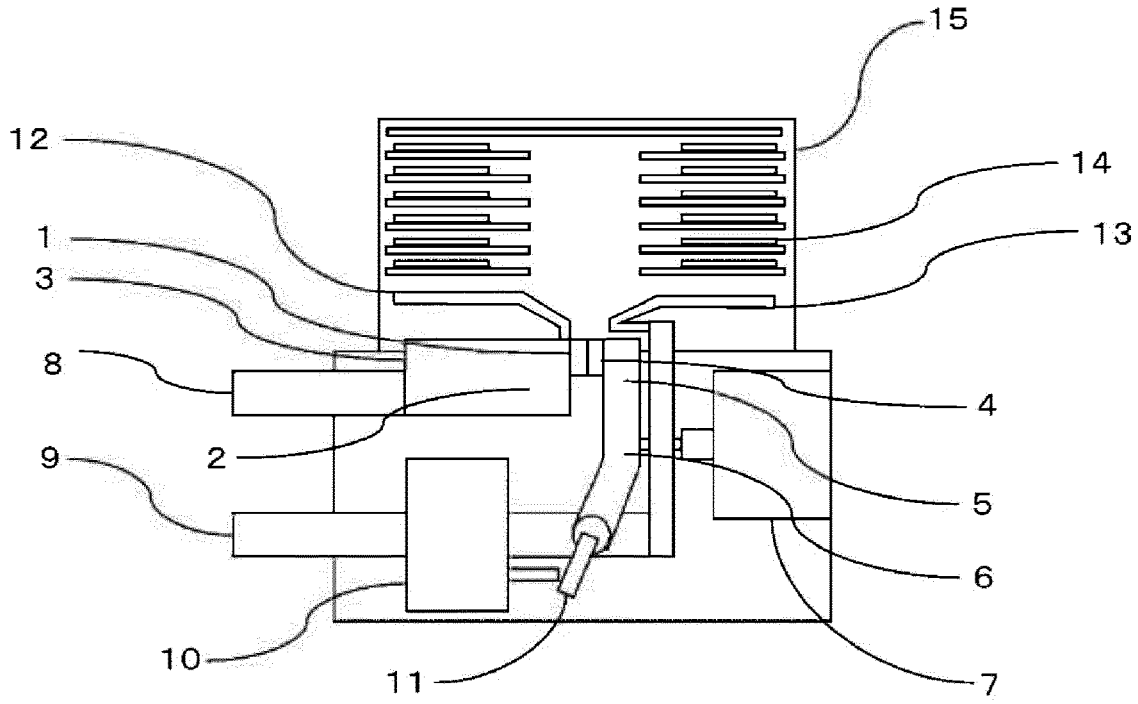


FIG. 2

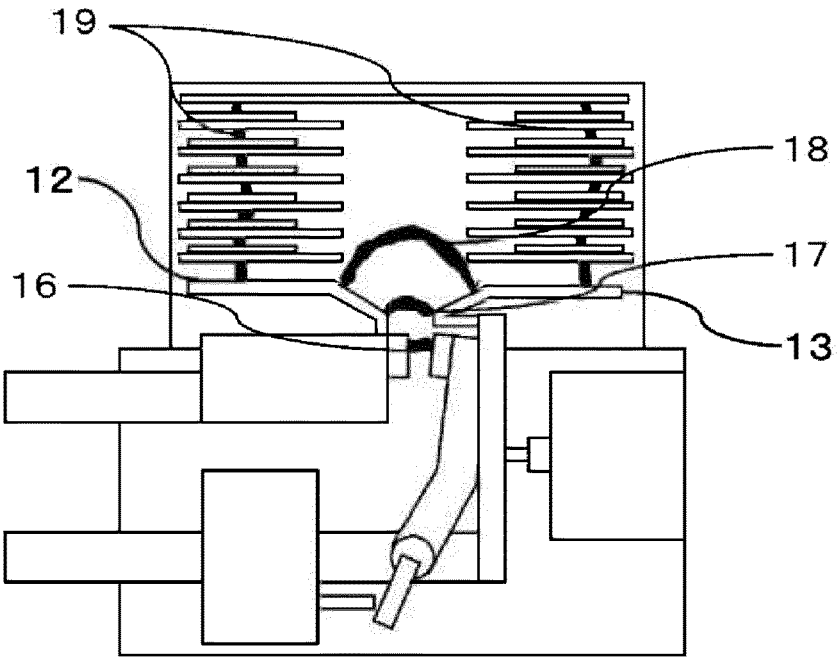


