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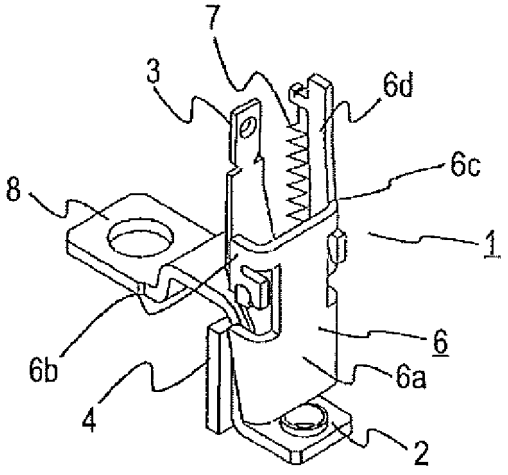
(54) SHORT CIRCUIT DETECTION APPARATUS FOR CIRCUIT BREAKER

(57) To reduce the number of parts and reduce the price by forming an armature support portion (4a) integrally with a stator (4), and secure a sufficient magnetic attractive force by making the support portion (4a) a cantilever structure so that no magnetic path forms across a fulcrum portion. By providing a support portion on a stator (4), the fluctuation in the size of a gap between an armature (6) and the stator (4) is reduced, and the magnetic property is stabilized,

FIG.1



EP 2 261 946 A1

Description

Technical Field

[0001] The present invention relates to a short circuit current detection device for a circuit breaker which, when there is a short circuit of a circuit in which a large short circuit current flows, activates a trip device, causing a main circuit contact to open.

Background Art

[0002] Generally, in a wiring circuit breaker, there is provided a short circuit current detection device which, in the event of short circuit trouble occurring in the main circuit, detects the short circuit current, and momentarily breaks the circuit. The short circuit current detection device is basically based on the following kind of operating principle.
That is, when a short-circuit current flows through the main circuit, a magnetic field is formed in the periphery of the energizing path and, by the magnetic field passing through a turnably supported armature and a stator disposed facing it, the armature is drawn toward the stator. Along with this, by the armature being turned centered on its support portion, urging a trip bar, and activating a breaking mechanism portion, the main circuit is broken.
[0003] In order to hold the armature turnably and stably, it is common to turnably support both end portions of the armature. At this time, in the event that both end portions of the armature are directly supported by the stator, a magnetic circuit is configured by the stator and armature across support portions of either end of the armature.
In this case, one portion of a magnetic flux caused by the short circuit current flows through the magnetic circuit across the support portions, the magnetic flux passing through the support portions does not contribute at all to the movement drawing the armature to the stator, as a result of which the attractive force of the armature decreases, and the attractive force necessary for the operation may become unobtainable.
[0004] Consequently, with this kind of short circuit current detection device, there has been an approach which uses a non-magnetic material for the support member supporting the armature as means of solving the heretofore described problem. As an example of making the support member non-magnetic without increasing the number of parts, there is a case of supporting the armature with the circuit breaker housing (for example, refer to Patent Document 1). This is because the circuit breaker housing is generally formed of a resin, which is a non-magnetic material.
[0005] When using the method of Patent Document 1, no magnetic circuit is configured across the armature support portion, so no reduction in the attractive force occurs. With this configuration, because there is no need for a part for armature support, the product cost is not increased by providing a groove for armature support in the housing, meaning that it is of practical use.
However, as the dimensional accuracy of a resin molded article is generally poor in comparison with a metal machined article, there is a large amount of fluctuation in the setting of the armature position with respect to the stator. In the event that the positional relationship of the stator and armature changes, the magnetic attractive force also changes, meaning that there is a problem in that fluctuation is liable to occur in the short circuit current detection property.
[0006] As another configuration using a non-magnetic support member, one is also proposed which uses a stainless steel non-magnetic member as a support member for supporting the armature (for example, refer to Patent Document 2). This configuration is such that a support member for supporting the armature is added separately, attached on the stator side, but with this configuration there is a problem in that, a dedicated support member being necessary, the number of parts increases, and the manufacturing cost increases.
[0007]