FIG. 3

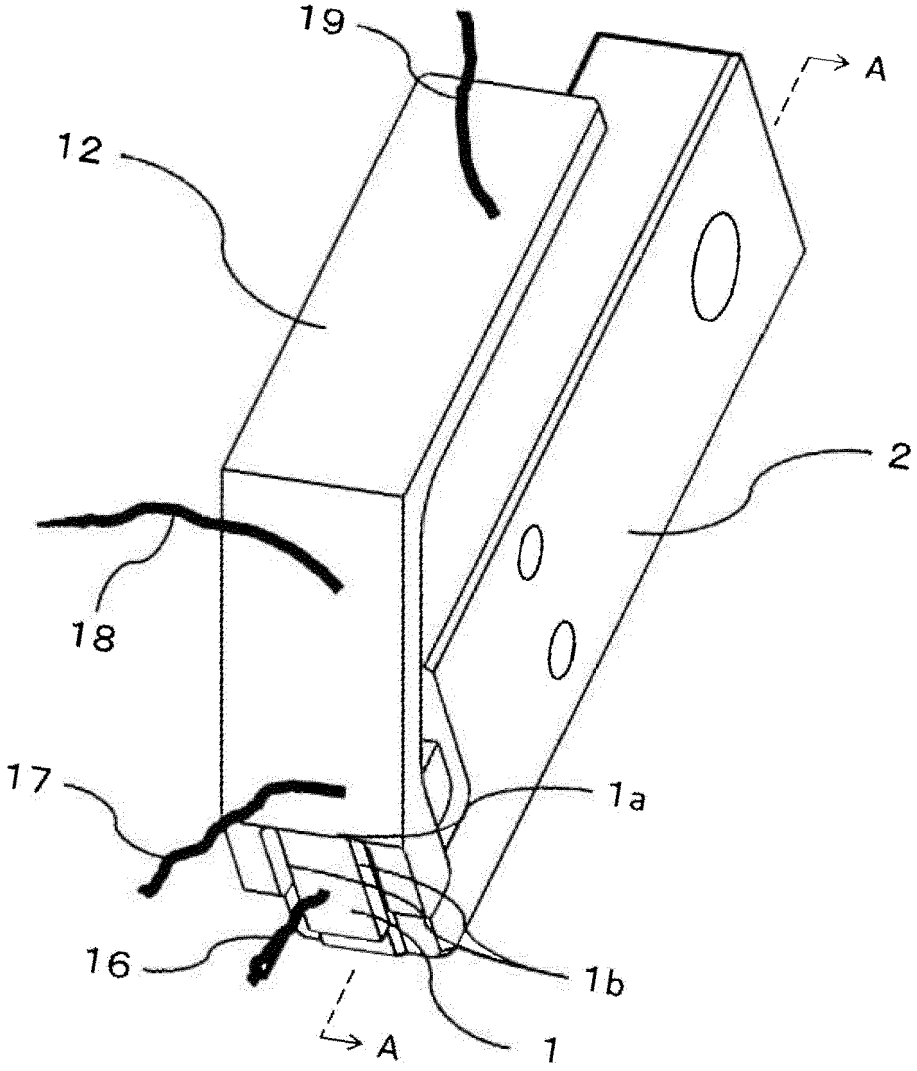


FIG. 4

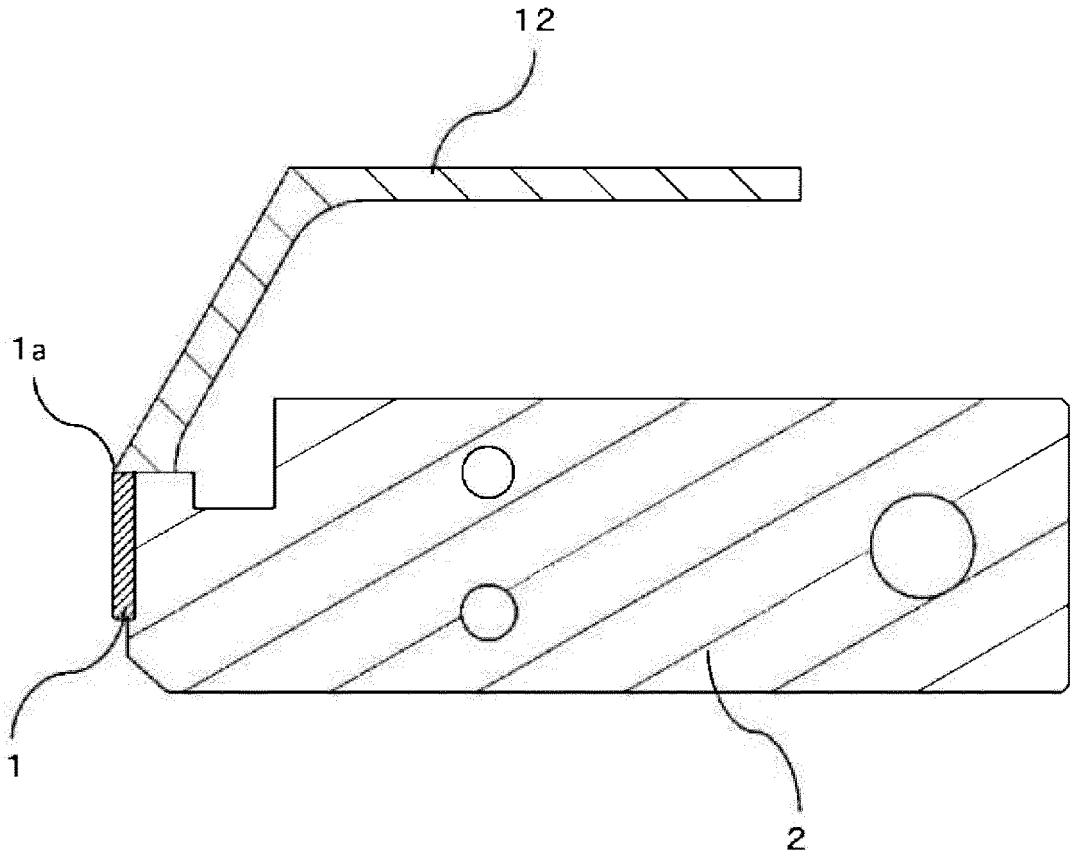


FIG. 5

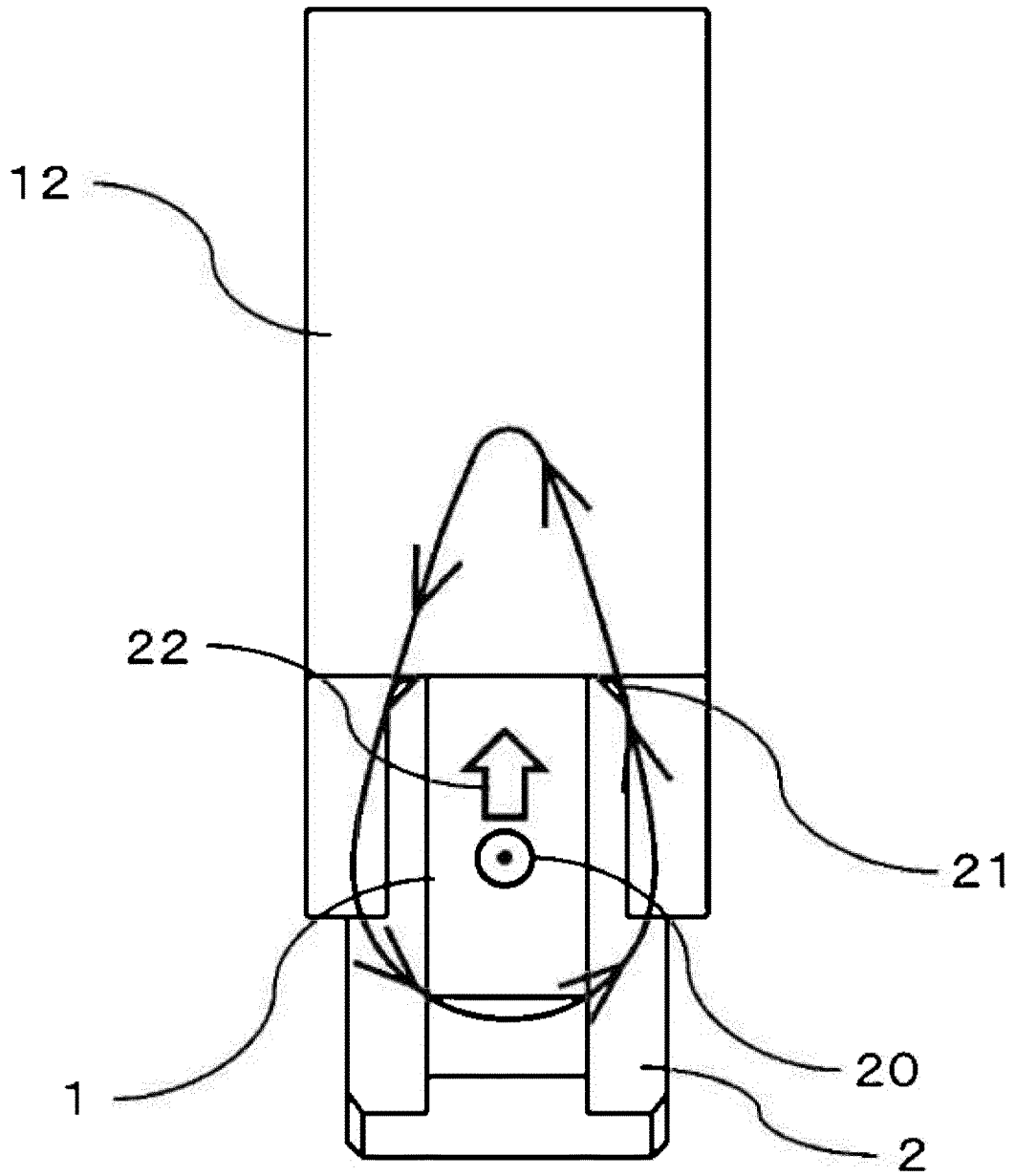