Patent Document 1: Japanese Unexamined Patent Application Publication JP-A-2000-231 870
Patent Document 2: Japanese Unexamined Patent Application Publication JP-A-10-283 899

Disclosure of the Invention

Problems that the Invention is to Solve

[0008] The invention, being contrived in order to solve the heretofore described kinds of problem, has an object of obtaining a circuit breaker short circuit current detection device which is of an armature support structure wherein no loss occurs in a magnetic flux across a support portion when there is a short circuit current energization, and can reduce the fluctuation in the size of a gap between a stator and an armature, without increasing the components at all.

Means for Solving the Problems

[0009] A circuit breaker short circuit current detection device according to the invention is characterized by comprising a conductor fixed in a case, a stator attached integrated with the conductor, and an armature, disposed facing the stator across the conductor, which turns based on a short circuit current flowing through the conductor, wherein the armature includes a movable portion facing the stator, at least one pair of arm portions extending from the movable portion, and an operating portion which activates a trip bar, and wherein the stator includes an armature support portion, extending to the armature side from one end portion of the stator, which engages with and fulcrum supports the arm portions of the armature.

Advantages of the Invention

[0010] According to the invention, with the short circuit current detection device, as the structure is such that it is possible to support the armature directly with the stator without adding a non-magnetic part in order to support the armature, it is possible to reduce the number of parts configuring the device, and possible to downsize and reduce the price.
Also, compared with the case in which the armature is supported by the resin housing of the circuit breaker, it is possible to reduce the fluctuation in the position of the armature with respect to the stator, meaning that it is possible to reduce the fluctuation in the short circuit current detection property without increasing the cost.