FIG. 6

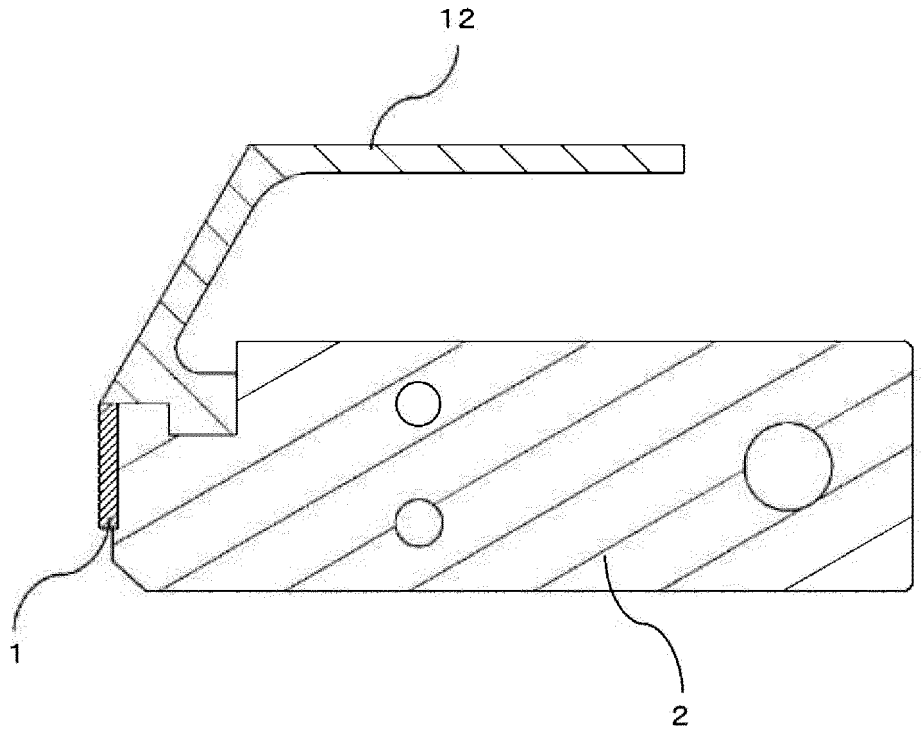


FIG. 7

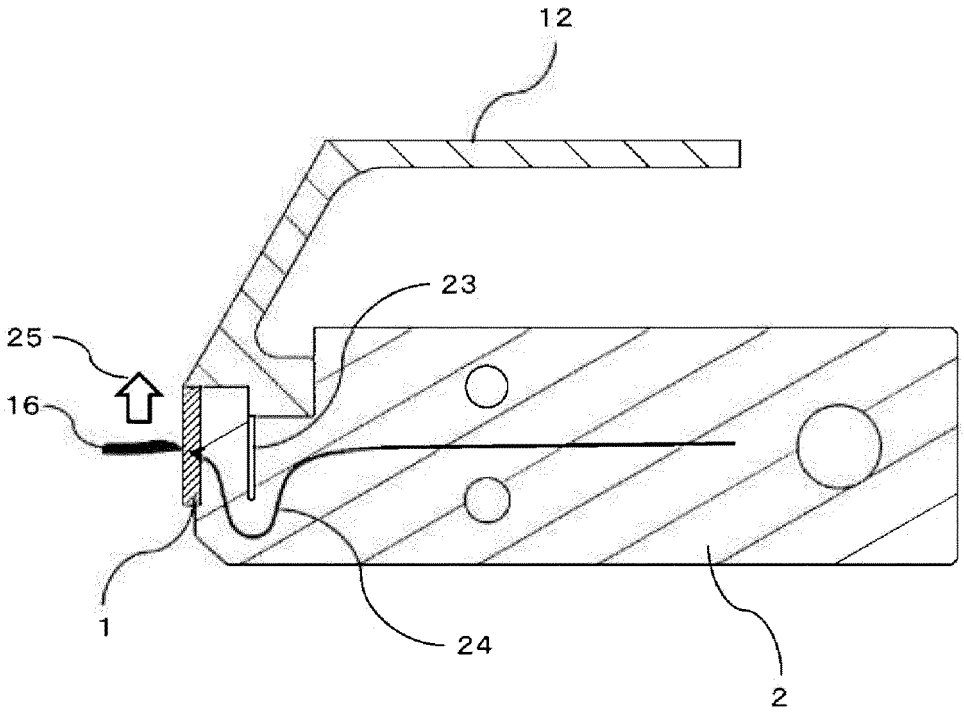


FIG. 8

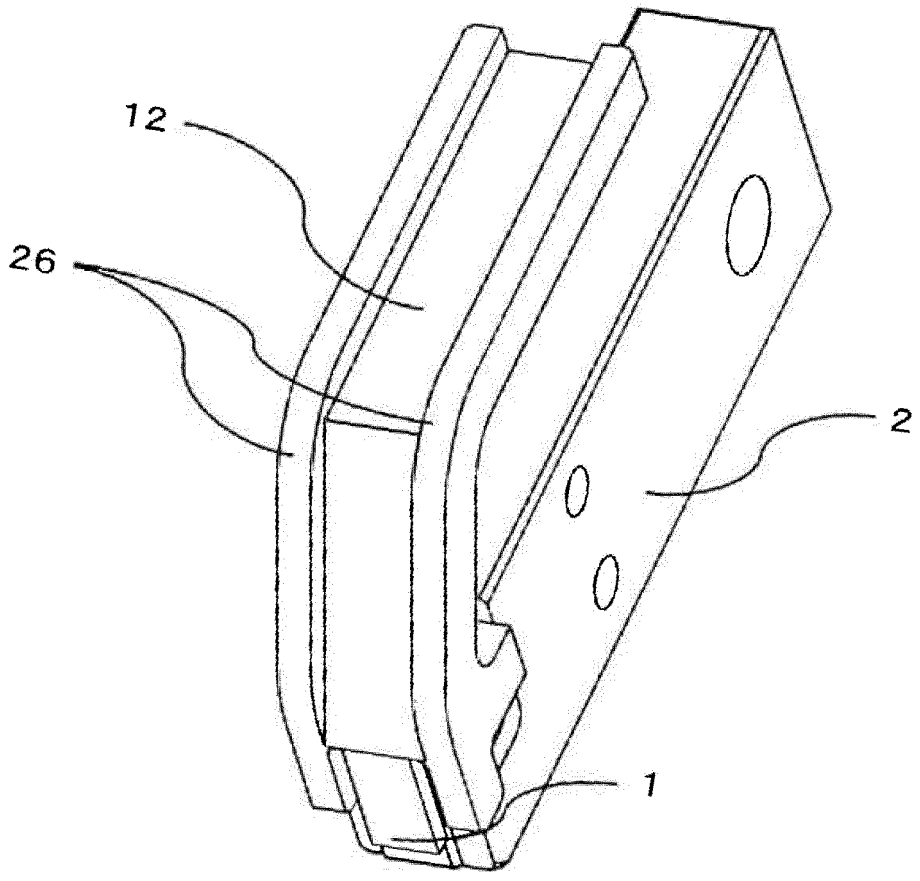


FIG. 9