Best Mode for Currying Out the Invention

Embodiment 1

[0011] FIG. 1 is a perspective view showing a short circuit current detection device 1 according to an Embodiment 1 of the invention, and FIG. 2 shows a condition wherein an armature 6 and a return spring 7 are removed from the short circuit current detection device 1 of FIG. 1. Component 2 in the drawings, being a heater configured of a conductor, is configured of a bottom portion 2a to be attached to a case, to be described hereafter, an upright portion 2b bent substantially perpendicularly from the bottom portion, and a lead-out portion 2c further bent approximately 90 degrees in a reverse direction, and is connected to an external conductor by a lead-out terminal 8. Component 3 is a bimetal, and is fixed to the upright portion 2b of the heater 2 with a pin 5, as in FIG. 2.
[0012] Component 4 is a stator, and is fixed with the pin 5 on the side of the heater 2 opposite to that of the mounting surface of the bimetal 3, integrated with the bimetal 3. For the integral fixing, besides caulking with a pin, it is possible to employ, for example, a welding or brazing method. Component 6 being the armature, it is disposed on the side of the upright portion 2b of the heater 2 opposite to that of the stator 4, and is turnably supported at its fulcrum by an armature support portion 4a of the stator 4. 7 is the return spring.
[0013] FIG. 3 being perspective views showing a detailed structure of the stator 4, FIG. 3B is a perspective view wherein FIG. 3A is seen from the opposite side. The stator 4 being made of, for example, a ferromagnetic substance such as iron, it is disposed facing the armature 6, to be described hereafter, across the heater 2, as previously described.
The stator 4 has the armature support portion 4a, extended from one end portion of the stator 4, reaching a position facing the stator 4 across the heater 2, and forming a substantial U-shape in combination with the main body of the stator when seen from the top of the drawing.
In FIG. 3, the armature support portion 4a is extended from the right side of the stator 4 facing the drawing, but it may also be extended from the left side. The armature support portion 4a includes, at either end thereof, support portions 4b and 4c which engage with arm portions 6b and 6c of the armature 6, to be described hereafter, and includes a latch portion 4d to which the lower end of the return spring 7 is attached.
[0014] FIG. 4 is a perspective view showing a detailed structure of the armature 6. The armature 6 is configured of a movable portion 6a, which has a surface facing the stator 4, the pair of arm portions 6b and 6c extending in the upper portion of the movable portion 6a, one portion of each of which is bent in an inward direction forming a sideways U shape, and an operating portion 6d extending upward from one of the arm portions (6c in the drawing). Engagement portions 6e and 6f, to be supported at the fulcrums by the heretofore described support portions 4b and 4c of the armature support portion 4a of the stator 4, are formed in the pair of arm portions 6b and 6c. The movable portion 6a includes bent portions 6g bent inwardly in such a way that the two end portions face each other, and cutaway portions 6h such that the armature 6 realizes fulcrum support with the stator 4 in a turnable condition.
[0015] As is clear from the above description, the armature 6 is disposed in a condition facing the stator 4 across the heater 2, which is a current path, and is turnably supported by the armature support portions 4b and 4c of the stator at the engagement portions 6e and 6f provided in the pair of arm portions 6b and 6c provided at both left and right ends.
When assembling, one end (the upper end) of the return spring 7 is attached to a latch portion 6i of the operating portion 6d of the armature 6, the other end (the lower end) is attached to the latch portion 4d of the stator 4, as heretofore described, and the operating portion 6d is urged in a direction away from a trip bar of a circuit breaker, to be described hereafter, by the contractile force of the return spring 7.
[0016] FIG. 5 shows a sectional view of the short circuit current detection device of the Embodiment 1 incorporated into a circuit breaker.
The short circuit current detection device is integrated with an overcurrent detection device utilizing the curvature of the bimetal 3. Next, a description will be given of an operation of the short circuit current detection device and overcurrent detection device.
In the drawing, the device 1 is the heretofore described short circuit current detection device, 11 is the trip bar, 12 is a power source side terminal, 13 is a fixed contact, 14 is a movable contact, 15 is a movable contact holder, 16 is an operating handle, and 17 is a trip mechanism portion.
[0017] The drawing shows a condition wherein the circuit breaker is activated by operating the operating handle 16. A main circuit current flows along a path from the power source side terminal 12, through the fixed contact 13, movable contact 14, movable contact holder 15, and heater 2, to a load side terminal 8.

Now, when an overcurrent exceeding the rated current flows, the heater 2 generates heat at the Joule heat caused by current energization, and the temperature of the bimetal 3 rises. When the temperature of the bimetal 3 rises, its leading edge curves in the direction of the trip bar 11. On the current increasing, the amount of heat generated increases, the temperature rises further, and the amount of curvature increases.

When an overcurrent exceeding the rated current flows, the amount of curvature increases, and the bimetal presses against the trip bar 11. On the trip bar 11 being pressed, the trip mechanism portion 17 operates, and a circuit breaking operation causing the movable contact 14 to momentarily become dissociated from the fixed contact 13 is carried out.

[0018] Next, a description will be given of a short circuit detecting operation. As a magnetic field is formed in the periphery of the current path when a large current flows through the heater 2, the stator 4 and armature 6 are magnetized, and a mutual attractive force is exerted. As a large current that exceeds ten times the rating flows when there is a short circuit, a large attractive force is exerted, and the armature 6 is pulled toward the stator 4 against the return spring 7.

At this time, as the armature 6 is rotationally moved in a clockwise direction centered on the fulcrum portion, the operating portion 6d in the upper portion of the armature 6 is pressed against the trip bar 11, the trip mechanism portion 17 is activated, and the heretofore described current path is broken.

[0019] In the heretofore described short circuit detecting operation, with the structure wherein the armature 6 is fulcrum supported by the stator 4 made of a ferromagnetic substance, as explained before, a magnetic flux generated in the periphery of current path passes through the fulcrum portion, with the result that the magnetic flux passing through the opposing faces of the stator 4 and armature 6 decreases, as previously described.

As the magnetic flux passing through the fulcrum portion does not contribute at all to the rotational movement of the armature 6, the rotational torque exerted on the armature 6 decreases and, it being difficult to obtain the force necessary for the tripping operation when the rotational torque decreases, the short circuit current detection property becomes unstable.

[0020] In a working example of the invention, by providing on the stator 4, the armature support portion 4a extending to the armature side from one end portion of the stator, which engages with and fulcrum supports the arm portions 6b and 6c of the armature, that is, by forming the support portion of the armature 6 in a cantilever shape integrated with the stator 4, the current path of the heater 2 or bimetal 3 does not pass through the inside of a magnetic loop formed by the stator 4 and armature 6 via the support portion.

Consequently, the magnetic field generated because of the main circuit current does not pass through the fulcrum portion, and it does not happen that the rotational torque exerted on the armature 6 decreases.

Embodiment 2

[0021] FIG. 6, being a side view showing a short circuit current detection device 1 according to an Embodiment 2 of the invention, shows a structural example wherein the heater is omitted by making the bimetal itself an energizing path. In the drawing, 9 is a flexible conductor of which one end is joined to the leading edge portion of the bimetal 3 and the other end is joined to the load side terminal 8, and 10 is a connecting conductor connected to the armature holder 15 of FIG. 5. For the heretofore described joining, caulking using rivets or the like, or a welding or brazing method, is used.

[0022] The Embodiment 2 differing from the Embodiment 1 only in that the heater 2 is omitted, the basic configuration of the short circuit current detection device 1 is the same. Consequently, in this case, the bimetal 3 itself is the energizing path, and the overcurrent detection operation is carried out by the bimetal temperature rising, and the bimetal curving, due to the resistance heat generation of the bimetal 3 itself.

With regard to the short circuit current detection operation, as a magnetic field is formed in the periphery of the current path flowing through the connecting conductor 10 and bimetal 3, the stator 4 and armature 6 are magnetized, and a mutual attractive force is exerted. As a large current such that exceeds ten times the rating flows when there is a short circuit, a large attractive force is exerted, and the armature 6 is pulled toward the stator 4 against the return spring 7.

At this time, as the armature 6 is rotationally moved centered on the fulcrum portion, the operating portion 6d in the upper portion of the armature 6 is pressed against the trip bar 11, the trip mechanism portion 17 is activated, and the heretofore described current path is broken.

[0023] As the stator 4 and armature 6 are disposed facing each other across an energizing path including the connecting conductor 10, as heretofore described, a magnetic field caused by the current is formed in the periphery of the conductor 10. At this time, a case of disposing the armature 6 on the trip mechanism portion 17 side of the energizing path, and a case of disposing the stator 4 there, are conceivable.

Herein, a description is given of an example wherein the armature 6 is disposed on the mechanism portion side, but conversely, a configuration wherein the stator 4 is disposed on the mechanism portion side is also possible. In this case, as the direction of rotation of the armature 6 is reversed, it is also necessary to reverse the operating direction of the trip bar, but the details of the working example are applicable in the same way.

[0024] Furthermore, as it also necessary to secure a space in which to dispose the current path between the armature 6 and stator 4, in the working example, by providing the bent portions 6g bent inwardly in such a way that the two end portions face each other on the movable

portion 6a of the armature 6, thus making the surface of the armature 6 facing the stator 4 a U-shape in cross-section, and by making the stator 4 side a flat plate shape, a space remains between the two even in a condition in which the armature 6 is drawn toward the stator 4.
It is also possible to reverse this, making the stator cross-section a U-shape, and the armature a flat plate shape. Also, both of them may be made a U-shape in cross-section.