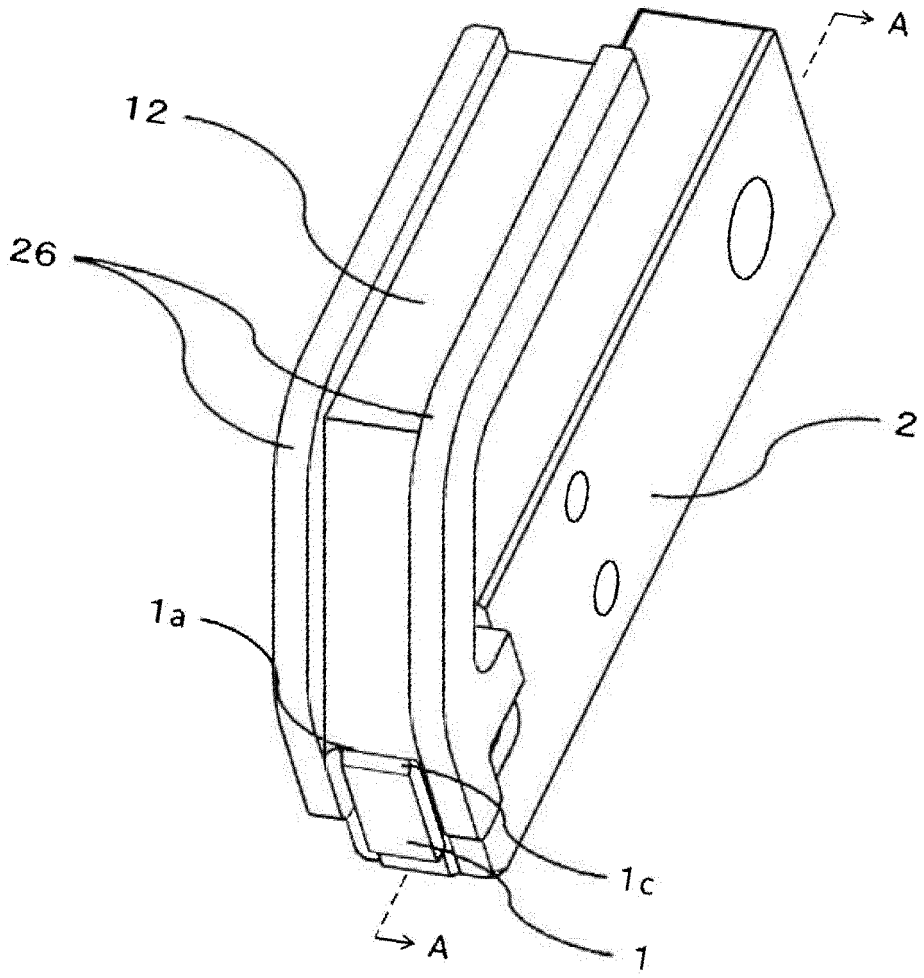
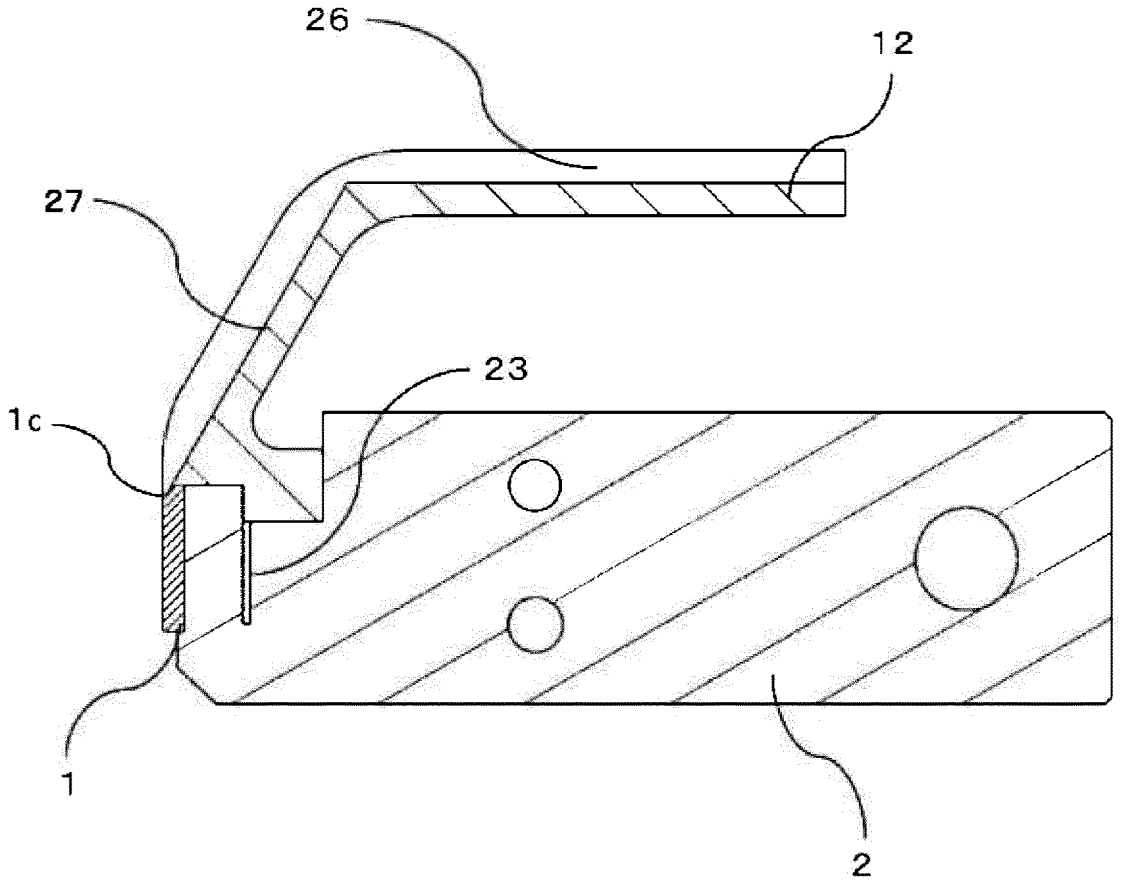