[0025] As heretofore shown, by providing the armature support portion 4a on the stator 4, and making the support portion a cantilever structure, it is possible to adopt a structure wherein the energizing path does not pass through the inside of the magnetic loop formed by the stator 4 and armature 6 across the support portion 4a.
As no loss occurs in the magnetic flux across the support portion when there is a short circuit current energization, it does not happen that the magnetic attractive force exerted on the armature decreases in comparison with the heretofore known structure.
Also, when comparing the working example with the heretofore known example wherein the armature is supported by the housing, as it possible to reduce the fluctuation in the size of the gap between the stator and armature, it is possible to stabilize the short circuit current detection property.
Also, as opposed to the heretofore known example wherein a non-magnetic armature support part is provided, a part for supporting the armature becomes unnecessary along with the conforming of the short circuit current detection property, meaning that it is possible to reduce the cost.

Brief Description of the Drawings

[0026]

FIG. 1 is a perspective view showing a short circuit current detection device according to an Embodiment 1 of the invention;
FIG. 2 is a diagram showing a condition wherein an armature and a return spring are removed from the short circuit current detection device of FIG. 1;
FIG. 3 is perspective views showing a detailed structure of a stator in the Embodiment 1 of the invention;
FIG. 4 is a perspective view showing a detailed structure of the armature in the Embodiment 1 of the invention;
FIG. 5 is a sectional view showing the short circuit current detection device of the Embodiment I of the invention in a condition in which it is incorporated into a circuit breaker; and
FIG. 6 is a perspective view showing a short circuit current detection device according to an Embodiment 2 of the invention.

Description of Reference Numerals and Signs

[0027]

1 = Short circuit current detection device
2 = Heater
3 = Bimetal
4 = Stator
4a = Armature support portion
4b = Support portion
4c = Support portion
4d = Latch portion
6 = Armature
6a = Movable portion
6b = Arm portion
6c = Arm portion
6d = Operating portion
6e = Engagement portion
6f = Engagement portion
6g = Bent portion
6h = Cutaway portion
6i = Latch portion
7 = Return spring
8 = Lead-out terminal
9 = Flexible conductor
10 = Connecting conductor
11 = Trip bar
12 = Power source side terminal
13 = Fixed contact
14 = Movable contact
15 = Armature holder
16 = Operating handle
17 = Trip mechanism portion

Claims

1. A short circuit current detection device for a circuit breaker, including:

- a conductor (2) fixed in a case;
- a stator (4) attached integrated with the conductor; and
- an armature (6), disposed facing the stator across the conductor, which turns based on a short circuit current flowing through the conductor, **characterized in that** the armature includes a movable portion (6a) facing the stator, at least one pair of arm portions (6b,6c) extending from the movable portion, and an operating portion (6d) which activates a trip bar (11), and
in that the stator (4) includes an armature support portion (4a), extending to the armature side from one end portion of the stator (4), which engages with and fulcrum supports the arm portions (6b, 6c) of the armature (6).

2. The short circuit current detection device for a circuit

breaker according to claim 1,
characterized in that the armature support portion (4a) includes engagement portions (4b, 4c) which engage with the arm portions (6b, 6c) of the armature (6), and
in that the armature (6) is fulcrum supported by the engagement portions (4b, 4c).

3. The short circuit current detection device for a circuit breaker according to claim 1,
characterized in that the armature support portion (4a) has a cantilever shape, and is formed integrated with the stator (4).

4. The short circuit current detection device for a circuit breaker according to claim 1,
characterized by not having a current path inside a closed curve formed by the stator (4), armature (6), and armature support portion (4a) bringing them into engagement.

FIG.1

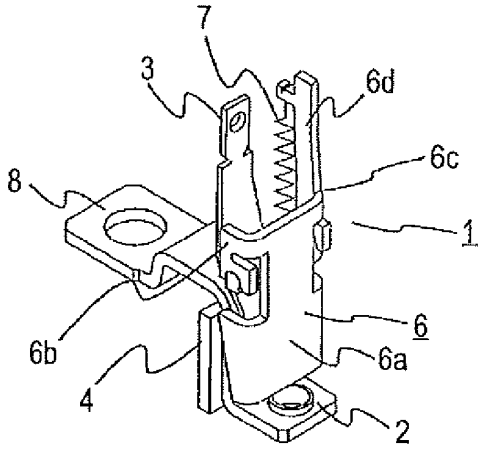


FIG.2

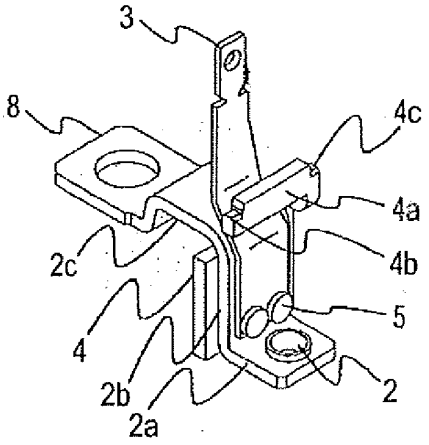


FIG.3A

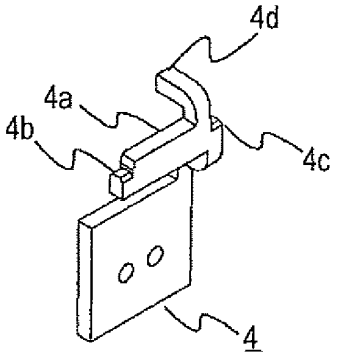


FIG.3B

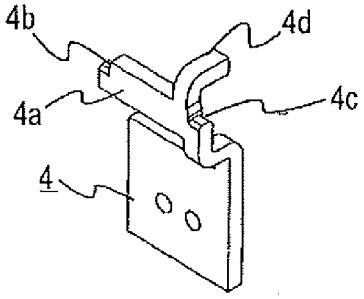


FIG.4

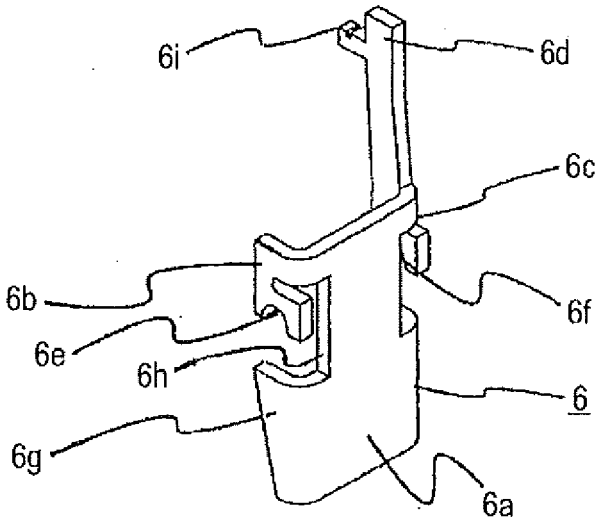


FIG.5

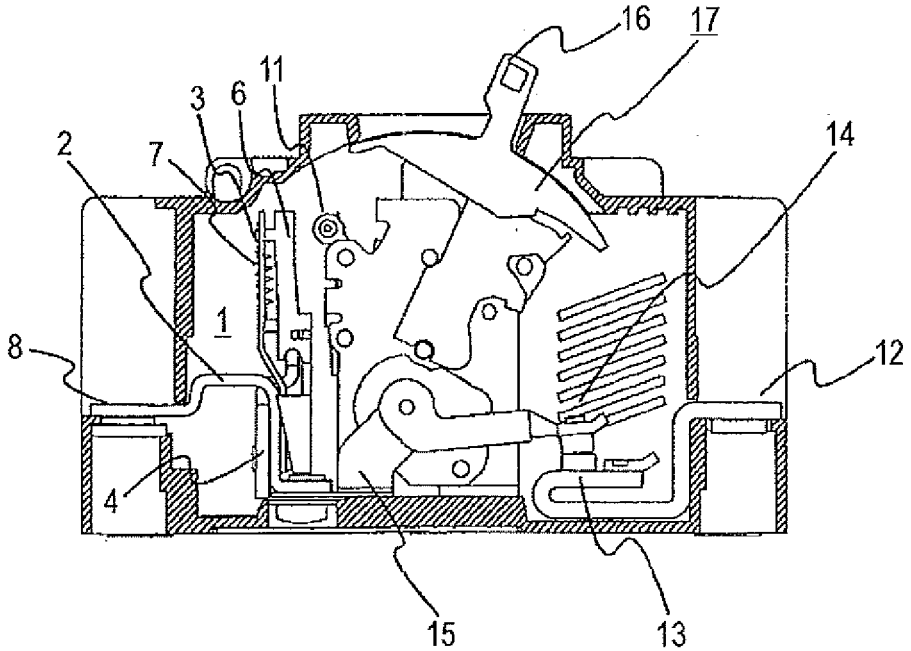
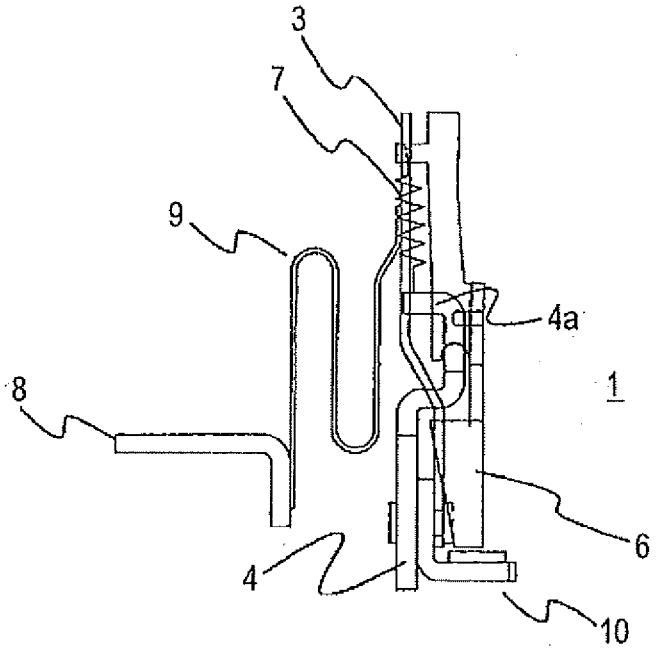


FIG.6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/056774

A. CLASSIFICATION OF SUBJECT MATTER
H01H73/22(2006.01)i

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)
H01H73/22, H01H73/36, H01H73/40, H01H73/50

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 1996-2008
Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 79800/1989(Laid-open No. 19236/1991) (Fuji Electric Co., Ltd.), 26 February, 1991 (26.02.91), Full text; Figs. 1 to 4 (Family: none)	1-4
A	JP 9-50754 A (Kawamura Denki Sangyo Kabushiki Kaisha), 18 February, 1997 (18.02.97), Full text; Figs. 1 to 4 (Family: none)	1-4

☒ 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
17 April, 2008 (17.04.08)	01 May, 2008 (01.05.08)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/056774

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 9-7490 A (Matsushita Electric Works, Ltd.), 10 January, 1997 (10.01.97), Full text; Figs. 1 to 22 (Family: none)	1-4
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 158963/1979(Laid-open No. 75454/1981) (Matsushita Electric Works, Ltd.), 19 June, 1981 (19.06.81), Full text; Figs. 1 to 2 (Family: none)	1-4
A	JP 4-280027 A (Fuji Electric Co., Ltd.), 06 October, 1992 (06.10.92), Full text; Figs. 1 to 9 (Family: none)	1-4

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000231870 A **[0007]**
- JP 10283899 A **[0007]**