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/021668

A. CLASSIFICATION OF SUBJECT MATTER
H01H 9/38(2006.01)i; H01H 73/02(2006.01)i; H01H 73/18(2006.01)i
FI: H01H73/18 A; H01H73/02 C; H01H9/38

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)
H01H9/38; H01H73/02; H01H73/18

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	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

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.
X Y	JP 2014-175113 A (HITACHI INDUSTRIAL EQUIPMENT SYSTEMS CO LTD) 22 September 2014 (2014-09-22) paragraph [0029], fig. 1, 5	1, 2 3-7
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 026733/1986 (Laid-open No. 1390241987) (MITSUBISHI ELECTRIC CORP) 02 September 1987 (1987-09-02) fig. 2	3-7
Y	JP 09-022645 A (FUJI ELECTRIC CO LTD) 21 January 1997 (1997-01-21) paragraph [0016], fig. 1	6, 7
Y	JP 2016-033891 A (KAWAMURA ELECTRIC INC) 10 March 2016 (2016-03-10) fig. 3	6, 7

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"&" document member of the same patent family

Date of the actual completion of the international search 18 August 2021 (18.08.2021)	Date of mailing of the international search report 31 August 2021 (31.08.2021)
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/JP2021/021668

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2001-160348 A (MITSUBISHI ELECTRIC CORP) 12 June 2001 (2001-06-12) fig. 15, 17	6, 7
A	JP 2010-170876 A (MITSUBISHI ELECTRIC CORP) 05 August 2010 (2010-08-05) entire text, all drawings	1-7

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/021668

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2014-175113 A	22 Sep. 2014	(Family: none)	
JP 62-139024 U1	02 Sep. 1987	(Family: none)	
JP 09-022645 A	21 Jan. 1997	(Family: none)	
JP 2016-033891 A	10 Mar. 2016	CN 105321782 A	
JP 2001-160348 A	12 Jun. 2001	(Family: none)	
JP 2010-170876 A	05 Aug. 2010	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2010170876 A **[0005]**